Original Research

The Influence of Meta-Cognitive Listening Strategies on Listening Performance in the MALL: The Mediation Effect of Learning Style and Self-Efficacy

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Abstract

The ability to understand listening is an essential skill for non-native speakers of English as a foreign language (EFL). Research has shown that several factors can influence EFL students' English listening comprehension, including the listening strategy they use during listening activities. This study, therefore, used the meta-cognitive listening strategy to explore the mediation role of learning style and self-efficacy in the relationship with listening performance. In this study, 632 Chinese university students participated in a survey and completed electronic questionnaires on MALQ (Meta-cognitive Awareness of Listening Questionnaire), PLSPQ (Perceptual Learning Style Preference Questionnaire), and GSE (General Self-Efficacy Scale). The data were analyzed using AMOS software and a structural equation modeling (SEM) technique. The results showed that students' listening strategy directly and positively predicted their English listening performance. Moreover, students' listening performance was fully mediated by learning style and self-efficacy. After discussing these findings, suggestions as well as limitations for future studies will be given. The findings of this study are expected to contribute to a better understanding of the factors that may affect EFL students' English listening comprehension and inform instructional practices in the EFL classroom. Specifically, the results of this study may suggest the use of teaching strategies tailored to individual learning styles and the adoption of measures to improve self-efficacy of EFL students. Ultimately, the goal of this research is to improve EFL students' English listening comprehension skills and enhance their overall language proficiency.

Plain Language Summary

This study examined the effects of meta-cognitive listening strategies on the listening performance of English as a foreign language (EFL) students in a mobile-assisted language learning (MALL) environment. The study also looked into the role of learning style and self-efficacy as mediators in this relationship. Data was collected from 632 Chinese university students through surveys and questionnaires. Analysis of the data revealed that students who used meta-cognitive listening strategies had better English listening performance. Furthermore, learning style and self-efficacy played a mediating role in the relationship between listening strategy and performance. The findings suggest that tailoring teaching strategies to individual learning styles and boosting self-efficacy can improve EFL students' English listening comprehension skills. It is hoped that this research contributes to a better understanding of factors influencing EFL students' listening

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comprehension and informs instructional practices in the EFL classroom. However, the study has limitations, such as a limited sample size and the use of self-report questionnaires, which may introduce subjectivity and bias. Future research could address these limitations by expanding the sample size and incorporating objective measurement tools.

Introduction

Research Background

The quick rise of mobile learning in the field of digital learning is facilitated by the quick development of information technology and the widespread use of mobile devices. The mobile-assisted language teaching that emerged in the 1980s and 1990s has expanded to the field of new mobile technologies, and has formed a new learning model in foreign language subjects, namely: mobile technology-assisted language learning (MALL) system (Lin & Lin, 2019; Torsani, 2016). The system utilizes mobile devices and apps to facilitate language learning outside of traditional classroom settings. In the field of language learning, listening skills play a vital role in understanding and communicating. However, many learners encounter difficulties in improving their listening skills and often struggle to understand spoken language and retain information accurately. (Alqahtani, 2015; Flowerdew & Miller, 2005; Richards, 2008).

For foreign language learners, listening comprehension is a very complex cognitive processing program, which may be affected by many aspects (Gilakjani & Ahmadi, 2011; Goh, 2000). Based on the background of mobile technology-assisted language learning, this paper will explore the influence of listening strategy on English listening comprehension. Listening comprehension is an important part of learning a foreign language, at the same time learning style is also a new and important idea. In past studies, many researchers found that learning styles are also related to individual attention and memory strategies. Visual learners may encounter difficulties in processing speech information, which may be related to their better processing of image and text information (Lange & Costley, 2020; Mayer & Moreno, 2003). At the same time, auditory learners are more likely to extract information from sounds and convert them into meaning (Syodorenko, 2010). The development of humanistic psychology makes the research value of educational emotional factors gradually increase (Dash & Dash, 2007; Jarosz et al., 2019; Szyszka, 2017).

Some scholars believe that self-efficacy is one of the biggest emotional factors in second language learning (Alnuzaili & Uddin, 2020; Marcos-Llinás & Garau, 2009). Consequently, since the 1970s, when the idea of foreign language self-efficacy was originally established, self-efficacy has gradually grown in popularity in the field of English acquisition research.

In recent years, researchers have combined listening anxiety, self-efficacy, listening motivation, listening strategies, meta-cognitive awareness and other factors to explore their relationship with English listening performance (Alnuzaili & Uddin, 2020; Cha, 2006; D. Y. Chan & Wu, 2004; Chow et al., 2018; Dalman, 2016), but the influence of learning style and self-efficacy on listening comprehension has not been as frequently studied. This is a clear research gap and therefore, this study mainly studies the influence of listening strategies on English listening performance through the mediating role of learning style and self-efficacy, hoping to provide some practical suggestions for the implementation of college English teachers' listening teaching and the improvement of students' listening.

There are important theoretical and practical significance in exploring the influence of meta-cognitive listening strategies on listening performance in the context of MALL. First, this study could contribute to a deeper understanding of the application of meta-cognitive listening strategies in MALL settings. By analyzing the use of different meta-cognitive listening strategies and their relationship with listening performance, we can reveal how learners can effectively use meta-cognitive listening strategies to improve their listening ability in a MALL environment, and provide guidance and suggestions for language learners and teachers.

Secondly, studying the mediating effect of meta-cognitive listening strategies on listening performance can provide insights into the mechanism of learning style and self-efficacy in this process. Learning style is an individual's tendency and preference in learning, while self-efficacy is an assessment of an individual's confidence and ability to complete a specific task. By understanding the mediating role of learning style and self-efficacy between meta-cognitive listening strategies and listening performance, we can gain insight into the influence of individual differences on the application of meta-cognitive listening strategies and listening performance, so as to optimize language learners' listening training.

Literature Review

MALL

In today's world, network information technology is changing with each passing day, and mobile Internet means are becoming more and more mature. Mobile-assisted language learning has become another growth point for foreign language education theory and practice to seek breakthroughs and achieve innovation under the background of developments in educational information (Alnuzaili & Uddin, 2020; Beatty, 2013; Cakmak, 2019; Cha, 2006; D. Y. Chan & Wu, 2004).

