Research Article

Optimizing User Experience: Designing an Engaging Educational Mobile Application for English Vocabulary Knowledge and, Student Engagement in Higher Education

Tiantian Yang [1], Abu Bakar Razali [2*], Nurul Nadwa Zulkifli [3]

[1] PhD Candidate, Faculty of Educational Studies, Universiti Putra Malaysia, Selangor, Malaysia
[2*] Deputy Dean, Faculty of Educational Studies, Universiti Putra Malaysia, Selangor, Malaysia
[3] Senior Lecturer, Faculty of Humanities, Management and Science, Universiti Putra Malaysia, Selangor, Malaysia
* **Corresponding Author:** abmr_bakar@upm.edu.my

ARTICLE INFO	ABSTRACT
	This study explores the potential of educational mobile applications (apps) in Chinese higher education for English as a Foreign Language (EFL) learning. Amidst increased mobile device usage among college students, educational apps offer promise for enhancing language learning. However, their true impact on student performance and the intricate relationship between app design, English vocabulary knowledge, and student engagement remain insufficiently explored. To bridge this gap, a comprehensive study involving 326 Yunnan Minzu University students was conducted. Utilizing partial least squares structural equation modeling (PLS-SEM), our analysis aimed to assess how engaging educational apps impact English vocabulary development and student engagement. Additionally, we examined the role of language skills and student involvement as potential moderators between app design and English academic achievement. Results indicate that well-designed educational apps significantly improve English vocabulary knowledge and increase student engagement. This underscores app design's pivotal role in enhancing academic success in English language learning. Moreover, language proficiency and student involvement were found to moderate the relationship between app design and English academic achievement, emphasizing personalized learning's potential to boost student motivation and overall success. Theoretical implications emphasize the critical role of app design in augmenting vocabulary acquisition and encouraging active student participation. This study provides insights into designing purposeful educational apps for effective EFL learning, benefiting educators and developers, and contributing to technology-enhanced language learning literature. **Keywords:** Educational Mobile Apps, App Design, English Vocabulary Learning, Student Engagement, Academic Performance.

INTRODUCTION

Mobile technology has radically changed many facets of society including education and it has become an indispensable part of our everyday life (Matzavela & Alepis, 2021). Especially in the area of English vocabulary acquisition in higher education new opportunities for educational activities have been made possible by the widespread use of smartphones and the simplicity of mobile applications (Rakhmatov, 2021). Academics, educators, and app developers are concentrating on developing engaging and practical educational mobile applications as the need for English language proficiency rises in a more globalized world (Eshankulovna, 2021; Rajendran & Yunus, 2021).

In China, English language study has become a vital component of academic and professional success in Chinese higher education (Liu & Cui, 2023). Because English vocabulary is important for language proficiency

and especially for employment for graduates in colleges, efficient vocabulary acquisition strategies are required for Chinese EFL college students to increase their language skills (Obaid, Mahdawi & Khalaf, 2022). With the widespread usage of mobile devices among Chinese college students, educational mobile applications present a viable route for improving vocabulary learning experiences (Yan & Singh, 2023). Despite their growing popularity, however, such apps require empirical research to determine their effectiveness and impact on student results (Wang & Kim, 2023).

Previous research has looked into the possible benefits of educational mobile apps in improving English language learning results (Criollo-C, Guerrero-Arias, Jaramillo-Alcázar & Luján-Mora, 2021). For example, Li and Hafner (2022) discovered that mobile-assisted vocabulary learning increased students' vocabulary acquisition and retention considerably. Huang and Swanto (2023) stressed the importance of app design characteristics such as interactivity and multimedia integration in encouraging language learners' engagement and motivation. These studies established the groundwork for future research on the impact of educational mobile apps on language learning outcomes.

However, while the earlier study has looked at the relationship between educational mobile applications and language acquisition, there is a significant research gap in terms of the elements that relate to app design, student engagement, and academic success (Shortt, Tilak, Kuznetcova, Martens & Akinkuolie, 2021). Increasing English language skills and increasing student engagement have been highlighted as potential mediators linking app design and enhanced academic outcomes (El-Sabagh, 2021; Liu & Cui, 2023). More empirical study is needed to understand mediating processes and academic success (Liu & Cui, 2023). Most studies have focused on general language learning, and Chinese higher education research is scarce (Dhimolea, Kaplan-Rakowski & Lin, 2022; Wang & Kim, 2023). As a result, the authors of this article conducted this research to fill these gaps by investigating the role of app design in developing English vocabulary knowledge, student engagement, and academic achievement in Chinese higher education settings.

