

Adopting strategies of mobile technology for assisted learning performance in higher education in China

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ABSTRACT

Mobile technology, particularly mobile-assisted learning, has long been a rapidly growing and dynamic field. A prominent focus within this domain is the development and implementation of mobile learning applications and systems. The widespread adoption of mobile learning has led to the emergence of numerous applications, granting higher education students increased autonomy in leveraging mobile devices to support their academic performance. However, the abundance of available options has made the strategic selection and effective use of appropriate applications a pressing issue. This study employed a mixed-methods approach to investigate strategies for adopting mobile learning applications in Chinese higher education institutions—a context in which limited research has been conducted despite the ongoing technological transformation in mainland China. The findings revealed that academic major significantly influenced students' learning performance supported by mobile applications, primarily due to differing academic demands [$F(11, 289) = 1.788, p = .056, \eta^2 = 0.064$]. Learners' positive perceptions of mobile learning applications were found to be crucial to their assisted learning outcomes. Moreover, most students acknowledged the necessity of receiving guidance when selecting learning applications. Among the various forms of support examined, teacher recommendations were particularly valued. However, both in-class and out-of-class support remained insufficient. While online searches and social media offer some assistance, there is a strong preference among students for direct guidance from instructors. Furthermore, existing mobile learning applications do not fully meet the diverse needs of all learners. To address these challenges, this study proposes an eight-stage adoption strategy aimed at enhancing university students' learning performance through more effective use of mobile applications.

1. Introduction

In recent years, mobile devices have proliferated in daily life at an unprecedented pace, and their integration into educational contexts continues to grow steadily. Ahmad [1] defines mobile devices as technological tools designed to meet users' needs, particularly in enhancing educational purposes and supporting knowledge acquisition. Crompton [2,3] further emphasizes that mobile devices serve as tools to improve student achievement, with pedagogy playing a crucial role in determining how effectively these tools are utilized. The potential and application of mobile technologies in higher education have become a central focus of educational research and practice, especially in light of their widespread adoption. The new generation of mobile devices makes it possible for students to learn, collaborate, and share ideas with each other at any time and anywhere and has become an important educational technology component in higher education [4].

The rapid evolution of wireless technologies and the advancement of mobile applications in higher education have been remarkable. Krull and Duart [5] pointed out that mobile-assisted learning in higher education was a burgeoning and flourishing field at the time, with m-learning applications and systems being a major focus. Mobile learning applications can offer broader access to teaching and learning resources, potentially enhancing student performance and achievement. Prensky [6], Cui and Wang [7], Kizito [8], and Wang [9] asserted that the use of mobile applications in teaching and learning provided positive impacts, including increased student motivation and improved understanding.

However, the increasing accessibility of smartphones has significantly accelerated the integration of mobile learning applications within the Chinese educational landscape. According to the China Internet Network Information Center (CNNIC), as of early 2023, mobile internet users in China have reached over 1 billion, constituting a vast market for

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educational tech innovations [10,11]. Consequently, the adoption of appropriate mobile applications at different stages of learning to enhance academic performance has emerged as a pressing issue. Aresta et al. [12] found that pedagogical design and individual preferences are fundamental to the successful adoption of mobile applications. In the absence of specific strategies for leveraging these tools to support learning outcomes, mobile device usage may instead become a source of distraction.

This raises a critical question: which applications are most suitable for learners at particular educational levels or with specific academic needs? More importantly, what strategies can learners employ, and what types of support can they receive from more capable peers or instructors to make informed choices? Gangaiamaran and Pasupathi [13] emphasize the importance of aligning app selection with learner needs, while Zhang and Pérez-Paredes [14] argue that, given the limited strategic and technological knowledge of many self-directed learners, teachers should play an active role in recommending diverse technological tools, sharing cognitive strategies for their effective use, and guiding students in actively integrating mobile technology into their learning processes.

Moreover, several review studies on mobile technologies and applications in higher education reveal that the majority of research has been concentrated in a few countries. The countries with the most studies represented were the United States (26), United Kingdom (25), Taiwan (21), Spain (16), and Turkey (16) [5]. This distribution highlights a significant research gap in mainland China, where related investigations remain limited despite the country's rapid advancements in technology-enhanced learning and its numerous prestigious higher education institutions. Given this context, further research exploring the adoption strategies of mobile applications to support learning performance in Chinese higher education represents a timely and valuable contribution to the field.

2. Merits and controversy of mobile technology

Mobile technologies continue to attract new users at an unpredictable pace, offering enhanced capabilities and increasingly sophisticated functions across various domains. The very term "mobile" stands for "mobility" or the ability to move freely and easily from one place to another [13]. Bernacki, Greene, and Crompton [15] emphasize that mobile technologies have become essential tools in empirical research, as they demonstrate how learning facilitated by such devices can create new opportunities to directly influence learning processes and outcomes. Additionally, these technologies enable the collection of previously inaccessible data, thereby contributing to improved understanding and modeling of the learning process.

Researchers have frequently emphasized the merits of mobile technology in supporting both teaching and learning. For example, the educational benefits of mobile technology have been widely identified, including sustaining learning anytime, anywhere [16,17]. Albadry [18] further highlighted that mobile technology can serve as a valuable tool for learners, enabling them to facilitate their learning, communicate with others, explore diverse perspectives, access a variety of information sources, and engage with learning materials. In addition, mobile technology can offer feedback, promote learner autonomy, and help individuals take greater control over their learning processes in pursuit of academic goals. A review of the existing literature clearly suggests that mobile technology has the potential to significantly enhance learning efficiency in multiple dimensions.

Mobile technology plays a pivotal role in enhancing individual learning performance. A considerable number of studies concern the critical role of mobile technology in learning effectiveness and efficiency [19]. This integration of technology into learning fetched positive outcomes that resulted in effective learning [20]. The proliferation of mobile technology provides a myriad of opportunities to support learning and performance both inside and outside the classroom [21]. Beyond these frequently cited advantages, mobile technology has also been

linked to increased learning motivation, particularly among language learners. Lai et al. [22] emphasized the significant potential of mobile technology in supporting college students' language acquisition. A growing number of studies have explored the use of mobile technology in classroom settings, with findings suggesting that many university students are primarily driven by extrinsic motivation in these contexts.

However, there is ongoing controversy regarding the impact of mobile technology on student motivation. As Ushioda [23] noted, some students may not feel intrinsically motivated to use mobile devices for learning, a finding echoed in Calabrich's [24] research. Calabrich observed a notable amount of skepticism towards mobile-assisted learning, with some participants expressing a lack of enjoyment for mobile-based tasks and feeling self-conscious about their learning outputs being publicly accessible online. Consequently, students may face various challenges when integrating mobile technology into their learning experiences. While mobile technology may be a great boon if properly used for learning purposes [25], it is crucial to address the potential overwhelming effect of the vast array of available online resources. Calabrich [24] suggests that students should receive proper guidance to navigate these resources effectively, preventing feelings of overload. To facilitate a more positive learning experience enhanced by mobile devices, greater efforts should be made by both educators and researchers to provide clear instruction and support in how to leverage mobile technology effectively for learning.

3. Current development of mobile learning

According to Guild [26], mobile learning (m-learning) is defined as "an activity that allows individuals to be more productive when consuming, interacting, or creating information, mediated through a compact digital portable device that the individual regularly carries and has reliable connectivity, fitting in a pocket or purse" [27]. However, the mentioned literature defined m-learning with relatively less attention to the process and aspects that intertwined during the learning process [28]. In contrast, Koole [29] provides a more comprehensive perspective, defining mobile learning as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction. This definition aligns more closely with the focus of the present research, as it emphasizes the learning process from these interconnected aspects in greater detail.

While mobile learning might not be considered as an essentially new learning approach in education [30], the constantly evolving and emerging mobile technologies and devices have turned it into a popular research focus across various discipline [31]. Mobile learning technology presents a valuable opportunity to leverage these technological innovations to address the emerging needs and demands of tertiary education. For instance, Wu et al. [32] employed a meta-analysis to review 164 mobile learning studies, finding that surveys and experimental methods were the most commonly used research approaches. The majority of studies focused on learning effectiveness, and the research outcomes were predominantly positive.