In recent years, MALL has always been concerned and valued by the majority of foreign language education researchers. The academic circles in China have successively reviewed the current situation, themes and contents of MALL research from multiple perspectives such as mobile learning theory, educational technology and linguistics, and explored the future development trend of Chinese foreign language education in the MALL environment (Beatty, 2013; Deng, 2022; Nguyen, 2018). Since around 2008, mobile learning has gradually matured, and has become another theoretical and practical research hot spot after E-learning (Abu-Al-Aish, 2014; Qu, 2021; Yuan, 2022). Relying on the substantial improvement and optimization of mobile technology, MALL research has begun to be independent of traditional language classroom learning and computer-assisted language learning (CALL), opening the road of language education reform and innovation based on mobile learning related theories and achievements. Through further analysis of the literature, it can be seen that the theories associated with the hot topic of "Mobile Learning" include constructivism, contextual learning, informal learning and collaborative learning from the perspective of pedagogy as well as structuralism, social cognitivism, conversation theory and activity theory from the perspective of linguistics (N. N. Chan et al., 2013; Panadgoo, 2022; Yakar et al., 2020).

The research content of this study mainly includes three aspects: "educational technology," "language teaching content and process" and "language teachers and learners." Computer-assisted language learning (CALL) is to carry out language teaching in the application of computers, realize the organic unity of teachers, students and computers, and is an innovative supplement to traditional foreign language teaching (González-Lloret & Ortega, 2014). The teaching environment of CALL is the most common multimedia courseware demonstration in the classroom. Computers assist teachers to present teaching materials, and students acquire foreign language content through human-computer interaction, but they still tend to be limited by teacher centered instruction.

With the popularization of wireless communication technology and mobile terminal equipment in China, CALL is expanding toward mobile technology-assisted foreign language teaching (MALL) step by step. Priyanti et al. (2019) pointed out that mobile learning has the characteristics of mobility and contextuality, and it is a brand-new learning technology and learning method. Mobile learning enables learners to use the network and terminal devices to obtain relevant information, resources or services at any place and any time according to their own needs, so as to make full use of the spare time to improve themselves. The learning in MALL background requires learning materials in the following two characteristics (1) The learning materials should be short and concise to meet the requirements of the mobile learning terminal; (2) The learning material should be practical and refined to meet the actual learning purpose of learners to solve problems.

The mobility of foreign language learners and the mobility of handheld devices have contributed to mobile learning in the language subject area. Compared with CALL, MALL has the advantages of high flexibility of mobile technology, low cost, small size, and user-friendliness (AbuSa'aleek, 2014; Marcos-Llinás & Garau, 2009; Persson & Nouri, 2018), and has the advantage of carrying multi-modal teaching content. MALL can encode voice, text, video and other information, which is convenient for teachers to carry out personalized and multi-modal foreign language teaching.

Meta-Cognitive Listening Strategy

Meta-cognitive listening strategies refer to the ability of individuals to monitor, regulate and adjust their own cognitive processes in listening tasks (Pintrich, 2002; Yang, 2009). By using effective meta-cognitive listening strategies, individuals can improve the efficiency of listening comprehension and information processing. First, studies have shown that meta-cognitive listening strategies are crucial for learners' listening comprehension (Bourdeaud'hui et al., 2021; Cao & Lin, 2020; Robillos & Bustos, 2022). The effectiveness of meta-cognitive listening strategies is also affected by task characteristics and individual differences. The study found that different types of listening tasks may require the use of different meta-cognitive strategies (Chero, 2023; Ghahri & Zarei, 2022).

The study also found that educational interventions and training have a positive effect on improving learners' meta-cognitive listening abilities (Arsyad & Villia, 2022; Milliner & Dimoski, 2021; Mitsea & Drigas, 2019). Through targeted training and practice, learners can learn to use appropriate meta-cognitive listening strategies and apply them in practical listening tasks. This type

of intervention and training can improve learners' listening comprehension and information processing skills and enhance their learning outcomes. For example, Robillos and Bustos (2022) attempted to investigate whether instruction of meta-cognitive strategies combined with instructional cycles could improve listening comprehension performance and their listening meta-cognitive awareness in 27 Thai EFL students. It put out teachers can help learners develop and use meta-cognitive listening strategies by cultivating learners' meta-cognitive awareness and providing appropriate listening tasks and strategic guidance. In addition, the application of technological tools also provides new possibilities for the cultivation and practice of meta-cognitive listening strategies, such as the use of speech recognition software for listening training and feedback.

The researchers have also paid attention to some factors that affect the use of meta-cognitive listening strategies by learners (Maftoon & Fakhri Alamdari, 2020; Milliner & Dimoski, 2021; Namaziandost et al., 2020). One of the most important factors is the learner's level of meta-cognitive awareness. Learners have a clear understanding of their own cognitive process and strategy application, and can better choose and adjust appropriate listening strategies. In addition, learners' language ability, task difficulty and personal interests will also affect the use of meta-cognitive listening strategies.

Although some achievements have been made in the study of meta-cognitive listening strategies, there are still some challenges and issues that need further exploration. For example, how to apply meta-cognitive listening strategies to different language learning environments and cultural backgrounds, and how to evaluate the impact of different meta-cognitive listening strategies on learners' listening comprehension ability, etc.

Learning Style

Language learning style is the product of the combination of cognitive psychology research and linguistics research. It refers to a relatively stable cognition and processing style displayed by language learners during the learning process. In the early stage of language learning style research, researchers believed that some learning styles were beneficial to learning, while others hindered learning (AbuSa'aleek, 2014; Ehrman & Oxford, 1990). Therefore, the purpose of their research was to discover the relationship between learning style and the success or failure of language learning, hoping to find out a good learning style and promote it. But later researchers generally realized that learning style is neutral, there is no good or bad. Each learning style has its strengths and limitations, and there is no perfect learning style (Kamińska, 2014; Keshavarz & Hulus, 2019). Therefore, there are

two main points in the study of learning style. One is to help learners recognize their own learning style, adjust according to learning needs, give full play to the strengths of their own learning style, and overcome its limitations by expanding their own learning style. The other is to help teachers identify students' learning styles and adopt corresponding teaching strategies accordingly.

Through literature review, it is found that there are different classification standards for learning styles, and the main ones are as follows: First, field-independent/field-dependent research proposed by psychologist Witkin et al. (1954). In English learning, field-independent learners tend to analyze and solve problems independently, so their grammar scores and reading scores are higher than field-dependent learners. On the contrary, field-dependent learners like to communicate and communicate with others, so their listening and oral expression skills are higher than field-independent learners. The second is Reid's research on perceptual learning style. Reid (1987) divides learners into visual, auditory, kinetic, tactile and group learners according to their preferred learning style. There are six categories including group-oriented and individual-oriented. Fleming (1995) uses his VARK scale to test students' learning style for experimental data research. The learning style theory put forward by Fleming divides learners into four types: visual, auditory, reading/writing and Kinesthetic. These types represent the way an individual acquires, processes, and remembers information (Fleming, 2012).