This research aims to investigate the effects of developing engaging and practical educational mobile applications on student engagement, the acquisition of English vocabulary, and academic success in the context of higher education in China. In essence, the purpose of this research is to add to the current body of knowledge by exploring the influence of building engaging educational mobile apps on English vocabulary learning and student involvement in higher education in China. This study aims to provide insight into the complicated interactions between app design, learning processes, and academic achievement by investigating the mediating roles of enhancing vocabulary knowledge and student engagement. The study's findings can help educational practitioners, app developers, and policymakers better understand how to use educational mobile apps to improve language learning outcomes and student engagement in the Chinese higher education environment.

LITERATURE REVIEW

A prominent priority in the field of improving user experience is the creation of educational mobile applications customized for English vocabulary learning within the higher education landscape (Qian, 2022). These apps should be entertaining and easy to use so students have a great experience (Dias & Brito, 2021). The idea is to interest and engage students in learning (Howell, 2021). Researchers in China have explored instructional mobile apps aimed at enhancing English vocabulary acquisition (Zhang & Crompton, 2021). Their findings indicate that such apps have the potential to positively impact language learning outcomes in the context of English as a Foreign Language (EFL) education. Additionally, Compen, De Witte and Schelfhout (2021) have emphasized the importance of motivating and engaging students in their learning journey to improve overall academic performance. To achieve this, Kumar et al. (2021) stress the significance of focusing on user experience and providing educational, engaging, and interactive material. The literature on this topic, as explored by (Law & Heintz, 2021), delves into various techniques and methodologies for enhancing user experience in educational mobile apps, encompassing design concepts, instructional approaches, and technology breakthroughs (Liu et al., 2021). Meanwhile, studies (e.g., Ting & Lina, 2023; Zahedi et al., 2021) have proposed combining gamification, researcher integration, adaptive learning techniques, and social interactions in educational apps to raise student interest, foster vocabulary retention, and improve general engagement in higher education settings. By building upon the insights gained from these studies, our research aims to develop compelling educational mobile apps to enhance English vocabulary learning and student engagement, thereby contributing to improved language acquisition in higher education settings.

Furthermore, there should be more studies that look into the specific issues that Chinese students have when studying English and how instructional mobile apps might help them overcome these obstacles. Moreover, understanding the English vocabulary learning process and student engagement among Chinese EFL students is

critical in today's globalized world (Zhang & Crompton, 2021). As China emphasizes the importance of English language education in its universities, it becomes crucial to investigate effective strategies to improve language proficiency and academic performance; as said by Compen et al. (2021). By exploring the impact of instructional mobile apps on English vocabulary acquisition and engagement, this study aims to provide valuable insights for policymakers and educators to tailor language learning interventions, fostering a linguistically proficient and globally competent generation of graduates (e.g., Ting & Lina, 2023; Zahedi et al., 2021). Designers may create apps that engage with learners and deliver a more culturally relevant and successful learning experience by catering to the distinct demands and preferences of the Chinese student community (Androsov & Zhang, 2023; Mukhibat & Effendi, 2023). More researchers should also shed light on the significance of optimizing user experience in the context of educational mobile apps for English vocabulary learning. This is so that developers and educators may collaborate to design mobile applications that empower students, facilitate vocabulary acquisition, and improve the entire learning experience in higher education institutions across China by studying the elements that lead to engagement and usability (Choi & Chung, 2021; Desnelita, Susanti, Rizal & Ritonga, 2023).

Designing Engaging and Useful Educational Mobile Apps for English Vocabulary Learning

Mobile apps have visual aesthetics, interactive elements, gamification, content display, and ease of navigation. In order to increase user motivation and interest, compelling educational mobile apps must include attractive imagery, interactive exercises, and intuitive interfaces (Papadakis, Kalogiannakis & Zaranis, 2021). Students are more likely to be interested and actively participate in vocabulary acquisition exercises if aesthetically appealing interfaces with appealing multimedia features, such as colorful images, videos, and animations, are created (LeFebvre, Parsons, Entwistle, Boyd & Allen, 2022). Incorporating gamification components, such as incentives, challenges, and leaderboards, can also give a sense of accomplishment and healthy competitiveness among learners, contributing to improved engagement and app usage (Retnaningsih, Nugroho, Triana, Putra & Mutiaraningrum, 2023; Saleem et al., 2022).