In Giannakopoulos and Eybers' [33] study, results from both questionnaires and interviews indicated that allowing students to use mobile devices for educational purposes can increase their engagement with learning, particularly when they feel empowered to utilize their devices to their full potential. The more successful students are with their mobile devices, the greater the rewards and motivation they experience. A similar conclusion was reached in Neha's [34] research, conducted among 200 participants, which found that mobile learning significantly enhances student engagement and increases motivation. Respondents expressed a strong desire to use mobile devices to access key course resources and engage in a wide range of learning activities. Additionally, Darmi and Albion [35] highlighted that the sense of personal belonging and the intimate relationship students have with their mobile phones initially attracted researchers to explore the potential of mobile phones in education.

4. Prosperity and pitfalls of mobile learning applications

In the 21st century, people are already too familiar with the concept of applications. Apps are the short form of the phrase “application software” generally downloaded from “app stores such as App Store, Google Play, Windows Phone Store, and BlackBerry App World” [13]. In the People’s Republic of China (PRC), the App Store and Android Store are commonly used to install apps that cater to a wide range of needs, including entertainment, gaming, education, and daily tasks. The rapid advancement of mobile technology, particularly mobile applications designed to assist learning, has garnered growing interest among educators. Undoubtedly, research on mobile learning applications is flourishing and entering a prosperous phase. Despite these developments, the use of mobile devices as learning tools is still being actively explored, remaining an important area of ongoing research [36]. Ekoç [37] suggested that, as a direction for future studies, the current use of mobile learning applications could be further examined by investigating users’ perceptions of specific apps tailored to their particular needs.

However, there are several pitfalls associated with the use of mobile applications in education. Learning apps available in the app stores are plenty and choosing the right app is definitely a tiresome job [13]. Kamandhari [38] highlighted the shift of responsibility onto the learner, noting that mobile learning “offers fluidity, provisionality, and instability, where the responsibility rests on the shoulders of the learners.” As there is no teacher to guide them, it may cause some problems [37]. Nami [39] also observed that, in his study, teachers did not recommend specific learning apps, which contributed to ineffective app usage—suggesting a lack of sufficient guidance and appropriate strategies. Additionally, given that different technologies demand particular types of literacy, it is crucial to equip students with the necessary knowledge and skills to use smartphone apps effectively.

Sergei and Ekaterina [40] argued that each mobile learning app offers a unique approach to learning, with distinct advantages and drawbacks. Consequently, no single app can be considered the best, which suggests the need for a combination of several apps to optimize learning efficiency. Students often face challenges in selecting the most suitable apps to develop the necessary skills. Almasri [41] also found that students are frequently compelled to spend money on various apps they believe may be useful, and the process of discovering effective apps can be time-consuming and costly. As a result, students want a trustworthy source of information and a recommendation based on the experience of students who have tried [41]. Given the concerns highlighted in the literature, further research is needed to explore mobile technology-enhanced learning apps, particularly from the perspective of the support provided by both peers and instructors.

5. Methodology

5.1. Aims and research questions

The primary aim of this study is to explore effective strategies that learners in Chinese higher education institutions can adopt to enhance their assisted learning performance through the use of mobile technology.

The specific pertinent research questions are as follows:

Research question 1: What is the relationship between the learners’ assisted learning performance from more capable ones (the teacher or peers) through mobile technology (applications) and their overall use of learning applications?

Research question 2: Is there any significant difference between the learners’ assisted learning performance from more capable ones (the teacher or peers) using mobile technology (applications) and demographic characteristics (gender, majors, location and year of study)?

Research question 3: What are learners’ perspectives towards their assisted learning performance from more capable ones (the teacher or peers) in their academic performance with mobile technology

(applications)?

Research question 4: What are learners’ adoption strategies and selection stages of choosing the appropriate mobile learning technology (applications) for their assisted learning performance in higher education institutions in China?

5.2. Participants and universities

This study involved a total of 300 participants from various universities in the People’s Republic of China (PRC), primarily located in Xi’an, Shaanxi Province—a region known for its concentration of higher education institutions, which contributes to the diversity of the target population. Among the participants, 200 were drawn from a range of academic majors and year levels, including first-year students, sophomores, juniors, and seniors. These students were selected from multiple universities across Xi’an and other cities in China. The researcher, employed as a part-time IELTS instructor at a private training institution, was able to access a wide pool of students from different academic backgrounds and various locations. The remaining 100 participants were undergraduate students from the Department of Humanities and Education at a private college in Xi’an, where the researcher holds a full-time teaching position. These participants were selected randomly from the student population.

The selection criteria for inclusion in the study were as follows: (1) the participant must be currently enrolled in a higher education institution in China, regardless of their academic major; and (2) the participant must have at least two years of experience using mobile technology for learning purposes. Individuals who did not meet both criteria were excluded from the study.

5.3. Instruments

This study aimed to collect data from multiple sources to ensure that the adoption strategies of mobile technology for assisted learning performance could be generalized within the context of Chinese higher education institutions. In alignment with Pimmer et al. [42], who emphasized the necessity of employing both qualitative and quantitative methods to gain a comprehensive understanding of mobile learning in higher education settings, this study adopted a mixed-methods approach. By integrating both qualitative and quantitative data, the study sought not only to corroborate findings across methods but also to provide complementary insights. Therefore, two primary instruments were employed: an online survey and semi-structured interviews.

The online survey was designed to collect participants’ demographic information, general usage of mobile learning applications, and their corresponding adoption strategies. It aimed to provide a broad overview of trends and patterns across a larger sample. The semi-structured interviews were conducted to explore participants’ in-depth perspectives on factors influencing their selection of mobile applications, including their standards, procedures, and decision-making processes. These interviews enabled the researcher to obtain richer, more nuanced insights that could not be captured through the survey alone.

The primary instrument for collecting quantitative data in this study was an online questionnaire. As noted by Dörnyei and Taguchi [43], questionnaires are widely employed in research due to their efficiency and flexibility as data collection tools. In quantitative research, the intent of sampling individuals is to choose individuals who are representative of a population so that the results can be generalised to a population [44]. To this end, random sampling was employed to ensure that each college student in the target population had an equal chance of being selected. The questionnaire was designed by the researcher and consisted of 45 close-ended items, utilizing multiple-choice and Likert scale formats.

These questions were structured to capture both general background information and more complex variables related to the research objectives. The survey was divided into three sections and required

approximately 10 min to complete. Section One focused on demographic and background information of the respondents. Section Two assessed participants' engagement with mobile technologies and applications. Section Three explored learners' adoption criteria for mobile learning applications, aiming to gather more detailed and specific information on their selection strategies and usage patterns. The structure and content of the questionnaire were carefully designed to ensure alignment with the study's research questions and to elicit comprehensive insights from the learners' perspectives.

The second primary instrument for qualitative data collection was the semi-structured interview. A semi-structured is a qualitative method of research used in the social sciences [45]. Unlike quantitative research, which often relies on probability sampling to statistically represent a broader population, qualitative research typically employs non-probability sampling methods. In this study, purposive sampling was adopted to ensure the inclusion of participants possessing specific characteristics relevant to the research objectives. As Ritchie et al. [46] suggested, purposive sampling enables in-depth exploration and understanding of key themes by selecting individuals who can provide rich and meaningful insights.

Each semi-structured interview was conducted on a one-on-one basis, lasting between 30 min to one hour. Although focus groups were initially considered, they were deemed inappropriate due to cultural and linguistic factors. Given that the participants were Chinese university students, many of whom are not proficient in English and typically communicate in Chinese, individual interviews were better suited to elicit open, honest, and critical responses. As such, all interviews were conducted in Mandarin Chinese, and the data were transcribed and later translated into English for analysis.

The interviews were conducted online, using platforms such as Zoom, allowing for greater flexibility and convenience. Participants were offered a range of pre-scheduled time slots and were free to select one that best fit their availability. This remote setup also helped overcome geographical limitations and enabled efficient audio recording of each session for later transcription. At the start of each interview, participants were given a brief introduction outlining the study's aims. They were asked to refer to specific mobile applications on their phones during the discussion to answer certain questions, but no prior preparation was required.

5.4. Data collection and data analysis

In terms of collecting data for the online questionnaires, 300 participants from different universities, different majors, and college years took part in the data-collecting process. Random selection of individuals for the sample was an attempt to give each individual in the population an equal chance of being selected. Therefore, in order to make sure each individual in the population has an equal probability of being selected, random sampling was employed. With randomisation, a representative sample from a population can be generalised to a population [47]. The survey consisted of 45 questions and was divided into three sections, which took around 10 min for respondents to finish.