Fleming believes that people usually have a clear preference for one or more learning styles, and educators need to use different teaching methods in the classroom to meet the needs of students with different learning styles. Some studies, for example, have found that visual students perform worse on English listening tests, while kinesthetic students perform better on phonemes and sentence comprehension (B. J. Lee, 2022; Naning & Hayati, 2011). However, other studies have found the difference, finding that auditory students perform best in English listening tests, while visual students perform the worst (Willingham, 2005).

In addition, some studies have also found that perceptual students perform better in overall understanding, while rational students perform better in partial understanding (Aleven & Koedinger, 2002; Chiu & Wang, 2008) At the same time, the results of another study showed that the listening performance of kinesthetic students is significantly better than that of the other two types of students and the use of images and videos in listening training can further improve their listening skills (Drago & Wagner, 2004; Mulyadi et al., 2017).

Numerous studies have shown that students with high academic performance have different learning styles from students with low academic performance (Demirbas &

Demirkan, 2007; Kvan & Jia, 2005; Wilkinson et al., 2014). Guild (1994) also found that when conducting research on college students, students with different grades have different learning styles. Myers (2006) found in the research that students with different learning styles have different academic performance

Despite the potential in learning styles research, contemporary research in neuro and cognitive sciences, exemplified by the work of Kirschner (2017) and others, challenges the notion that individuals possess distinct and consistent learning styles that significantly impact their learning outcomes. Critics argue that the concept of learning styles, which categorizes individuals into visual, auditory, or kinesthetic learners, lacks empirical support and scientific grounding. They maintain that there is insufficient evidence to substantiate the claim that tailoring instruction to match an individual's supposed learning style enhances learning outcomes. Instead, learning is seen as a complex, multifaceted process influenced by various factors beyond a singular learning style classification.

Although the validity and significance of learning styles is debated, it remains relevant in education and research. Including learning styles as a variable in the study provides several justifications: its historical significance in shaping instructional strategies, the influence of participant perceptions and self-identification on learning experiences, practical implications in accommodating diverse learning preferences, and its exploratory nature in contributing to scholarly conversations and guiding future research or instructional practices.

Self-Efficacy

Self-efficacy is the core concept in the social learning theory proposed by the famous American psychologist Bandura. Bandura (1982, 2006) believed that human behavior, thinking patterns and emotions are not only affected by the results of behavior, but also by the expectations of self-behavior ability and behavior results. Self-efficacy refers to the self-belief and confidence held by an individual to complete a specific task (Ueki & Takeuchi, 2013), which can regulate individual agency by affecting individual choice, effort, anxiety, and perseverance in the face of challenges and new tasks (Bandura et al., 1999; Pajares, 2003). A large number of empirical studies have proved that self-efficacy is an important factor affecting learners' language proficiency and can significantly predict learners' foreign language academic achievement (Raoofi et al., 2012; Tilfarlioglu & Ciftci, 2011; Zheng et al., 2017).

The research field of self-efficacy mainly includes the following aspect which includes the aspects of academic performance and attitude. Researchers explored the relationship between students' beliefs about their abilities in English language learning and their academic

performance. Students with high self-efficacy tend to show better academic performance (Cobo-Rendón et al., 2020; Yokoyama, 2019). According to Lane and Lane (2001), results showed that stable self-efficacy measures were associated with 11.5% of performance variance with "confidence to cope with the intellectual demands of the program as the only significant predictor". In addition, some scholars have found that self-efficacy affects their learning motivation and learning attitude. Students with high self-efficacy usually have more positive learning motivation and more persistent learning efforts (Rafiola et al., 2020; Shin, 2018; Torres & Alieto, 2019). According to Shin (2018), it was observed that students with low self-efficacy tended to avoid challenging class activities, while those with high self-efficacy were more inclined to embrace such challenges.

The researchers explored the relationship between students' self-efficacy and their language anxiety level in the process of language learning. Lower self-efficacy may be associated with higher language anxiety (Bárkányi, 2021; Rafiola et al., 2020). Bárkányi (2021) puts that learners with intrinsic motivation are more likely to complete the courses than those who sign up to manage a personal situation or advance in their career or studies. Learners present higher self-efficacy beliefs at the end of the courses than at the beginning, while anxiety levels are affected to a much smaller degree by course completion. Although spoken interactions in this learning environment are not synchronous, apprehension and anxiety prevent many learners from fully participating in the speaking activities. In addition, there are some papers on self-efficacy and the use of learning strategies, as well as self-efficacy and cross-cultural communication. The research found that students' self-efficacy will affect their choice and use of different learning strategies (Akamatsu et al., 2019; Hayat et al., 2020; D. Lee et al., 2020; Ömer & Akçayoğlu, 2021). Students with high self-efficacy tend to use active and effective learning strategies. Higher self-efficacy may also help students to confidently participate in cross-cultural communication and overcome language barriers (Charoensukmongkol & Pandey, 2020; Klassen, 2004; Wang et al., 2018; Yada et al., 2019).

Although there have been studies focusing on the impact of listening strategies on academic performance, it is a relatively new research direction to explore the impact of listening strategies on listening performance by using learning style and self-efficacy as mediating variables. This research can provide a more comprehensive understanding of how listening strategies affect academic performance through learning styles and self-efficacy during listening activities. For example, certain listening strategies may be better suited to specific learning styles and, by enhancing self-efficacy, further improve academic performance. This research design can also help educators

and students understand how to choose the most effective listening strategies based on their own learning style and self-efficacy to improve academic performance.

Methodology

Research Design

This study investigates the impact of listening strategy on students' English listening performance in mobile-assisted English listening classes. The study employs quantitative research methods, conducted in three stages. In the first stage, students' listening strategy, learning style and self-efficacy were assessed using scales and questionnaires to obtain data. The second stage involves an English listening test with mobile technology support, mainly using the Chaoxing app for online testing. In the third stage, SPSS22 and AMOS software is used for data analysis.

Participants

The experimental sample consists of 632 students majoring in Education, Science and Business from two Universities in Anhui, China. Before the experiment started, the students signed the informed consent form and informed the purpose and conditions of the experiment. The classes were formed based on the results of the college entrance examination, and a quasi-experimental design was adopted for this research. It is important to note that all students participated voluntarily and provided their consent by signing an agreement. The recruitment period for this study began on August 1, 2022, and concluded on November 31, 2022. 632 students from the two universities jointly took English news listening and were randomly arranged into 15 classes.

Instrumentation

This article was approved by the Taylor's University Ethics Committee prior to data collection. There are four experimental tools involved in this paper which are listed below: MALQ (Meta-cognitive Awareness of Listening Questionnaire), PLSPQ (Perceptual Learning Style Preference Questionnaire), and GSE (General Self-Efficacy Scale), the online News English listening test. The following will introduce the experimental tools in detail from several aspects.