Another important part of creating effective educational mobile applications for English vocabulary acquisition is making sure they are easy to navigate and accessible (Choi & Chung, 2021). User-friendly interfaces, clear directions, and intuitive capabilities help students to smoothly navigate through the program, allowing them to focus on the learning content rather than technical complexity (Chen, Zou, Xie & Cheng, 2021). Furthermore, implementing personalized features, such as adaptive learning algorithms or individual progress tracking, can tailor the app experience to each student's particular requirements and talents, improving the app's overall usability and efficacy (Bang, Li & Flynn, 2023).

By providing students with an interactive and immersive learning environment, well-designed educational mobile apps can favorably improve academic achievement (Zhang, Zou & Xie, 2022). These apps engage students with exciting content, interactive exercises, and multimedia features to improve vocabulary knowledge, interpretation, and use in both written and spoken contexts (El-Sabagh, 2021; Liu & Cui, 2023). This improves pupils' English language skills and academic performance (Shah et al., 2022). Educational mobile apps allow students to learn a language anytime, anywhere (Law & Heintz, 2021). This ease of access can lead to increased exposure to English language content, allowing students to practice and reinforce their vocabulary abilities more frequently, which can improve their academic achievement (Qian, 2022). Furthermore, the capacity of these apps to provide quick feedback and individualized learning experiences might help kids further along their language development journey, potentially leading to better performance in examinations and evaluations (Howell, 2021). By providing a variety of interesting and engaging tasks, educational mobile apps play an important role in developing English vocabulary knowledge (Zhang & Zou, 2022). These apps can provide students with a variety of vocabulary exercises, including flashcards, word games, quizzes, and contextualized practice, allowing them to actively engage with and reinforce their vocabulary knowledge (Al-Jarf, 2022). These apps adapt to diverse learning styles and preferences by providing a number of learning modes, including visual, aural, and kinesthetic approaches, boosting vocabulary learning efficacy (El-Sabagh, 2021).

Furthermore, these apps can employ spaced repetition techniques, which take advantage of the spacing effect to improve word recall (Zhang et al., 2022). Educational mobile apps can assist students in consolidating their learning and increase long-term recall by deliberately repeating and revisiting vocabulary units at particular intervals (Still, 2023). Furthermore, including context-rich examples, collocations, and usage scenarios within the app content can help students comprehend word definitions, subtleties, and acceptable usage, developing English vocabulary knowledge (Dinh, 2022).

Engaging and interactive educational mobile apps can also increase student engagement by providing a dynamic and immersive learning experience (Carroll, Lindsey, Chaparro & Winslow, 2021). These apps can generate a sense of difficulty, success, and fun through features such as gamification aspects, rapid feedback,

progress tracking, and prizes, pushing students to actively participate and persevere in their vocabulary learning journey (Mohd et al., 2023).

Furthermore, including social interaction features within the app, such as discussion boards, peer cooperation, or virtual language exchange chances, can boost student engagement by cultivating a feeling of community and encouraging collaborative learning experiences (Tang & Hew, 2022). Interacting with other students, sharing experiences, and receiving support and criticism can boost motivation and engagement (Martin & Borup, 2022).

Student involvement mediates the link between educational mobile apps for English vocabulary learning and academic performance (Hu, bin Sidek, Abd Rahman, Yusof & Chen, 2023). These apps have the ability to boost students' active involvement, motivation, and dedication through cultivating engagement, resulting in greater vocabulary knowledge, improved academic outcomes, and a more enriching learning experience (Shah et al., 2022).

Research Objective and Research Hypotheses

This research aims to investigate the effects of developing engaging and practical educational mobile applications on student engagement, the acquisition of English vocabulary, and academic success in the context of higher education in China (Figure 1). In essence, the purpose of this research is to add to the current body of knowledge by exploring the influence of building engaging and usable educational mobile apps on English vocabulary learning and student involvement in higher education in China. Several hypotheses are developed to be tested in the study as mentioned below:

H1: The design of engaging educational mobile apps for English vocabulary learning significantly influences students' academic performance.

H2: Developing English vocabulary knowledge significantly mediates the relationship between the design of educational mobile apps and students' academic performance.