In the quantitative phase, the collected data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 26. To begin with, the normality of the data distribution was assessed using the Kolmogorov-Smirnov test. Additionally, a reliability analysis was conducted to assess the internal consistency of the questionnaire items, employing Cronbach's alpha coefficient. To address Research Question 1, which investigates the relationship between the learners' assisted learning performance from more capable ones (the teacher or peers) through mobile technology (applications) and their overall use of learning applications, a Pearson product-moment correlation analysis was conducted to determine the strength and direction of the relationships among the relevant variables. To address Research Question 2, which explores whether there is significant difference between the learners' assisted learning performance from more capable ones (the

teacher or peers) using mobile technology (applications) and demographic characteristics (gender, majors, location and year of study), independent-samples *t*-tests and one-way Analysis of Variance (ANOVA) were employed, as appropriate, depending on the number of groups being compared.

For the qualitative component, 30 students were randomly and voluntarily selected from the pool of 300 questionnaire respondents to participate in semi-structured interviews. The purpose of these interviews was to gain deeper insights into learners' adoption strategies and selection processes when choosing suitable mobile learning technologies (applications) to enhance their assisted learning performance. Additionally, the interviews aimed to explore students' perspectives and experiences regarding the support they received from teachers and peers in relation to their academic performance through mobile technology use. To create a comfortable and relaxed environment conducive to open and honest responses, the interviews were conducted one-on-one and in Chinese, allowing participants to express themselves more accurately and freely. Each interview was audio-recorded (with participants' consent), transcribed, and then translated into English for analysis. Following the data collection, the interview responses were coded and thematically analyzed to identify recurring patterns and concepts. These themes provided qualitative evidence to support the development of an understanding of effective adoption strategies for mobile technology to enhance learning performance in higher education settings.

The goal of qualitative data analysis in this study was to uncover underlying meanings and insights related to the research questions. As Basit [48] notes, analysis in qualitative research typically begins with the collection of interview data or documents and continues throughout the transcription and interpretation process. Unlike statistical analysis, qualitative data analysis is iterative and ongoing, involving continuous engagement with the data to identify patterns, themes, and relationships.

Upon completion of both the quantitative and qualitative phases, the results were compared and contrasted to arrive at a comprehensive interpretation of the findings. This integrative approach enabled the triangulation of data, enhancing the validity of the research outcomes and informing the development of adoption strategies for mobile technology to support assisted learning performance in Chinese higher education institutions.

6. Results

6.1. Quantitative results

RQ1. The Relationship between Overall Use of Mobile Learning Applications and The Dependent Variable

This section addresses Research Question 1: What is the relationship between the overall use of learning applications and the learners' assisted learning performance from more capable ones (the teacher or peers) with the use of mobile technology (applications) ?

The analysis of the correlation matrix reveals a significant association between the overall use of learning applications and the learners' assisted learning performance when supported by more capable individuals (such as teachers or peers) through mobile technology (applications) (see Table 6.1). The title row of the correlation matrix represents the independent variable (overall use of learning applications), while the remaining sections of the matrix illustrate the strength and direction of the relationship between this independent variable and the dependent variables related to learners' assisted learning performance.

The relationship between the overall use of learning applications and learners' assisted learning performance from more capable individuals, facilitated by the use of mobile applications, was assessed using Pearson's correlation coefficient (*r*), as presented in Table 6.1. The results revealed a strong positive linear relationship between the overall use of

Table 6.1

Summary of correlation matrix of the overall use of mobile learning applications and learners' assisted learning performance from more capable ones with the use of mobile applications.

	Assisted learning performance from more capable ones with the use of mobile technology	Overall use of mobile learning applications
Assisted learning performance from more capable ones with the use of mobile technology	1	.790**
Overall use of learning applications	.790**	1

Note. **. Correlation is significant at the 0.05 level (2-tailed).

learning applications and learners' assisted learning performance from more capable ones ($r = 0.790, p < .05$). This indicates that as learners' attitudes toward the overall use of learning applications improve, their assisted learning performance—whether supported by teachers or peers—tends to increase. In other words, an enhancement in learners' engagement with mobile applications correlates with a positive improvement in their learning performance with the aid of more capable ones.

RQ2. Independent-Sample t Test Between Gender and The Dependent Variable

Table 6.2 presents the results related to Research Question 2: Is there any significant difference between the demographic characteristics (gender, majors, location and year of study) and the learners' assisted learning performance from more capable ones (the teacher or peers) with the use of mobile technology (applications)?

This research question aims to explore which demographic factors may influence learners' assisted learning performance with the use of mobile applications, specifically focusing on gender, major, location, and year of study. Participants were asked to provide demographic information regarding their gender, academic major, location, and year of study.

To assess the relationship between gender and assisted learning performance, an independent-sample *t*-test was conducted. The results indicated no significant difference in learners' assisted learning performance based on gender, with $t(300) = 0.351, p = .803$. Male learners ($M = 3.982, SD = 0.695$) had slightly higher scores than female learners ($M = 3.955, SD = 0.650$), but this difference was not statistically significant. The effect size for this difference is considered large, and the 95 % confidence interval for the difference in means ranged from -0.126 to 0.181 .

These findings suggest that, within this sample, gender did not play a significant role in influencing learners' assisted learning performance when using mobile learning applications.

One-way ANOVA analysis between demographic characteristics (major, year of study and location) and the dependent variable

Three one-way analyses of variance (ANOVA) were conducted to explore differences in learners' assisted learning performance from more capable ones (teachers or peers) with the use of mobile technology (applications), based on various demographic characteristics. The independent variables for each analysis included gender, major, location,

Table 6.2

Independent-samples *t* Test between gender and the dependent variable.

Gender	N	Mean	SD	p value	η^2	CI
Male	127	3.982	.695	.657	.020	$-0.126, 0.181$
Female	173	3.955	.650	.658		

Note. $p < 0.05$.

The assumption met Levene's test at $\alpha < 0.05$.

and year of study. The results of the one-way ANOVA revealed no significant relationships between year of study or location and learners' assisted learning performance with the use of mobile applications. These findings suggest that learners' performance was not significantly influenced by these demographic factors.

However, a significant relationship was found between academic major and learners' assisted learning performance from more capable ones with the use of mobile technology. Specifically, the analysis revealed a significant effect of major on learning performance, with $F(11, 289) = 1.788, p = .056, \eta^2 = 0.064$. This indicates that the academic major had a notable impact on learners' performance, with a medium effect size ($\eta^2 = 0.064$). The full details of the analysis can be found in Table 6.3.

This suggests that students' academic major may influence how effectively they utilize mobile learning applications for assisted learning, with some majors showing greater engagement or performance in this context.

RQ3. Learners' Perspectives of Assisted Learning Performance from More Capable Ones with Mobile Learning Applications

This section addresses Research Question 3 of the study: what are learners' perspectives towards their assisted learning performance from more capable ones (the teacher or peers) in their academic performance with mobile technology (applications)?

The findings regarding university learners' responses to the dimension of "Assisted Learning Performance from More Capable Ones" are presented in Table 6.4. More than 80 % of the participants agreed or strongly agreed with the seven items in this dimension. However, the item "Experts or more capable ones (my teacher or other peers) always instruct me to use his/her recommended mobile learning applications in class or after class" received the highest percentage of disagreement, with respondents indicating lower levels of agreement ($M = 3.88, SD =$

Table 6.3

One-way ANOVA Analysis between major, location, year of study and the dependent variable.

Demographics		N	M	SD	p value	η^2
Major	Philosophy	14	3.34	1.019	.056	.064
	Economics	23	4.07	0.54		
	Education	106	4.02	0.644		
	Law	4	4.5	0.577		
	Literature	39	3.92	0.74		
	History	2	3.79	0.101		
	Science	7	3.9	0.787		
	Engineering	48	4	0.762		
	Agriculture	5	4.17	0.65		
	Medicine	2	3.36	0.707		
	Management	35	4.02	0.557		
	Arts	15	3.91	0.589		
	Total	300	3.97	0.668		
Location	Eastern part of China	8	3.6	1.156	.567	.023
	Western part of China	33	3.91	0.782		
	Central part of China	87	3.99	0.624		
	Northern part of China	20	4.01	0.388		
	Southern part of China	52	4.13	0.598		
	Northeast China	2	4.21	1.111		
	Southeast China	9	3.92	0.682		
	Northwest China	76	3.89	0.686		
	Southwest China	13	3.88	0.747		
	Total	300	3.97	0.668		
Year	Freshman	139	4.03	0.603	.479	.008
	Sophomore	14	3.93	0.802		
	Junior	78	3.93	0.643		
	Senior	69	3.89	0.787		
	Total	300	3.97	0.668		

Note. **. Correlation is significant at the 0.05 level (2-tailed).