MALQ. MALQ (meta-cognitive Awareness and Learning Questionnaire) is a self-report instrument used to assess meta-cognitive awareness and strategies in the context of learning which are developed by Vandergrift et al. It measures individuals' knowledge and understanding of their own cognitive processes, as well as their ability regulate and control their learning. The instrumentation of MALQ involves administering a questionnaire to individuals to gather information about their meta-cognitive awareness and strategies. The questionnaire typically consists of multiple-choice or 5 Likert scale items that assess various aspects of meta-cognition, such as monitoring, planning, evaluating, and regulating one's learning (Vandergrift et al., 2006).

PLSPQ. This survey adopted Reid's (1987) Perceptual Learning Style Preference Questionnaire, which contains 30 questions in total and is divided into six dimensions, namely, group activity type, individual activity type, visual type, auditory type, tactile type and dynamic type. The question options are divided into five grades, from "completely disagree" to "completely agree." Students are required to answer according to the actual situation.

GSE. GSE (General Self-Efficacy Scale) is a tool used to assess an individual's confidence in their own abilities and self-efficacy. There are 10 questions in the questionnaire. In order to unify the three questionnaires, the five-level Likert scale is used for scoring: from "strongly disagree" to "strongly agree."

News English Listening Test. This study examines the effectiveness of a News English listening course from the "Listening to the News" third edition textbook, published by Foreign Language Teaching and Research Press. The selected textbook is designed with a focus on practicality, knowledge expansion, and application ability, which will help learners improve their English skills while also enhancing their overall quality of understanding. The Voice of America (VOA), British Broadcasting Corporation (BBC) original recordings are used in this course, utilizing both British and American accents to ensure a diverse learning experience. To address multimodal teaching needs, a variety of exercises are designed, and the latest mobile technology is incorporated through the Chaoxing software mobile platform. This platform provides students with interactive resources including text, audio, graphics, and pictures, allowing them to complete various multi-modal tasks. The first unit focuses on current affairs news, which has the unique characteristics of interactivity, and information volume, making it an excellent channel for college students to understand politics, culture, and the world. In total, the listening test consists of four news paragraphs, two dialogue interviews, and two monologues, each lasting approximately 3 min. After listening comprehension, students are assessed through various types of exercises such as multiple-choice, fill-in-the-blank, and matching questions, with a total score of 100 points and a maximum completion time of 40 min.
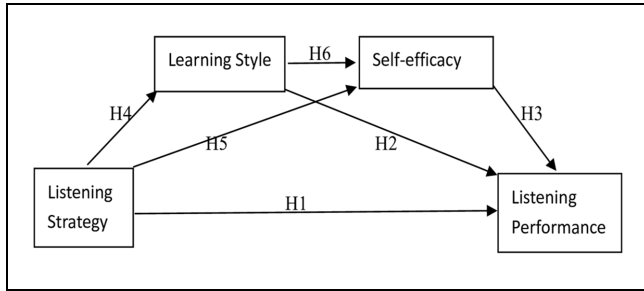
Figure 1. Mediation model of EFL listening process within MALL context.

Present Study and Hypothesis

With the rapid development of the mobile Internet and the popularity of smartphones, mobile-assisted language learning (MALL) has gradually become one of the important ways for learners to acquire language skills. MALL not only provides the convenience of language learning anytime and anywhere, but also provides learners with a variety of learning resources and communication platforms. In a MALL environment, listening skills is one of the key abilities for learners to obtain language input, understand language information, and communicate effectively with others. However, even in a MALL environment, learners still face various challenges when facing complex listening tasks. In order to better cope with these challenges, learners can use meta-cognitive listening strategies, that is, consciously manage and monitor their own listening process to improve listening performance. Meta-cognitive listening strategies include skills such as attention control, inference and prediction, and context utilization, which can help learners better understand listening materials, capture key information, and solve listening problems.

The present study explored the mediating mechanism of learning style and self-efficacy between listening strategy and listening performance within the MALL context. We proposed a multiple mediation model to investigate this (see Figure 1).

The following hypotheses will be tested with a sample of Chinese university students in EFL classes implementing multimodal teaching in the context of MALL. The following is the hypothetical model:

H1: Meta-cognitive listening strategies can positively affect listening performance
H2: Learning style can positively affects listening performance
H3: Self-efficacy can positively affect listening performance
H4: The effect of Listening strategy on listening performance is mediated by learning styles

H5: The effect of Listening strategy on listening performance is mediated by self-efficacy
H6: Learning style and self-efficacy play a chain mediating effect between meta-cognitive listening strategies and listening performance

Data Analysis

The study employed a hypothetical research model characterized as a chain mediation model, wherein listening strategies exert an impact on listening performance through a sequential mediation pathway involving learning style and self-efficacy. To scrutinize this model, AMOS28 was utilized for confirmatory factor analysis, aiming to ascertain convergent validity and discriminant validity. Subsequently, SPSS 22 was employed to assess common method bias, generate descriptive statistics, and conduct correlation analysis through the utilization of the Harman single factor test. Upon validating the reliability and validity of the data, a structural equation model was constructed, and the mediation effect was examined using the bias-corrected percentile bootstrap method. This methodology allows for the exploration of diverse mediation effect models across large, medium, and small sample sizes, enabling the estimation of more precise confidence intervals for the magnitude of the mediation effect.

Results

Descriptive Statistics and Reliability and Validity Test

The dependent variable examined in this study is the students' listening scores. To assess the normality of the data, a normality analysis was conducted using SPSS22. Table 1 below presents the normality test for the data.

The Shapiro-Wilk test statistic yielded a result of .996, indicating that the data followed a normal distribution. The sample size consisted of 632 participants. Moreover, the significance value (Sig) obtained from the analysis was .180, which exceeded the threshold of .05. Additionally, the average listening score was found to be 76.27, with a standard deviation of 6.956. These results confirm the adherence of the data to a normal

Table 1. Tests of Normality.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Score	.039	632	.022	.996	632	.180