H3: Student engagement significantly mediates the relationship between the design of educational mobile apps and students' academic performance.
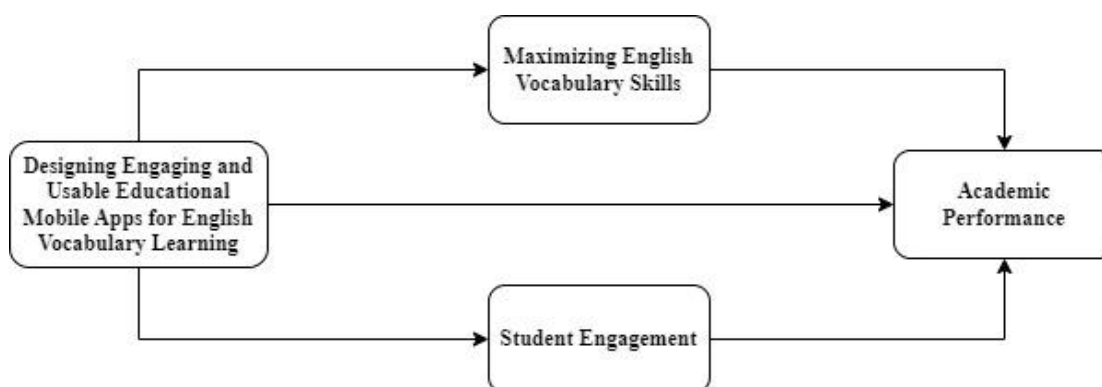

Figure 1. Conceptual model

METHODOLOGY

Data for this study were gathered from college students in Yunnan, China. The sample size for this study was 326 students. Purposive sampling was used to choose participants, guaranteeing representation from many institutions and specialties to increase the generalizability of the findings. The data collection method was done through online surveys and face-to-face contacts. First, a structured questionnaire based on the study factors was created, which included the design of instructional mobile apps, academic performance, optimizing English vocabulary abilities, and student involvement. A trial group of students completed the questionnaire online to assess its clarity and applicability. Following the refinement of the questionnaire based on their feedback, it was emailed to the target sample.

The data was collected using the questionnaire, a five-item scale used to assess the Design of Engaging and Usable Educational Mobile Apps for English Vocabulary Learning (Mohtar, Jomhari, Omar, Mustafa & Yusoff, 2023). Whereas to assess the Academic Performance a five-item scale of Wang, Qadi, Asmat, Aslam Mian and Luo (2022) was used. In this study to assess the development of English vocabulary Knowledge the scale of Rezaei,

Mai and Pesaranghader (2014) was used. An eight-item scale by Bertolani, Mortari and Carey (2014) has been used to measure Student Engagement.

This study's data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM is a robust statistical technique that allows for the evaluation of complex interactions between variables in exploratory research. The investigation was divided into two stages: 1) measurement model evaluation and 2) structural model evaluation. The measurement items' reliability and validity were investigated throughout the measurement model evaluation. This includes tests like confirmatory factor analysis (CFA), analyzing internal consistency with Cronbach's alpha, and testing convergent and discriminant validity using indicators like factor loadings and average variance extracted (AVE).

After verifying the measurement model, the structural model tested hypotheses and examined variable relationships. Bootstrapping was utilized to evaluate route coefficient significance and estimate model variables' direct and indirect effects. The independent factors' variance in predicting the dependent variable was calculated using R-squared values.

Throughout the research process, ethical norms were rigorously followed. Informed consent ensured voluntary participation and confidentiality for all participants. The researcher's institution approved the study. This mixed-method study used PLS-SEM to examine the relationships between educational mobile app design, English vocabulary enhancement, student engagement, and academic performance among Yunnan college students.

RESULTS

Table 1 shows each study variable's Cronbach's alpha. The measuring scales' reliability was assessed using Cronbach's alpha coefficient, which measures item internal consistency within each construct. Internal consistency and reliability increase with Cronbach's alpha. The variable "Academic Performance" had a Cronbach's alpha coefficient of 0.736, indicating that the items assessing academic ability had a reasonable level of internal consistency. With a Cronbach's alpha of 0.854, the construct "Designing Engaging Educational Mobile Apps for English Vocabulary Learning" demonstrated a higher level of internal consistency, indicating good reliability of the assessment items. Similarly, the construct "Developing English Vocabulary Knowledge" had a Cronbach's alpha of 0.822, indicating that it had excellent internal consistency.