Table 6.4

Descriptive statistics for assisted learning performance from more capable ones.

Statement	N	Percent (100 %)					M	S*D
		(f)	(f)	(f)	(f)	(f)		
		SD	D	LA	A	SA		
I always ask for advice from experts or more capable ones (my teacher or other peers) when choosing a mobile learning application.	300	0.3 (1)	4 (12)	19.7 (59)	55.7 (167)	20.3 (61)	3.92	0.77
It is important to draw on experts or more capable ones (my teacher or other peers) for their suggestions or guidance when choosing a mobile learning application.	300	0.3 (1)	4.3 (13)	15.7 (47)	56.7 (170)	23 (69)	3.98	0.77
It is important to draw on experts or more capable ones (my teacher or other peers) for their suggestions or guidance when actually using a mobile learning application.	300	0.3 (1)	4 (12)	12.7 (38)	59 (177)	24 (72)	4.02	0.75
Experts or more capable ones (my teacher or other peers) are a great help to me in choosing a mobile learning application.	300	0.3 (1)	4 (12)	13 (39)	59.7 (179)	23 (69)	4.01	0.74
Experts or more capable ones (my teacher or other peers) always share useful mobile learning applications in or after class.	300	0.3 (1)	4 (12)	15.3 (46)	57.3 (172)	23 (69)	3.99	0.76
Experts or more capable ones (my teacher or other peers) always instruct me to use his/her recommended mobile learning applications in class or after class.	300	0.3 (1)	6.3 (19)	18 (54)	55.7 (167)	19.7 (59)	3.88	0.81
My academic performance has improved with the assistance of experts or more capable ones (my teacher or other peers) with the use of mobile learning applications.	300	0 (0)	3.7 (11)	17.7 (53)	56.7 (170)	22 (66)	3.97	0.74
Overall							3.97	0.76

Scale description: SD=Strongly Disagree, D=Disagree, LA=Less Agree, A=Agree, SA=Strongly Agree; M=Mean; S*D=Standard Deviation.

0.81). Conversely, the statement “It is important to draw on experts or more capable ones (my teacher or other peers) for their suggestions or guidance when actually using a mobile learning application” scored the highest mean ($M = 4.02$, $SD = 0.75$), reflecting a strong belief in the importance of instructor or peer guidance when using mobile learning tools.

The overall mean score for this dimension was 3.97, with a standard deviation of 0.76, suggesting that, on average, students acknowledged the value of teacher assistance in the context of mobile learning. However, despite this recognition of the importance of guidance, a significant proportion of students reported a lack of consistent support, both in and out of class, to help them effectively use mobile learning applications. This gap highlights a need for more structured and consistent instructional support from teachers and peers when incorporating mobile technologies into learning environments.

RQ4. Learners' Perspectives of Adoption Criteria of Mobile Learning Applications

This section addresses Research Question 4 of the study, which

examines the adoption criteria and selection priorities learners consider when choosing mobile learning applications to support their learning performance.

Research question 4: What are learners' adoption strategies and selection stages of choosing the appropriate mobile learning technology (applications) for their assisted learning performance in higher education institutions in China?

Table 6.6 presents a descriptive analysis of university learners' responses to the items related to the adoption criteria for mobile learning applications. The majority of students agreed or strongly agreed with the ten items in this scale. Notably, 93.4 % of the respondents agreed that they would choose a learning application based on its ability to meet their specific needs, with this item receiving the highest mean score of 4.25 ($SD = 0.62$). This indicates that learners prioritize functionality and relevance to their academic needs when selecting mobile learning applications.

Following this, 89 % of participants expressed a preference for learning applications that offer free premium features, which scored a mean of 4.18 ($SD = 0.72$). Similarly, 86.6 % of learners agreed with the

Table 6.6

Descriptive statistics for adoption criteria of mobile learning applications.

Statement	N	Percent (100 %)					M	S*D
		(f)	(f)	(f)	(f)	(f)		
		SD	D	LA	A	SA		
I would like to choose a learning application for its high download rate.	300	1.3 (4)	4.3 (13)	19 (57)	55 (165)	20.3 (61)	3.89	0.82
I would like to choose a learning application because people with experience in social media recommended it.	300	0.7 (0)	1.7 (5)	9.7 (29)	64.3 (193)	23.7 (71)	4.09	0.67
I would like to choose a learning application because more capable ones (my teacher or other peers) recommended it.	300	0.7 (1)	1.7 (5)	8.7 (26)	60 (180)	29 (87)	4.15	0.70
I would like to choose a learning application because most people I know use it.	300	0.3 (1)	3.7 (11)	14.7 (44)	55.7 (167)	25.7 (77)	4.03	0.76
I would like to choose a learning application for its good design and layout.	300	1 (3)	1 (3)	11.3 (34)	57.3 (172)	29.3 (88)	4.13	0.72
I would like to choose a learning application for its user-friendly interface.	300	1.3 (4)	1.3 (4)	9.7 (29)	61.3 (184)	26.3 (79)	4.1	0.73
I would like to choose a learning application for free premium functions.	300	1 (3)	1 (3)	9 (27)	56.7 (170)	32.3 (97)	4.18	0.72
I would like to choose a learning application because it meets my certain needs.	300	0 (0)	1 (3)	6.7 (20)	58.7 (176)	33.7 (101)	4.25	0.62
I would like to choose a learning application after a careful analysis and comparison.	300	0.3 (1)	0.7 (2)	12.3 (37)	56.3 (169)	30.3 (91)	4.16	0.68
I like to share some useful learning applications with others.	300	0.7 (2)	2 (6)	12.7 (38)	57.3 (172)	27.3 (82)	4.09	0.73
Overall							4.11	0.71

Scale description: SD=Strongly Disagree, D=Disagree, LA=Less Agree, A=Agree, SA=Strongly Agree; M=Mean; S*D=Standard Deviation.

statement “I would like to choose a learning application after a careful analysis and comparison” ($M = 4.16$, $SD = 0.68$), reflecting a thoughtful and comparative approach to selection. Additionally, 89 % of participants preferred learning applications recommended by more capable ones (teachers or peers), with a mean score of 4.15 ($SD = 0.70$), suggesting that guidance from teachers or peers plays a significant role in their adoption decisions.

On the other hand, the item “I would like to choose a learning application for its high download rate” received the lowest mean score of 3.89 ($SD = 0.82$), with 75.3 % of participants agreeing less with this statement. This result indicates that, while the popularity of an app (as indicated by its download rate) may influence learners’ choices, it is not as important as other factors such as the app’s specific academic utility, quality, and recommendations from trusted sources.

Overall, the data suggest that the primary considerations for university learners when selecting mobile learning applications are their academic needs, the availability of free premium features, and recommendations from teachers or peers. High download rates, however, were found to be a less significant factor in the selection process for academic purposes compared to other criteria.

6.2. Qualitative results

RQ3. Learners’ Perspectives Towards Their Assisted Learning Performance from More Capable Ones with Mobile Applications

This section presents key findings from the qualitative analysis of interview data. A total of 30 university students participated in the interviews, identified as respondents 1 to 30. Of these, 13 were male and 17 were female, representing a diverse cross-section of students from various majors, academic years, and universities in China, thereby enriching the depth and scope of the research.

The majority of the participants emphasized the significant value of assistance received from teachers and more capable peers when selecting or using mobile learning applications. They expressed strong appreciation for the professional and reliable guidance provided by these individuals, which they believed contributed to more efficient learning. Additionally, students noted that such assistance not only helped them identify suitable applications but also enhanced their ability to utilize these tools effectively, thereby improving their overall academic performance.

Participants highlighted that they found the recommendations from teachers or more capable peers particularly helpful in navigating the abundance of available mobile learning apps. They believed that having guidance from these more experienced individuals was essential for maximizing the effectiveness of mobile learning, as it helped them avoid wasted time on ineffective applications. These insights underscore the importance of teacher or peer support in optimizing the use of mobile learning applications to support academic success.