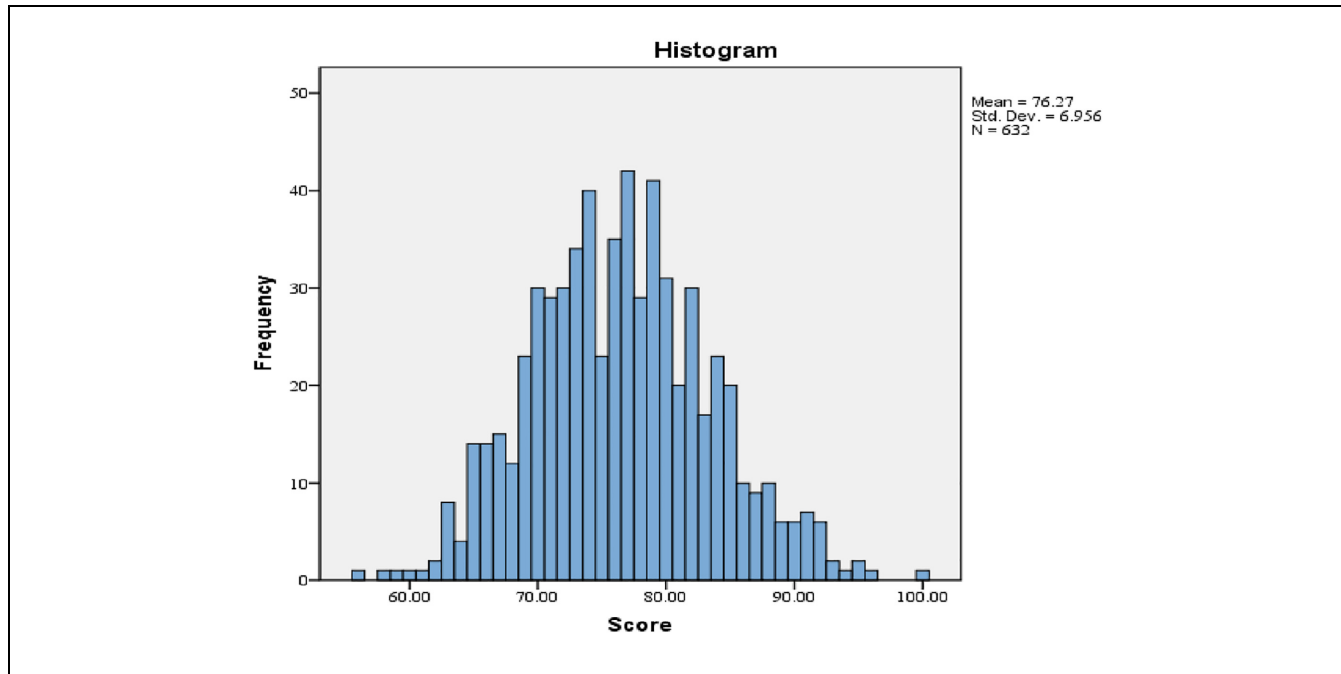*Note.* [a]Lilliefors significance correction.

Figure 2. Histogram.

distribution, thereby enabling its utilization for further research purposes.

In order to assess the reliability and effectiveness of the questionnaire, initial analysis involved examining the histogram and P-P diagram generated by SPSS software. Figure 2 below shows that the distribution of the questionnaire data appeared to approximate a normal distribution. Descriptive statistics, including mean and standard deviation, were computed for all research variables.

Reliability testing was performed using the internal consistency method. To assess convergent validity, standardized factor loading (SFL), combined reliability (CFR), and average variance extraction (AVE) were jointly examined (Hajjar, 2018). In accordance with established empirical standards, Cronbach's coefficient was used as a measure of reliability. A coefficient of .80 or higher was considered excellent, while values between .70 and .80 were deemed good. The minimum acceptable value ranged from .65 to .70, while coefficients below .65 were considered unqualified (Chatterjee, 2021). As such, Cronbach's coefficients exceeding .7 were considered acceptable in this study. Notably, all Cronbach's coefficients obtained from the questionnaire exceeded .8, indicating a high level of internal consistency within the sample data.

Convergent validity was assessed based on the requirement that the AVE value be greater than 0.5, along with a CR value exceeding 0.7. In this study, all AVE indicators surpassed 0.5, and the CR value exceeded 0.7.

Consequently, the scale exhibited good convergent validity.

To examine discriminant validity, the square root of the AVE for each variable was placed on the main diagonal of the table. Correlation coefficients between variables were listed on the left side of the main diagonal before subjecting them to the discriminant validity test. Table 2 showed us the scale discriminant validity test.

On the findings derived from the analysis of Table 2, it is evident that the square root of AVE of all variables surpasses the correlation coefficient observed within the respective column. Additionally, the correlation coefficient is also found to be below .8. These results suggest that each dimension exhibits superior discriminant validity.

Test of Common Method Biases

Common method bias (CMB) refers to the situation where all items are sourced from a single questionnaire, leading to potential artificial covariation between predictor and criterion variables, thereby enhancing the reliability of empirical findings. In this study, Harman's single factor test was employed to evaluate the extent of common method bias. To achieve this, measurement items from all study variables were combined, and factor analysis was conducted to examine the unrotated component matrix. The factor analysis yielded 12 factors, which align with the 12 dimensions of the study. The first factor accounted for 29.795% of the variance, which is below

Table 2. Scale Discriminant Validity Test.

Item	Aud	Kin	Coo	Vis	Exp	Ind	GSE	Pla	Dir	Per	Men	Pro
Aud	0.86											
Kin	0.47**	0.85										
Coo	0.48**	0.48**	0.87									
Vis	0.45**	0.49**	0.5**	0.86								
Exp	0.49**	0.5**	0.52**	0.5**	0.84							
Ind	0.45**	0.45**	0.49**	0.5**	0.55**	0.86						
GSE	0.25**	0.32**	0.36**	0.3**	0.33**	0.3**	0.87					
Pla	0.19**	0.26**	0.27**	0.24**	0.24**	0.22**	0.33**	0.86				
Dir	0.16**	0.26**	0.26**	0.2**	0.25**	0.18**	0.29**	0.47**	0.85			
Per	0.17**	0.24**	0.25**	0.19**	0.19**	0.17**	0.3**	0.52**	0.47**	0.88		
Men	0.16**	0.21**	0.2**	0.22**	0.2**	0.22**	0.31**	0.46**	0.47**	0.47**	0.86	
Pro	0.21**	0.26**	0.27**	0.21**	0.24**	0.26**	0.33**	0.5**	0.47**	0.45**	0.41**	0.87

The values marked with ** indicate that the square root of AVE(Average Variance Extracted) of each construct exceeds the correlations between constructs, thus demonstrating discriminant validity.

the threshold of 40%. Moreover, the variance explained by the first common factor in the exploratory factor analysis was also below 40% (Meade et al., 2007). Consequently, the issue of common method bias within this questionnaire is not severe, and the empirical analysis outcomes derived from the sample data can be considered reliable.

Hypothesis Testing

Drawing upon the theoretical framework, this study proposes the following model: the dependent variable, Score, is influenced by the independent variable, MALQ, as well as the mediator variables, PLSPQ and GSE. These mediator variables operate in a sequential manner, forming a chain mediation model. Specifically, the relationship between MALQ and Score is mediated by the sequential influence of PLSPQ and GSE.