Cronbach's alpha coefficient for the variable "Student Engagement" was 0.818, indicating a credible measurement of student engagement. This shows that the items used to assess student participation in the context of the study had a high level of internal consistency. These findings corroborate the measurement scales' reliability in the study, demonstrating that the items assessing academic performance, the design of instructional mobile apps, maximum English vocabulary knowledge, and student engagement were internally consistent and reliable measures.

Table 1. Scale reliabilities via Cronbach's alpha

Measurement Scale	Cronbach's Alpha
Academic Performance	0.736
Designing Engaging Educational Mobile Apps for English Vocabulary Learning	0.854
Developing English Vocabulary Knowledge	0.822
Student Engagement	0.818

The factor loadings, composite reliability, and average variance extracted (AVE) for each research construct are included in Table 2's results of the measurement model assessment. These numbers shed light on the measurement items' internal consistency, convergent validity, and reliability. Academic performance consisted of five items. These items' factor loadings, which ranged from 0.552 to 0.743, showed satisfactory measurement validity. The academic performance construct's composite reliability was 0.795, which indicates high internal consistency. The academic performance had an average variance extracted (AVE) of 0.540, which means that 54% of the variance in the construct was captured by the measuring items.

Three components (DEMA1, DEMA 2, and DEMA 3) were included in the construct "Designing Engaging Educational Mobile Apps for English Vocabulary Learning". These items had factor loadings that ranged from 0.783 to 0.934, which is a sign of a high degree of measurement validity. The design of educational mobile apps construct's composite reliability was 0.913, which denotes strong internal consistency. This construct's AVE was 0.778, indicating that measuring items could explain 77.8% of its variance. "Developing English Vocabulary

Knowledge" had five items, and these items' factor loadings ranged from 0.630 to 0.871. It showed acceptable measurement validity. The development of English vocabulary knowledge composite reliability was 0.874, which suggests a high level of internal consistency. The measuring items had captured 58.5% of the variance in the construct since the AVE for this construct was 0.585.

There were eight items in the "Student Engagement" construct. These items' factor loadings, which ranged from 0.509 to 0.787, showed satisfactory measurement validity. The student involvement construct's composite reliability was 0.860, indicating strong internal consistency. The measuring items accounted for 50.1% of the variance in this construct, according to the AVE of 0.501. The measurement items for each construct generally showed good factor loadings and internal consistency, confirming the reliability and validity of the measurement scales employed in the study, according to the results of the measurement model assessment (Table 2).

Table 2. Construct reliability and validity

	Factor	Original Sample	Composite Reliability	AVE
Academic Performance	AP1	0.595	0.795	0.540
	AP2	0.662		
	AP3	0.552		
	AP4	0.743		
	AP5	0.742		
Designing Engaging Educational Mobile Apps for English Vocabulary Learning	DEMA1	0.934	0.913	0.778
	DEMA2	0.783		
	DEMA3	0.922		
Developing English Vocabulary Knowledge	MEVS1	0.863	0.874	0.585
	MEVS2	0.630		
	MEVS3	0.651		
	MEVS4	0.776		
	MEVS5	0.871		
Student Engagement	SE1	0.745	0.860	0.501
	SE2	0.723		
	SE3	0.509		
	SE4	0.630		
	SE5	0.600		
	SE6	0.787		
	SE7	0.717		
	SE8	0.539		

The Fornell-Larcker criterion was used to examine the discriminant validity of the constructs in the study (Table 3). The criterion evaluates the correlations between constructs to the square root of the AVE values. Table 1 shows the relationships between the diagonal constructs and the square root of the AVE values. The AVE value for the construct "Academic Performance" was 0.663, which was greater than the correlation coefficients for the other constructs. Because the AVE value of academic performance is bigger than the correlations with other constructs, this shows that it has discriminant validity. For the concept "Designing Engaging Educational Mobile Apps for English Vocabulary Learning," the square root of the AVE value is 0.609, which is greater than the correlation coefficients for the other constructs (0.372 and 0.782). This implies that instructional mobile app design demonstrates discriminant validity.