As Interviewee 19 stated:

Teachers and peers may have more knowledge and experience with certain learning apps. They can provide suggestions and guidance on the advantages and disadvantages, scope of application, and usage techniques of these learning apps, which will help me better understand these tools and choose the one that suits my needs. Additionally, recommendations from teachers or peers can help college students avoid selecting learning apps that are not suitable for them, thereby improving learning efficiency and outcomes.

However, when many students were asked whether they had someone to instruct them in using learning applications, they responded that, while there is typically no one to directly assist them, they recognized the importance of having such guidance. They acknowledged that having proper instruction is both necessary and crucial for maximizing the effectiveness of these apps.

Generally, no one guides me in using learning apps. In my personal experience, when I try to use a new app, I initially don’t know how to use it correctly and efficiently, so I end up only using the most basic features. However, if someone who has experience with the app can guide me on how to explore its full potential, it would certainly enhance my learning tasks. Therefore, receiving guidance from others is not only helpful but essential—it truly adds value to the learning process. (Interviewee 5)

On the other hand, a few students believe that assistance from teachers or peers is unnecessary because they feel they can independently search for learning apps that meet their needs. They find the functions of these apps to be straightforward and easy to use. However, when they seek recommendations for other apps, they often rely on advice from teachers, experts, or more knowledgeable peers—even if they do not know them personally. Additionally, although these students may not actively seek help, they still appreciate and value any assistance when it is offered.

I prefer to search for apps on my own because the learning apps recommended by others may not suit my needs. Everyone has different learning methods. (Interviewee 23)

The interview analysis revealed that the majority of learners acknowledged the importance of receiving assistance and guidance from more capable individuals when selecting or using learning applications. Given the overwhelming number of options available on the market, expert opinions and firsthand experience can help learners make more informed and efficient choices, ultimately enhancing their learning performance. However, a key issue highlighted was that most learners felt they lacked sufficient guidance and support from others. A small number of interviewees, on the other hand, preferred to search for useful learning apps independently, rather than seeking assistance from teachers or peers.

RQ4. Learners’ Adoption Strategies and Selection Stages

For the qualitative analysis of learners’ adoption strategies and selection stages, interview data were imported into NVivo and analyzed systematically. The researcher employed selective coding to organize and categorize the data, ensuring that the emerging codes were used to guide the ongoing analysis, shown as Table 6.5. Initially, the data were coded into preliminary themes, which were then refined and grouped into more abstract categories. After reviewing, defining, and naming these themes, the researcher identified the expected stages and strategies learners use when adopting mobile learning applications. These findings provide a deeper understanding of the decision-making process and factors influencing learners’ choices in selecting appropriate mobile learning tools.

The findings from the qualitative survey revealed eight key themes related to the adoption strategies and selection stages of mobile learning technology (applications) in higher education institutions, which provide insight into how learners choose and adopt learning applications. These themes are illustrated to answer Research Question 4, in Fig. 6.1 and further explained in the detailed discussion below. The themes emerged from the analysis of interview data, offering valuable insights into the factors and processes influencing learners’ adoption of mobile learning technologies.

Table 6.5
Coding sample of the interview.

Excerpt:	After receiving recommendations from my classmates, peers, and teacher, I downloaded three English learning applications and tested them individually. Based on my experience and preferences, I selected the one that best suited my needs and continued using it.
Coding:	Obtaining recommendations from my classmates/peers and our English teacher (peers and the teacher). Tried them one by one (function analysis). Kept one of them according to my preference (individual needs).

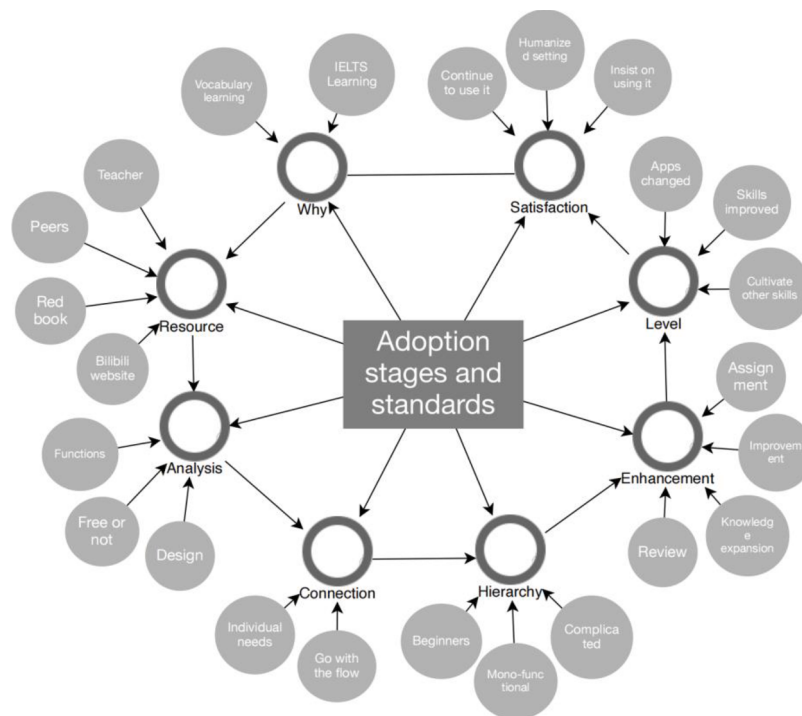


Fig. 6.1. Themes related to adoption strategies of mobile learning applications.

Why choosing the app

When learners seek a suitable mobile learning application to enhance their study experience, it is crucial for them to first define the primary reason or goal for their choice. Understanding the “why” behind their selection is a fundamental starting point. Whether the aim is to improve a specific skill, prepare for a particular exam, or supplement regular course materials, having a clear objective helps learners avoid misguided decisions. This clear purpose ensures that they focus on applications that align with their academic needs and goals, ultimately enhancing their learning outcomes.

First, I need to clarify my learning goals and needs. What exactly do I want to learn? Is it programming, foreign languages, professional skills, or something else? What is my current study level? And what does my study schedule look like? Answering these questions helps me narrow down my options and choose the right app for my needs. (Interviewee 24)

Participants in this study came from various majors, universities, and academic years, which clearly indicates that their objectives for using learning applications vary. Among the most frequently mentioned were English learning apps, including those designed for vocabulary memorization, test preparation, and apps aimed at enhancing specific language skills such as listening, reading, writing, and speaking.

Research from multiple facets

Following the clarification of learning goals, it is essential for learners to conduct thorough research through diverse channels to identify the most suitable mobile learning applications available on the market. Participants in this study identified four primary sources of information they used during this selection process. The majority expressed a strong reliance on direct recommendations from teachers or peers, valuing their firsthand experience and perceived credibility. In addition to interpersonal recommendations, many participants reported supplementing this advice with independent research. This included exploring widely used platforms in the PRC, such as Xiaohongshu (Red Book) and Bilibili, where users share extensive reviews, tutorials, and personal experiences on a wide range of topics, including educational tools. These platforms serve as valuable resources for learners to gain

insights into application features, effectiveness, and real-world usability from more experienced users.

Firstly, I determine my own needs. Then I ask teachers, classmates, or friends to learn more from their experiences. After that, I verify and download the apps through my own testing. (Interviewee 8)

This statement reflects a structured, multi-step strategy adopted by many learners: beginning with a clear understanding of personal learning objectives, followed by consultation with more knowledgeable individuals, and concluding with personal evaluation. This layered approach allows learners to triangulate information from different sources, thereby improving their chances of selecting an effective and appropriate mobile learning application.

Analysis based on pros and cons

Following the initial research phase, learners emphasized the importance of conducting a detailed comparative analysis of potential learning applications. This process involves weighing the strengths and weaknesses of each option based on individual learning goals and preferences. For instance, among English learning apps:

One app may offer comprehensive explanations and practice activities for reading and listening; Another may provide well-structured, free recorded classes covering a range of skills; A third may incorporate AI features to support interactive speaking practice. Such comparisons help students identify which app best aligns with their personal learning style, objectives, and technical needs. The semi-structured interviews revealed that learners often rely on a set of informal yet consistent criteria—such as content richness, user interface, interactivity, and the credibility of recommendations—making their final app selection a well-informed decision.