Goodness of Model Fit and Mediation Effect Test

Utilizing the initial conceptual model depicted in Figure 1, the present study employed structural equation modeling (SEM) through the Amos software to examine the causal relationships between variables. This approach enabled the estimation of path coefficients and the assessment of model fit for each variable's impact on the dependent variable, Score. The goodness of fit indices for all models fell within the expected range according to theoretical values. Regarding the theoretical hypotheses, H1 postulated a positive direct effect of the independent variable, MALQ, on the dependent variable, Score. The analysis yielded a path coefficient of 3.505, with a *p*-value of .000 (below the significance threshold of .05), indicating a significant positive effect. Thus, H1 was confirmed. Similarly, H2 proposed a positive indirect effect

of the mediator variable on Score. The analysis revealed a path coefficient of 3.088, with a *p*-value of .000, supporting a significant positive effect and confirming H2. Likewise, H3 suggested a positive indirect effect of the mediator variable, GSE, on Score. The analysis yielded a path coefficient of 2.483, with a *p*-value of .000, indicating a significant positive effect and confirming H3.

The remaining three indirect effects were also examined. The analysis indicated that the path coefficient for MALQ $\Rightarrow$ PLSPQ was 0.465, with a *p*-value of .000, suggesting a significant positive influence. Similarly, the path coefficient for MALQ $\Rightarrow$ GSE was 0.412, with a *p*-value of .000, indicating a significant positive effect. Lastly, the path coefficient for PLSPQ $\Rightarrow$ GSE was 0.390, with a *p*-value of .000, signifying a significant positive influence. Please refer to Table 3 for further details.

Based on the aforementioned analysis, the mediation effects can be summarized as follows:

The direct effect, representing the direct influence of MALQ on Score, was found to be 3.505. After conducting the Bootstrap 5000 Number of bootstrap samples test, the 95% BC confidence intervals were calculated as follows: LLCI 2.475, ULCI 4.797. Since these confidence intervals do not include 0, the impact is considered significant.

Moving on to the indirect effects, the analysis revealed the following results:

The indirect effect of MALQ $\Rightarrow$ PLSPQ had an effect size of 0.465, with a 95% confidence interval (CI) ranging from 0.343 to 0.617. These confidence intervals exclude 0, indicating a significant effect.

The indirect effect of MALQ $\Rightarrow$ GSE had an effect size of 0.412, with LLCI 0.248 and ULCI 0.597. Similar to

Table 3. Mediation Effect Model Test.

		PLSPQ		GSE		Score		Score	
		B	*p*	B	*p*	B	*p*	B	*p*
MALQ		0.465	0.000	0.412	0.000	6.414	0.000	3.505	0.000
PLSPQ		—	—	0.390	0.000	—	—	3.088	0.000
GSE		—	—	—	—	—	—	2.483	0.000
R^2		0.210		0.280		0.430		0.650	
Model fit summary	CMIN/DF < 5					1.112			
	RMR < 0.08					0.058			
	GFI > 0.9					0.910			
	NFI > 0.9					0.945			
	IFI > 0.9					0.994			
	CFI > 0.9					0.994			
	RMSEA < 0.08								

the previous effect, these confidence intervals exclude 0, signifying a significant effect.

The indirect effect of PLSPQ on GSE had an effect size of 0.390, with a 95% confidence interval (CI) ranging from 0.243 to 0.573. The confidence intervals exclude 0, indicating a significant effect.

The indirect effect of PLSPQ ⇒ Score had an effect size of 3.088, with a 95% confidence interval (CI) ranging from 2.063 to 4.278. These confidence intervals exclude 0, suggesting a significant effect.

Lastly, the indirect effect of GSE ⇒ Score had an effect size of 2.483, with a 95% confidence interval (CI) ranging from 1.793 to 3.206. Similar to the previous effects, these confidence intervals exclude 0, indicating a significant effect.

Considering the total effect, which represents the overall influence of MALQ on Score, the effect size was calculated as 6.414, with a 95% confidence interval (CI) ranging from 5.213 to 7.911. Since the confidence intervals do not include 0, the effect is considered significant. Please refer to Figure 3 for detailed information.

In line with theoretical hypothesis H4, PLSPQ was found to mediate the relationship between MALQ and Score. Through analysis, the mediating effect of MALQ ⇒ PLSPQ ⇒ Score was calculated as 1.436, obtained by multiplying the effect sizes of 3.088 and 0.465. The bootstrap test was conducted using 5000 resamples. Based on the analysis, the 95% bias-corrected (BC) confidence intervals were calculated as LLCI 0.946 and ULCI 2.136. Since these confidence intervals do not include 0, the mediation effect is considered significant, indicating partial mediation. The mediating effect accounts for 22.31% of the relationship, thus confirming H4.

Similarly, according to theoretical hypothesis H5, GSE was found to mediate the relationship between MALQ and Score. The analysis revealed a mediating effect of MALQ ⇒ GSE ⇒ Score, calculated as 1.022 by multiplying the effect sizes of 2.483 and 0.412. After conducting 5000 Number of bootstrap samples tests using Bootstrap, the 95% BC confidence intervals were determined as LLCI 0.572 and ULCI 1.607. Since these confidence intervals do not include 0, the mediation effect is considered significant, indicating partial mediation. The mediating effect accounts for 14.98% of the relationship, validating H5.

Moreover, theoretical hypothesis H6 proposed a chain mediation role for PLSPQ and GSE between MALQ and Score. The analysis revealed a mediation effect of MALQ ⇒ PLSPQ ⇒ GSE ⇒ Score, calculated as 0.450 by multiplying the effect sizes of 0.465, 0.390, and 2.483. After the Bootstrap 5000 Number of bootstrap samples test, the 95% BC confidence intervals were determined as LLCI 0.259 and ULCI 0.752. Since these confidence intervals do not include 0, the mediation effect is considered significant, indicating partial mediation. The mediating effect accounts for 7.02% of the relationship, confirming H6.

Examining the overall model, the total mediation effect size was calculated as 2.909, obtained by summing the mediating effects of 1.436, 1.022, and 0.450. After conducting the analysis, the 95% BC confidence intervals were determined as LLCI 2.293 and ULCI 3.694. Since these confidence intervals do not include 0, the total mediation effect is considered significant, indicating partial mediation. The total mediation effect accounts for 44.31% of the relationship. Thus, the established model demonstrates a chain mediation pattern. Please refer to Table 4 for more details.