Similarly, the AVE value for the construct "Developing English Vocabulary Knowledge" is 0.673, which is greater than the correlation coefficients for the other constructs (0.367, 0.787, and 0.765). This suggests that discriminant validity is important for improving English vocabulary knowledge. Finally, the AVE value for the construct "Student Engagement" is 0.911, which is greater than the correlation coefficients for the other constructs (0.593, 0.740, 0.853, and 0.663). This implies that student involvement has discriminant validity.
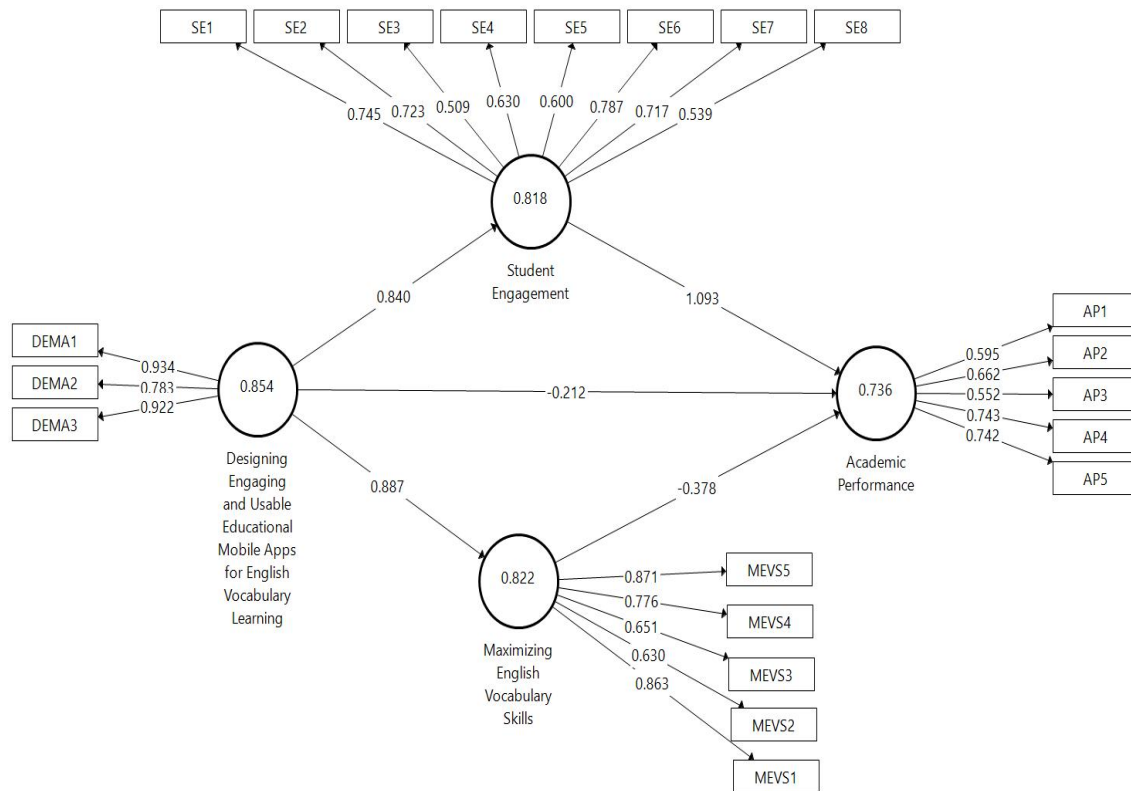
Figure 2. Measurement model

The study's findings confirm the discriminant validity of the constructs using the Fornell-Larcker criterion. Each construct has a greater AVE value than its correlations with other constructs, showing that they assess different aspects and are not substantially connected (Figure 2).

Table 3. Fornell-larcker criterion

	1	2	3	4
Academic Performance	0.663			
Designing Engaging Educational Mobile Apps for English Vocabulary Learning	0.372	0.782		
Developing English Vocabulary Knowledge	0.367	0.787	0.765	
Student Engagement	0.593	0.740	0.853	0.663

Table 4 displays the predictive quality evaluation findings, including Q2predict, RMSE (Root Mean Square Error), and MAE (Mean Absolute Error). These metrics provide information about the research model's predicted performance and accuracy. The model's Q2predict value was 0.711, indicating strong predictive quality. The model can explain and forecast a large percentage of the dependent variable's volatility using the independent factors. The average difference between predicted and actual dependent variable values is 0.063, measured as RMSE. A lower RMSE suggests improved predictive accuracy and a narrower difference between expected and actual values.