I will then read the comments on Red Book to learn the specific content of the potential apps, and download and try them out and compare the pros and cons. (Interviewee 3)

Across all responses, several common adoption criteria consistently emerged. Foremost among these was the minimization or complete absence of advertisements, as frequent interruptions were seen as

disruptive to the learning experience. Secondly, the cost of the application was a critical factor—students overwhelmingly preferred applications that were free or offered essential functions without requiring payment. A well-structured, user-friendly interface was another crucial standard, with participants emphasizing the importance of ease of navigation and a smooth, intuitive user experience. Convenience and operational fluency—such as quick loading times and logical feature placement—were also highly valued. Finally, applications that offered comprehensive and integrated functionalities, such as reading, listening, speaking, and writing tools in one platform, were preferred, as they reduced the need to switch between multiple apps.

These shared preferences underscore students' practical and performance-oriented approach to selecting mobile learning tools, reflecting a balance between efficiency, accessibility, and usability.

Connection with individual needs

After receiving guidance and recommendations from various sources, and conducting a thorough analysis of the strengths and weaknesses of different apps, the next crucial step is to align these options with individual learners' needs. This connection ensures that learners select the most suitable applications to enhance their academic performance. Given the diversity in learners' levels and requirements, it is essential that the chosen apps cater to their unique learning goals.

Next, I need to assess whether the app aligns with my learning needs across various scenarios. (Interviewee 22)

This suggests that learners are not simply looking for a one-size-fits-all solution, but rather a tool that adapts to their unique requirements in different learning situations—whether for academic study, skill improvement, or exam preparation. The connection between app features and learner needs is vital. It ensures that learners are not overwhelmed with irrelevant features but instead can focus on the functions that matter most to them. This targeted approach increases the chances of successfully achieving their learning outcomes.

Hierarchy of selected apps. Once learners have selected the most appropriate apps for specific learning purposes based on their individual needs, it is likely that multiple apps will be chosen. In such cases, establishing a hierarchy of these apps is essential for efficient use. Teachers also can provide a prioritized list, guiding learners on when to use each app based on its features and the specific learning requirements of the students.

I have downloaded several English learning apps, including Baicizhan, Youdao Dictionary, and Duolingo, but found that they were not well-suited to my needs. Duolingo, for example, felt too basic and seemed more appropriate for beginners. After attending a peer-sharing session, I decided to download an IELTS-focused app, and later supplemented my learning with another app that better aligned with my specific objectives. (Interviewee 5)

Enhancement of learning performance

Once the appropriate mobile learning applications have been selected, learners are expected to actively engage with these tools to enhance their targeted skills. This involves consistent input and output practices aimed at advancing their academic proficiency. It is also essential that all preceding stages in the adoption process—such as identifying learning needs, researching available applications, and evaluating their suitability—collectively contribute to maximizing learning outcomes and overall performance.

I typically use a learning application for a period of time to evaluate its effectiveness. I assess whether it supports my learning progress and whether the specific skills I aim to improve have been enhanced. Based on this evaluation, I then decide whether the app is worth retaining for long-term use. (Interviewee 20)

Level to be re-evaluated

After a designated period, typically one or two months, students must assess their current learning progress to evaluate the effectiveness of the mobile applications. This process helps determine whether the apps have met their learning objectives. Additionally, students should reassess their evolving learning needs to identify if new applications are required to support further academic or skill-based goals. If new learning needs arise, the cycle may return to the initial “why” stage to select new applications that cater to advanced learning objectives. Conversely, if no new needs emerge, students can proceed to the final stage, ensuring satisfaction with the selected applications for supporting their language learning performance.

Continuous Evaluation and Adjustment: once a mobile learning application is selected and study begins, it is essential to continuously evaluate its effectiveness. As learners progress, they may discover that certain aspects of the app no longer align with their needs, or their learning requirements may evolve. In such cases, it becomes necessary to reassess the chosen app and make adjustments as needed to ensure it remains suitable for their academic goals. (Interviewee 24)

Satisfaction to be achieved

Finally, after university learners have used the selected mobile learning applications for a certain period, it is crucial to assess their satisfaction with the assistance provided by teachers or peers in conjunction with these mobile technologies. Ensuring that learners are content with the support received will confirm that the adoption strategies employed have been effective and beneficial in enhancing their learning performance.

I recommended the “Do Not Memorize Words” app to my classmates because I needed an efficient way to learn vocabulary during my preparation for the postgraduate entrance examination. The app is user-friendly, straightforward, and not overly complex, making it an ideal tool for my study needs. Ultimately, it proved effective in helping me memorize a significant number of words and achieve my learning objectives. Given its success, I was satisfied with the app and felt confident recommending it to my classmates. (Interviewee 28)

Based on the collected evidence, it can be concluded that this prototype serves as a practical and user-oriented guide for university students, shown as Fig. 6.2. It facilitates a more efficient and informed navigation of the overwhelming variety of mobile learning applications, ultimately supporting learners in identifying and selecting the most appropriate tools to meet their specific academic goals and enhance learning performance.

7. Discussion

Findings 1. Assisted Learning Performance.

In terms of overall usage, nearly two-thirds of the respondents agreed that mobile learning applications contribute to making teaching and learning more accessible. They reported improvements in their learning skills and believed that the use of such applications positively impacted their academic performance. These findings are consistent with insights gained from the qualitative interviews, where participants emphasized that support from more capable individuals—such as teachers and peers—can significantly enhance learning outcomes when mediated through mobile applications. These results align with prior research by Halim and Phon [49], Alkhateeb and Al-Duwairi [50], Demir and Akpinar [51], and Pechenkina et al. [52], which all highlighted the pedagogical benefits of mobile-assisted learning.

However, it was also evident that learners did not perceive existing mobile applications on the market as fully capable of addressing all their individual learning needs. This aligns with Klimova [53], who noted that although numerous mobile learning applications are available, they

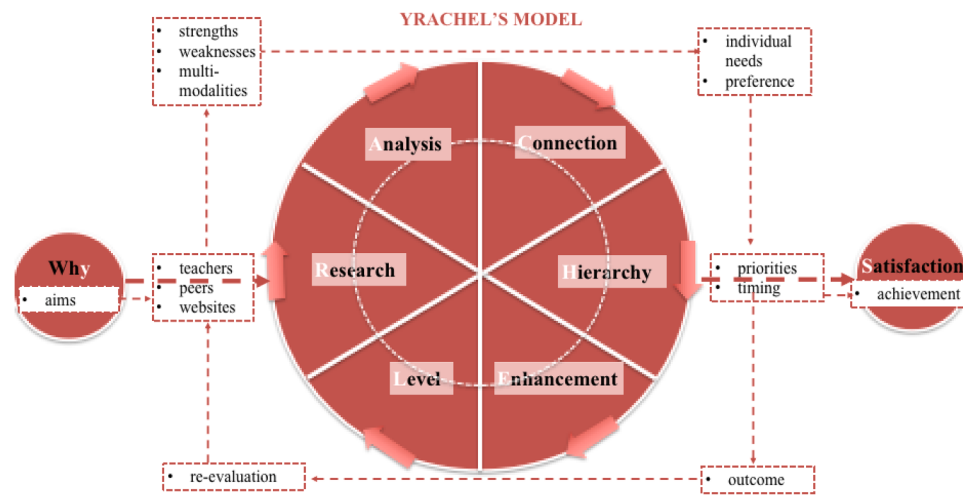


Fig. 6.2. Model of adoption strategies of mobile learning applications.

often fail to meet the specific and diverse needs of learners. Several interviewees expressed dissatisfaction or unmet expectations regarding certain app features. For instance, Interviewee 8 pointed out that many learning apps lack reminder functions, making it easy to forget daily tasks and fall into habits of procrastination. As a result, users may gradually deviate from their initial learning intentions.

In relation to other aspects, the item “I enjoy using mobile learning applications to learn more about topics I am interested in” received the highest mean score of 4.10. This suggests that mobile learning applications effectively increase learners’ intrinsic motivation to explore additional knowledge. These findings align closely with those of previous studies, including Togaibayeva et al. [54], Baideldinova et al. [55], and Nalliveetil and Alenazi [56], which collectively support the motivational benefits of mobile-assisted learning. Furthermore, most students reported enjoying the use of mobile applications as tools to support and enhance their academic performance.