Discussion

This study investigates the relationship and mediation mechanism between university students' listening
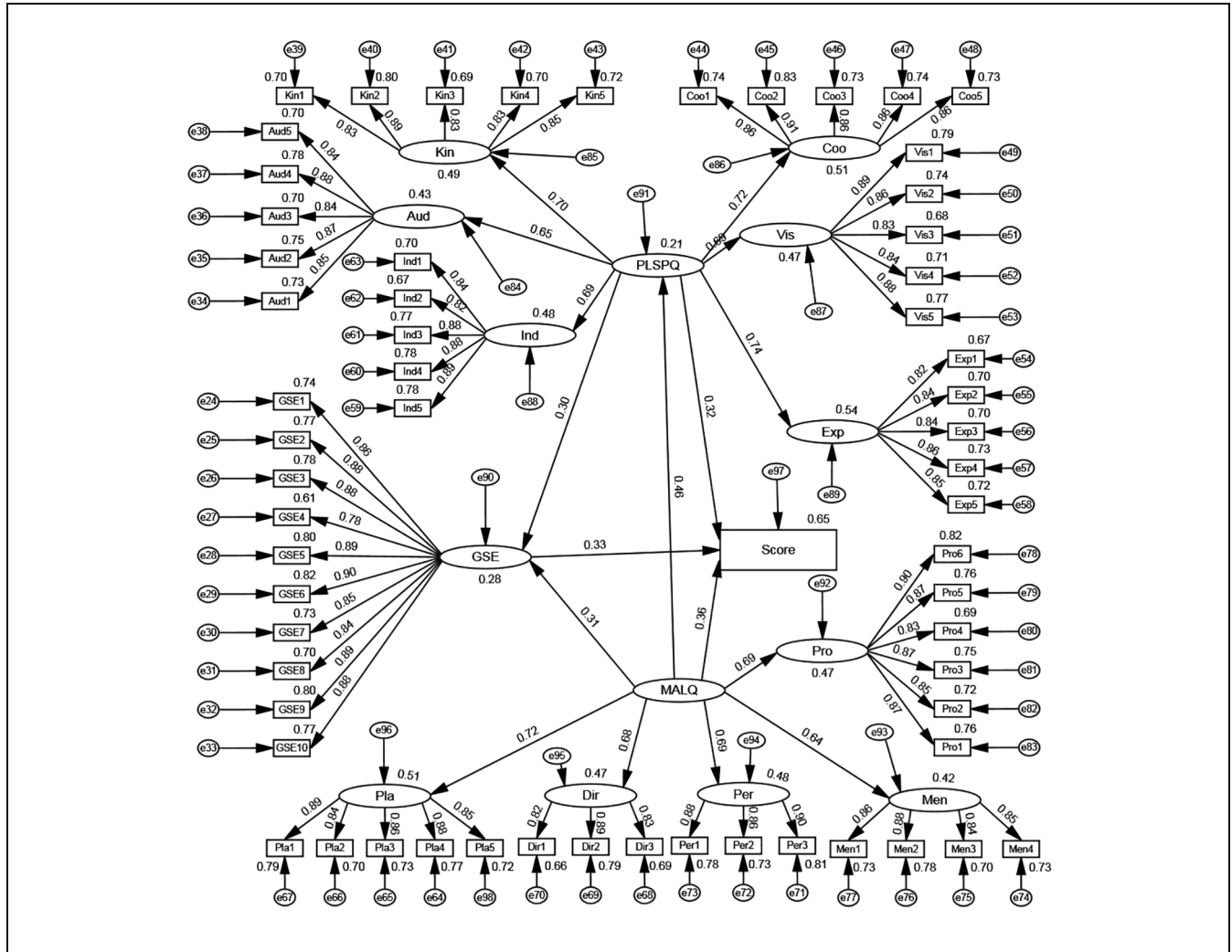
Figure 3. Mediating effect Analysis of MALQ ⇒ PLSPQ ⇒ Score Pathway.

Table 4. Results of Analysis of Chain Mediation Effects.

Item	Effect	Boot LLCI	Boot ULCI	p	Mediation type	Effect ratio (%)
MALQ ⇒ PLSPQ ⇒ Score	1.436	0.946	2.136	.000	Partial mediation	22.31
MALQ ⇒ GSE ⇒ Score	1.022	0.572	1.607	.000	Partial mediation	14.98
MALQ ⇒ PLSPQ ⇒ GSE ⇒ Score	0.45	0.259	0.752	.000	Partial mediation	7.02
Total mediation effect	2.909	2.293	3.694	.000	Partial mediation	44.31

Note. Boot LLCI refers to the lower limit of 95% interval of Bootstrap sampling, and Boot ULCI refers to the upper limit of 95% interval of Bootstrap sampling.

strategies and academic performance in the context of MALL. Introducing learning style and self-efficacy as the intermediary mechanism, few studies have explored the entire English learning process and mechanism of students from the perspective of learners. This study collected 632 students' English listening performance samples from Chinese universities, and used SEM

technology to study how listening strategies affect listening performance through the mediation role of learning style and self-efficacy.

First, our findings support Hypothesis H1, that meta-cognitive listening strategies have a positive effect on listening performance. This finding further emphasizes the importance of meta-cognitive listening strategies in

teaching and learning listening. By applying meta-cognitive listening strategies, students are able to actively monitor and regulate their own listening processes, including anticipating, generalizing, and inferring, to better understand and process listening material. This active learning approach enables students to more accurately capture key information and improve their performance in listening tests. In addition, the use of meta-cognitive listening strategies can also help students enhance their self-control over listening tasks and improve their learning motivation and self-confidence. Therefore, educators and students should pay attention to and actively cultivate students' ability to use meta-cognitive listening strategies, so as to improve their listening performance and learning effect.

Second, our findings also support Hypothesis H2, that learning style has a positive effect on listening performance. This finding highlights the importance of learning style in listening learning. Different students have different learning preferences and styles, and they tend to use learning methods that suit their own learning styles. By understanding their own learning styles and adopting corresponding learning strategies, students can understand and apply listening materials more effectively, and thus achieve better scores in listening tests. For example, visual learners may be better at understanding listening material through diagrams and images, while oral learners may be better at improving listening skills through oral exercises. Therefore, educators and students should pay attention to students' learning styles and provide corresponding learning resources and supports according to their needs to help them achieve better results in listening learning.

Our findings also verified Hypothesis H3, that is, self-efficacy has a positive effect on listening performance. This finding further emphasizes the importance of self-efficacy in listening learning. The results of the study showed that the more confident students were about their ability to successfully complete the listening task, the better they performed on the listening test.

Through increased self-efficacy, students develop trust and confidence in their own abilities to more positively face listening challenges. They will be more willing to accept listening exercises and exams, and more actively use listening strategies to understand and apply listening materials. This positive attitude and behavior helps improve their listening scores.