The resulting MAE value of 0.067 represents the average absolute difference between the predicted and actual values. A lower MAE, like a lower RMSE, shows better predictive accuracy and a smaller difference between projected and actual values. Overall, the predictive quality assessment results indicate that the research model predicts the dependent variable effectively based on the independent factors (Zaman et al., 2020). The Q2predict number indicates a high level of predictive quality, and the RMSE and MAE values show a tiny difference between projected and actual values, showing the model's accuracy.

Table 4. SEM model fitness index

Q²predict	RMSE	MAE
0.711	0.063	0.067

Table 5 shows each variable's R-square value. The coefficient of determination (R-square) shows how much of the dependent variable's variance the model's independent variables can explain. "Academic Performance" has

0.431 R-square. This means that the independent factors in the study can explain about 43.1% of the variance in academic achievement. It implies that factors other than those investigated in this study contribute to the remaining variation in academic performance (Yunpeng & Zaman, 2023).

The R-square value of the variable "Developing English Vocabulary Knowledge" is 0.786. This means that the independent variables addressed in the study may explain roughly 78.6% of the variance in developing English vocabulary knowledge. It implies a strong association between the model's variables and the ability to improve English vocabulary abilities. In the case of the variable "Student Engagement," the R-square value is 0.706. This implies that the independent factors in the study can explain about 70.6% of the variance in student engagement elements (Aktan, Anjam, Zaman, Khwaja, & Akram, 2023). It demonstrates a substantial association between the model's variables and the level of student involvement. These findings emphasize the extent to which the independent variables contribute to predicting the diversity in academic achievement, English vocabulary skill maximization, and student engagement. The R-square values reveal the proportion of variation explained by the independent variables in each variable, providing a measure of the model's goodness of fit and the strength of the correlations under consideration (Zaman, Nadeem, & Nawaz, 2020).

Table 5. Coefficient of determination via R-square

Variable	R-square
Academic Performance	0.431
Developing English Vocabulary Knowledge	0.786
Student Engagement	0.706

Table 6's F-square values demonstrate how much the independent variables affected their dependent variables. F-square shows the percentage of variance in the dependent variable attributed to a given independent variable. For "Designing Engaging Educational Mobile Apps for English Vocabulary Learning," the F-square values for the first, second, and third independent variables are 0.057, 3.673, and 2.401, respectively (Zaman, Aktan, Baber, & Nawaz, 2021). These numbers show the magnitude and importance of each independent variable's influence on the dependent variable. A higher F-square value indicates that the independent variable has a stronger impact on the dependent variable.

For "Developing English Vocabulary Knowledge," the F-square value is 0.044. This shows the magnitude and importance of the independent variable's impact on enhancing English vocabulary abilities. Although the effect size is somewhat smaller than that of the other variables, it still helps to explain the variation in English vocabulary knowledge development. The F-square value is 0.502 for the variable "Student Engagement," concluding. This suggests that the independent variable's impact on student involvement is significant. The higher F-square value shows that the independent variable has a significant role to play in explaining the variation in student engagement.

In general, the F-square values give details on the magnitudes and importance of the independent variables' effects on the corresponding dependent variables in the study. They draw attention to the strength of the connections and how much each independent variable contributes to understanding the variation in the relevant dependent variable.

Table 6. F-square

	Academic Performance	Developing English Vocabulary Knowledge	Student Engagement
Designing Engaging Educational Mobile Apps for English Vocabulary Learning	0.057	3.673	2.401
Developing English Vocabulary Knowledge	0.044		
Student Engagement	0.502		

Table 7 shows the results of the hypothesis testing for the study, including the original sample (O), standard deviation (STDEV), T statistics, and p-values. These figures shed light on the significance and strength of the linkages examined in the research hypothesis (Zaman, Aktan, Agrusa, & Khwaja, 2023). The first hypothesis (H1) was to assess the effect of engaging and useful educational mobile apps for English vocabulary knowledge development on students' academic performance. The T statistic of 1.364 suggests a substantial impact size, but the p-value of 0.173 shows that the connection is not statistically significant at the desired significance level (often set at p 0.05). As a result, we are unable to find sufficient data to support H1, meaning that instructional mobile app design has no significant impact on students' academic progress.