However, a notable reluctance was observed when participants were asked about paying for mobile learning applications or subscribing to premium services. The general unwillingness to incur costs suggests that many university learners are highly price-sensitive. This observation is consistent with findings by Wang et al. [9], who argued that while learning effectiveness is a more accurate indicator of the success of paid mobile learning applications than other variables, monetary costs still exert a dominant influence on learners’ intention to continue using such services. This insight is further validated by the qualitative interview data, where the criterion of “free access” was frequently emphasized in students’ app adoption decisions. Interestingly, despite its significance, the price sensitivity of university learners remains an underexplored area in the existing literature on mobile learning applications. This gap presents a valuable opportunity for future research to delve deeper into the relationship between app pricing models and user adoption or retention behaviors.

With regard to assistance from more capable others, the statement “Experts or more capable individuals (e.g., my teacher or peers) always instruct me to use their recommended mobile learning applications in class or after class” received the highest proportion of “disagree” and “strongly disagree” responses. In contrast, more than 80 % of respondents acknowledged that obtaining suggestions or guidance from experts or more capable peers is essential when using mobile learning applications. This apparent discrepancy highlights a gap between students’ perceived need for support and the actual support they receive.

This finding is consistent with previous research indicating that while students often require assistance in navigating mobile technologies for learning, such support is frequently insufficient or lacking [20, 14]. The interview data further reinforce this point, with many

participants emphasizing the importance of receiving guidance from their teachers or peers in the selection and use of mobile learning applications. Nevertheless, most students also noted that such assistance is rarely offered in practice, underscoring a persistent mismatch between learners’ needs and the educational support provided.

One underlying reason for the limited assistance provided by educators may be a lack of knowledge or familiarity with mobile learning applications themselves. Some teachers may not be fully aware of how to evaluate or select appropriate applications, nor may they recognize the importance of offering support when mobile learning tools are incorporated into the educational process. Rakhmatov’s [57] study underscores this issue, identifying a significant deficiency in teachers’ understanding of mobile learning applications, particularly in relation to their intended purpose and functional operation. However, the study also demonstrated that with targeted intervention—most likely in the form of training or professional development—teachers showed significant improvement in both their knowledge and ability to utilize these tools, as evidenced by the positive shift from pre-test to post-test scores.

If such a gap exists among university-level educators, it is reasonable to assume that a similar knowledge deficit may be present among students. Consequently, for teachers to effectively support learners in using mobile learning applications, they themselves must first develop a comprehensive understanding of these tools. According to the interview findings, many students regard their teachers as authoritative sources of information and guidance. Therefore, teacher competence in this area directly influences students’ ability to navigate mobile learning effectively.

In summary, assistance from more knowledgeable others—whether teachers or peers—is essential to enhancing learning performance. When learners are guided appropriately and have access to knowledgeable support, their use of mobile learning applications can be significantly more productive. Thus, fostering digital pedagogical competence among educators should be a priority to bridge this support gap and maximize the educational benefits of mobile technologies.

Findings 2. Adopting Strategies of Mobile Learning Applications

The final and most significant finding of this research directly addresses the primary research aim. Survey results revealed that 93.4 % of respondents agreed or strongly agreed with the statement that they would choose a learning application because it meets their specific needs, yielding the highest mean score of 4.25 (SD = 0.62) among all ten items. This finding is strongly corroborated by the qualitative data, in which the majority of interviewees emphasized that identifying and meeting individual learning needs is the foremost strategy in their decision-making process for app adoption. The second-highest mean

score was 4.18, with 89 % of participants indicating a preference for choosing a learning application due to the availability of accessible premium functions. This aligns with interview responses suggesting that users prefer not to pay for learning applications and are especially drawn to those offering valuable free features. Interestingly, the same percentage of learners (89 %) reported that they would opt for a learning application recommended by more capable others, such as teachers or peers. This reflects a recurring theme in the interviews, where peer and teacher recommendations were frequently cited as influential factors in app selection.

Moreover, participants expressed strong agreement with the statement, “I would like to choose a learning application after a careful analysis and comparison,” reinforcing another key finding from the interviews. In the third stage of the adoption process described qualitatively, learners highlighted the importance of conducting a thorough analysis of the pros and cons of potential applications before making a final decision. Together, these quantitative and qualitative results provide a cohesive understanding of learners’ mobile app adoption behavior, underscoring that app selection is primarily driven by individual learning needs, cost-effectiveness, peer/teacher influence, and critical evaluation.

Overall, both the qualitative and quantitative findings indicate that the primary consideration for most university students when selecting learning applications is their specific academic needs and goals. Learners demonstrated a clear preference for free, high-quality content, reflecting a cost-sensitive approach to mobile learning. In addition, assistance and recommendations from more capable others, such as teachers and peers, played a significant role in influencing app adoption decisions. Interestingly, high download numbers were not viewed as a critical factor in choosing educational applications, particularly when compared with other adoption criteria. Instead, user-generated content, such as comments and reviews available under app listings, emerged as a common method used by learners to assess the app’s value and relevance. Moreover, many of the adoption criteria identified in the survey were also consistently mentioned in the interviews, highlighting a strong alignment between the two data sources and thus reinforcing the reliability and validity of the research findings.

8. Conclusion and implications

Based on the findings and in-depth discussion, several key insights emerged from this study. Notably, academic major was found to have a significant influence on learners’ assisted learning performance when using mobile applications. This suggests that discipline-specific academic requirements and learning objectives play a crucial role in shaping how students engage with mobile learning tools. In contrast, variables such as gender, geographic location, and years of university study did not demonstrate a statistically significant relationship with the dependent variable. Although this finding diverges from some previous studies, it is justifiable given the specific context and design of the current research. Furthermore, the variable “overall use of mobile learning applications” showed a positive and significant relationship with learners’ performance, reinforcing the value of regular and meaningful engagement with such tools. However, it is important to note that certain dimensions within this sub-scale exhibited only weak correlations with the dependent variable, suggesting that not all aspects of mobile app use contribute equally to academic outcomes. Crucially, learners’ positive perceptions of mobile learning applications were found to be strongly associated with improved learning performance. This highlights the importance of fostering favorable attitudes toward mobile-assisted learning through institutional support, teacher guidance, and the development of user-friendly, pedagogically sound applications.

The findings of this study reveal that most university learners perceive their learning performance to be significantly enhanced through the support of more capable others when using mobile learning

applications. However, students consistently reported a lack of sufficient guidance and assistance in this context. The role of teacher involvement is particularly critical: empirical evidence suggests that teacher recommendations and instructional support can substantially improve student engagement and outcomes. For instance, research shows that classrooms integrating these tools experience a 30 % increase in student engagement [58], and guided instruction with mobile apps yields an average 15 % improvement in assessment scores [59]. Moreover, teachers contribute to the personalization of learning experiences by recommending applications that align with students’ individual goals. According to Parsons [60], 65 % of educators observed improved student performance as a result of consistent mobile app usage. These findings underscore the indispensable role of teacher facilitation in maximizing the educational benefits of mobile learning technologies. Nonetheless, the current mobile learning application market falls short in addressing the diverse and evolving needs of university learners. This highlights the necessity for further development of new applications and the enhancement of functionalities in existing ones to provide more comprehensive learning support. In response to these challenges, this study proposes a newly developed framework designed to guide the strategic adoption of mobile technologies for assisted learning performance within higher education institutions in the People’s Republic of China (PRC).

This study has addressed several critical questions and provides valuable implications for practice regarding the use of mobile technology to enhance learning performance among Chinese university students. By examining the relationships between various factors related to assisted learning through mobile technology, this research contributes to the growing body of knowledge on mobile-assisted learning, particularly within the context of higher education in the People’s Republic of China (PRC). The findings revealed that students hold a generally positive attitude towards utilizing mobile learning technologies (applications) to support their learning performance. A significant number of respondents acknowledged the crucial role of guidance from teachers and peers in selecting appropriate learning applications. While online searches and social media can serve as helpful tools for some students in identifying useful apps, many expressed a strong preference for seeking recommendations from their own teachers. This preference is rooted in the academic authority that teachers hold, making their advice a more trusted and reliable source compared to the often uncertain and commercially driven suggestions found online. In light of these findings, it is essential for university lecturers to equip themselves with mobile technology literacy, enabling them to better meet the evolving learning needs of students in a mobile technology-driven educational environment. Furthermore, the results indicate that a significant number of users are reluctant to pay for mobile learning apps. This reluctance is likely linked to perceptions about the value and effectiveness of these applications, suggesting that students are more inclined to choose free or low-cost options unless the benefits of premium features are perceived as substantial.