Our findings validate Hypothesis H4, that learning style plays a mediating role between meta-cognitive listening strategies and listening performance. This finding shed light on the importance of learning style in listening learning and further explains why meta-cognitive listening strategies have a positive effect on listening performance.

Through further analysis, we found that learning style played a mediating role between meta-cognitive listening strategies and listening performance. This means that learning style affects students' listening performance by affecting their use of meta-cognitive listening strategies. Specifically, learning styles may affect students' processing methods and strategy choices for listening materials. For example, visual learners may be better at understanding listening material through diagrams and images, while oral learners may be better at improving listening skills through oral exercises. Therefore, differences in learning styles lead to differences in students' selection and application of meta-cognitive listening strategies, thereby affecting their listening performance.

Our findings also validate Hypothesis H5, that self-efficacy plays a mediating role between listening strategies and listening performance. This finding reveals the importance of self-efficacy in listening learning and further explains why the use of listening strategies has a positive effect on listening performance.

This means that students' level of confidence in their ability to successfully complete the listening task affects their listening performance by influencing their choice and use of listening strategies. Specifically, the level of self-efficacy may affect students' attitudes toward listening challenges and their evaluation of their abilities, thereby affecting whether they actively use listening strategies and face listening problems. Students with higher self-efficacy are more likely to adopt proactive learning strategies, such as prediction, generalization and inference, so as to better understand and process listening materials and improve their listening scores.

Finally, our findings also support Hypothesis H6, that is, learning style and self-efficacy play a chain mediating effect between meta-cognitive listening strategies and listening performance. This finding reveals a complex interrelationship among learning style, self-efficacy, and meta-cognitive listening strategies, and further explains why learning style and self-efficacy have combined effects on listening performance.

Our findings revealed an interaction between learning styles and self-efficacy. Learning styles can affect students' assessment of their abilities and attitudes toward listening tasks, which in turn affects their self-efficacy. At the same time, self-efficacy will also affect students' confidence and enthusiasm in using meta-cognitive listening strategies. This interaction led to the joint influence of learning style and self-efficacy on students' use of meta-cognitive listening strategies.

Specifically, learning styles affect students' listening performance by influencing students' selection and application of meta-cognitive listening strategies. At the same time, self-efficacy also affects students' confidence and enthusiasm for meta-cognitive listening strategies,

thereby affecting listening performance. Therefore, the interplay between learning style and self-efficacy collectively affects students' listening performance when using meta-cognitive listening strategies.

Taken together, our findings provide insight into the factors influencing listening performance. Meta-cognitive listening strategies, learning styles and self-efficacy all have an important impact on students' listening performance. These findings help educators and students recognize key factors in improving listening performance and provide guidance for developing effective listening instruction strategies.

Implications and Limitations

Educators play a vital role in nurturing students' ability to utilize meta-cognitive listening strategies in their learning journey. It is crucial to teach various meta-cognitive listening techniques and provide relevant exercises and guidance, enabling students to actively monitor and regulate their listening processes. This includes skills such as anticipating, generalizing, and inferring. Furthermore, educators can enhance students' practical skills by encouraging the application of these strategies in listening tasks and offering timely feedback and support.

Additionally, educators should consider students' learning styles and provide appropriate learning resources and support tailored to their needs. By understanding students' learning styles, educators can offer suitable methods and strategies. For instance, visual learners can benefit from charts and images to aid their listening learning, while oral learners can engage in oral exercises to enhance their listening skills.

It is vital for educators to help students develop a sense of trust and confidence in their own abilities, thereby boosting their self-efficacy. Positive encouragement, along with providing successful learning experiences, can foster students' self-efficacy. Moreover, organizing relevant listening exercises and exams allows students to showcase their listening abilities, fostering further confidence.

Educators should recognize the interplay and relationship among learning styles, self-efficacy, and meta-cognitive listening strategies. Considering these factors holistically, they can design diverse teaching activities and tasks that cater to the learning needs and preferences of different students. Simultaneously, they can guide students in employing meta-cognitive listening strategies that align with their individual learning styles, ultimately enhancing their listening scores and overall learning outcomes.

While this study provided important information on the impact of meta-cognitive listening strategies, learning styles, and self-efficacy on English learners' listening performance, several research limitations remain. First, the sample was limited to students from two universities in China, so the results may not be generalizable, and the sample needs to be further expanded to obtain broader conclusions. Secondly, the study used a self-report questionnaire method, which may have the possibility of subjectivity and memory bias. Thirdly, this study faces limitations due to the ongoing debate surrounding the validity of learning styles as a research variable. Critics argue that the concept lacks empirical support and that tailoring instruction based on learning styles may not enhance learning outcomes. These arguments challenge the generalizability and reliability of associating specific listening performance outcomes with learning styles. Despite recognizing the debate, this study explores learning styles as a potential mediator, but caution should be exercised in interpreting the results, and future research may consider alternative frameworks or variables. Future research can be verified by combining objective measurement tools.

Conclusion

This study explored the influence of meta-cognitive listening strategies on English learners' listening performance in a mobile-assisted language learning environment (MALL), and the mediating role of learning style and self-efficacy. Through 632 Chinese college students participating in the survey and completing electronic questionnaires, AMOS software and structural equation modeling techniques were used for data analysis. The findings revealed that students' listening strategies directly and positively predicted their English listening performance. In addition, students' listening performance was partially mediated by learning style and self-efficacy. After discussing these findings, suggestions and limitations for future research are presented.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Tan Shaojie as the author of the research paper titled "The Influence of Meta-cognitive Listening Strategies on Listening Performance in the MALL: The Mediation Effect of Learning Style and Self-Efficacy," declare that there are no

conflicts of interest that could influence the outcome or interpretation of this study. We affirm that we have not received any direct financial support or benefits from any organization or individual that may have a financial or personal interest in the findings of this research. Moreover, we have not received any materials, funding, or other forms of assistance that may have influenced the design, execution, or reporting of the study. Our objective in conducting this research is solely to contribute to the field of education and enhance knowledge regarding the impact of meta-cognitive listening strategies on listening performance in MALL (Mobile-Assisted Language Learning), specifically exploring the mediating role of learning style and self-efficacy. We understand that maintaining scientific integrity is of utmost importance, and we have taken necessary precautions to ensure transparency and objectivity throughout the research process. Any potential conflicts that could arise have been adequately addressed to ensure the validity, accuracy, and impartiality of our findings.

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Data Availability Statement

The data that supports the findings of this study are openly available in the 4TU. ResearchData. The dataset, with the DOI: 10.4121/8c542faa-e880-485d-8b4d-bd30e5936da4.v1, can be accessed and downloaded.

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