Brenton [61] also highlighted that both teachers and students share the aspiration that technology could significantly enhance the efficiency and effectiveness of teaching, ultimately improving learning outcomes both in and outside the classroom. However, the improvements in learning outcomes have often been less significant than anticipated. This can be partly attributed to the fact that learners may not have access to the same technological capabilities on their devices due to issues such as security, privacy concerns, and other technological or environmental restrictions. More crucially, there remains a significant need for guidance and support from teachers, particularly when students are introducing new learning applications into their educational routines. Equal access to the functionalities and capabilities of devices is therefore a critical factor that influences the flexibility and richness of mobile learning. While new technologies continue to emerge, the primary focus of this study is to explore how learners can effectively select and use mobile applications to enhance their learning performance. As Brenton

[61] rhetorically questioned, “What are the affordances of human teachers in a technology-based learning era?” In this context, adopting mobile technology strategies for assisted learning performance, particularly through guidance from teachers, experts, or even more capable peers, appears to be a sound approach, especially when viewed through the lens of Vygotsky’s Zone of Proximal Development (ZPD).

It is important to acknowledge the limitations of this study, which may affect the generalizability of the findings. First, the research was conducted within China’s higher education institutions, involving students from various majors, locations, and years in university. Although the study aimed to encompass a broad range of universities across China, it may not fully represent all institutions nationwide. Second, the study focused solely on students, thereby excluding the perspectives of teachers. The extent to which teachers use mobile technology both in and outside of the classroom, as well as their views on adopting mobile technology strategies to enhance students’ learning performance, were not explored due to time and resource constraints. Third, the results of this study may not be applicable to higher education institutions in other countries, or to different educational stages within China. However, the findings could inform future research on mobile technology use in various educational contexts. Fourth, the study specifically examined mobile learning applications as tools to assist learning performance, while other aspects of mobile technology were outside the scope of this research due to budgetary and time limitations. Finally, data were collected via questionnaires and interviews with students. Given the limited sample size, the study’s findings may not fully capture the diversity of majors or geographic locations within Chinese higher education institutions, as the distribution of respondents across these categories was not sufficiently balanced.

In conclusion, this study has contributed valuable new data and a theoretical framework to the existing body of research on mobile technology and its role in enhancing assisted learning performance in the People’s Republic of China (PRC). The findings underscore the importance of receiving guidance and support from more capable individuals—such as teachers and peers—when selecting and using mobile applications, as this guidance plays a critical role in improving learning outcomes. Furthermore, the study highlights the significance of well-developed adoption strategies for integrating mobile technology into learning practices. Both the quantitative and qualitative data substantiate the importance of these strategies in fostering effective mobile learning experiences.

Consent for publication

Not applicable

Ethics approval and consent to participate

Ethics committee: Prof. Dr. Zamberi Sekaw, Chair, Ethics Committee for Research Involving Human Subjects, Universiti Putra Malaysia.

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Availability of data and materials

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Ruichen Yuan: Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Habibah Ab Jalil:** Validation, Supervision. **Muhd Khaizer Omar:** Validation, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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1. Yuan Ruichen: PhD candidate Yuan Ruichen is a newbie researcher who has a ten-year experience of teaching English as a full-time job, mainly focusing on the teaching of IELTS among high school students and college students. She has done marvelous job by helping thousands of students pass the exam and got into their dream schools. She has also won many teaching prizes in the past decade. In the past few years, mobile technology has become prevalent in her teaching process, which has provided convenience and efficiency to both teaching and students' learning and it intrigued her interests into this area, hence she chose educational technology as her further study direction, especially with mobile application learning.

Research area:
Mobile-assisted Learning
Mobile Application Learning
Higher Education Teaching and Learning

2. Habibah Ab Jalil: Associate Professor Dr. Habibah Ab Jalil is an academic in the Faculty of Educational Studies, Universiti Putra Malaysia (UPM) since 2000. An instructor for courses related to information and communication technology (ICT) in education for graduate and undergraduate students. She holds a Bachelor of Science with Education (Hons) majoring in Physics, a Master of Science (Physics Communications) UPM and a doctorate from the University of Bristol, United Kingdom. She was actively involved in the multimedia production for educational courseware and become a facilitator for multimedia production workshops since 1996 in Cyber Creative Laboratory (CCL) and Department of Physics, Faculty of Science UPM until 2002. Parallel to the development of ICT, then she explored another important area of ICT in Education which is Online Learning through her doctoral study. In particular, she studied the Learning Management System (LMS) in Higher Education context from the sociocultural perspective. She has studied the process of teaching and learning through online interaction. She was invited as a speaker in one of the Economic and Social Research Council / Worldwide Universities Network (ESRC/WUN) Research Seminar series entitled 'Researching Dialogue and Communities of Enquiry in E-learning in HE. Results from the seminar series, a book has been produced titled 'The Sage Handbook of E-learning Research' (2007) and she infused a new conception of 'teaching' in a virtual environment called 'teaching as assisting others' performance' recommended in one of the chapter.

At international level, she was an Associate Member of Association for Learning Technology, ALT (UK based), was a Junior member of International Federation for Information Processing (IFIP), was a member of Global Learn Asia Pacific 2011, International Society of the Learning Sciences, Association for the Advancement of Computing in Education (AACE). She was invited as the Malaysia representative by the UNESCO to the Second Regional Expert Meeting - MOOCs as a Catalyst to Enhance Teaching and Lifelong Learning in Asia and the Pacific in 2016. At national level, she was a member of the Malaysian Public Universities Council of e-Learning or Majlis e-Pembelajaran IPTA Malaysia' (MEIPTA) representing UPM and a member of Malaysian Association for Mobile Learning. She was assigned as the lead researcher for the study of MOOC on a national level in 2016 which have a major impact on UPM and the country. She involved in the development of various national policy including National policy on e-Learning (DePAN) and DePAN 2.0, Malaysian MOOC Development Guideline, National Open Educational Resources and National Gamification.

At University level, she was a Coordinator and Associate Fellow of Teaching and Learning Innovation Division, Centre for Academic Development (CADE), UPM, particularly coordinate programs and research related to SCL, Blended Learning, LMS, MOOC and OER at the Universiti Putra Malaysia. Now, she is the Technology Coordinator of Putra Future Classroom (PFC), Faculty of Educational Studies, taking role in establishing and strategizing the operation and direction of the first PFC in UPM. Her interest towards Science and Education, including in giving awareness to young children and University students of the importance of Astronomy are proven through various voluntary work in the area. She involved in various research project including on Math/Science Education, disadvantages children, technology-based research, Student-centered Learning, Students' Soft-skill in Higher Education, Organization Development, Educational Management Information System (EMIS) and Assessment. She is actively involved in both undergraduate and post-graduate student research in the Faculty. She has already published several book chapters, a book, articles in both local and international journals and proceedings which related to her field of expertise.

3. Muhd Khaizer Omar: Dr. Muhd Khaizer Omar graduated from the School of Teaching and Curriculum Leadership, College of Education, Health and Aviation, Oklahoma State University, under the supervision of Associate Prof. Dr. Mary Jo Self, Emerita Prof. Dr. Lynna Ausburn, Prof. Dr. Juliana Utley, and Prof. Dr. Pamela Brown. He graduated with PhD in Workforce and Adult Education Curriculum, Instruction, and obtained Graduate Online Teaching Certificate. He is very much focusing on Technical and Vocational Education Training (TVET) and Service-Learning.

He is presently working as a senior lecturer at the Department of Science and Technical Education, in the Faculty of Educational Studies, University Putra Malaysia. He was awarded three years in a row (2013–2016) as Distinguished Graduate Scholarship at the Oklahoma State University and Lloyd L. Wiggins Endowment Scholarship proved his quality as graduate student. His dissertation on job satisfaction and retention of career-

switchers was presented in ACTER, the premier research conference specifically for Career and Technical education research. When undergoing his PhD, he was active with non-governmental agencies for example Oklahoma Food Bank and participated in numerous service-learning projects at the university.

Dr. Muhd Khaizer has written and published a number of academic papers with the lecturers/professors who taught/supervised him during his PhD studies, and with

colleagues at UPM as well as with postgraduate students who he actively supervises. He has been also involved directly with many academic organizations within and outside of UPM in organizing conferences and seminars, such as Association for Career and Technical Education Research (ACTER), International Vocational Education and Training Association (IVETA) International Conference on Educational Research and Practice (ICERP), and Graduate Research in Education (GREduc) seminars.