The impact of improving English vocabulary knowledge as a mediator in the relationship between the design

of instructional mobile apps and students' academic progress was studied in Hypothesis 2 (H2). The T statistic of 12.467 indicates a big effect size, while the p-value of 0.000 indicates a highly significant correlation (Zaman, Nawaz, Javed, & Rasul, 2020). These findings give strong support for H2, showing that enhancing English vocabulary abilities has a significant impact on the relationship between educational mobile app design and student academic achievement. Hypothesis 3 (H3) examined student involvement as a mediator between educational mobile app design and academic achievement. The p-value of 0.007 shows a statistically significant correlation, and the T statistic of 2.707 suggests a modest effect size. Thus, student involvement strongly influences the link between instructional mobile app design and academic attainment.
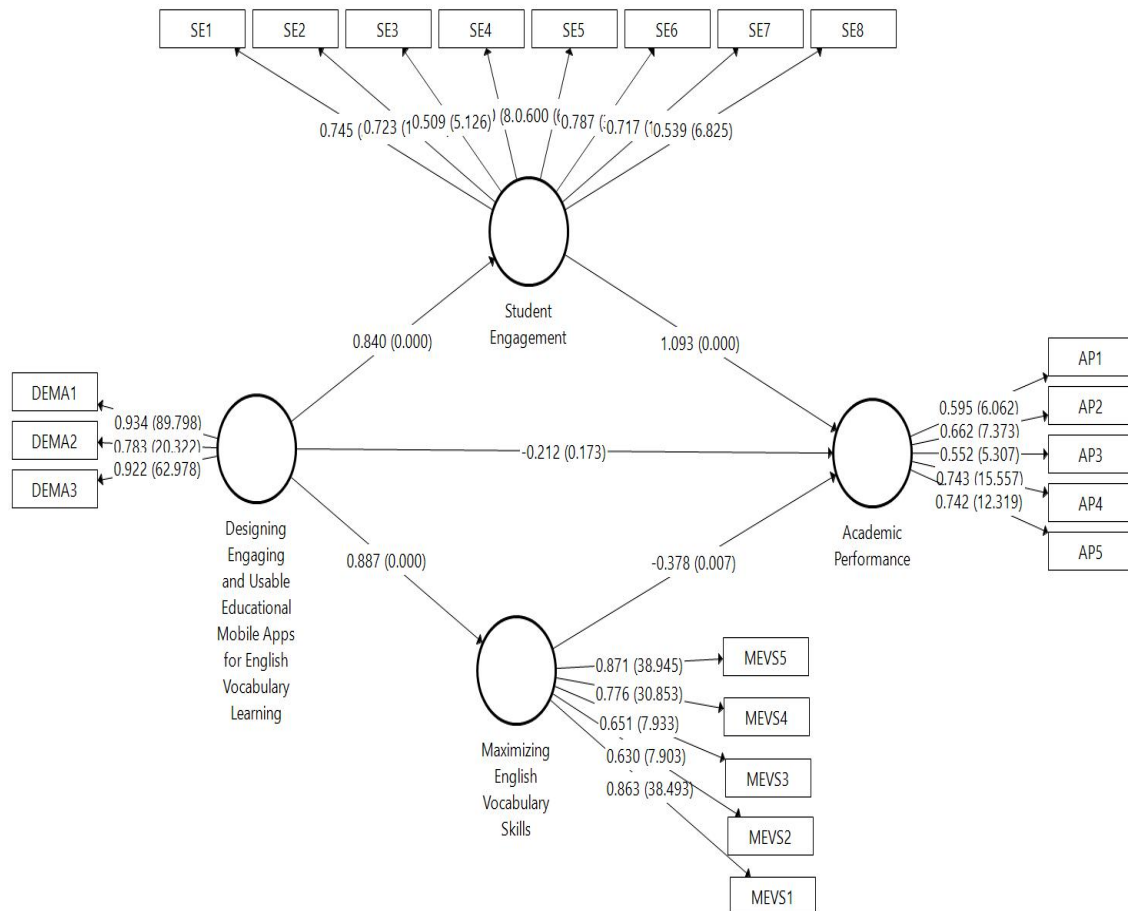

Figure 3. Structural model

In conclusion, while the design of instructional mobile apps has no direct influence on students' academic performance (H1), it has a strong indirect effect via the mediating variables of boosting English vocabulary knowledge (H2) and student engagement (H3). These findings highlight the need to consider mediating factors when researching the impact of educational mobile app design on academic performance (Figure 3).

Table 7. SEM via path analysis

Research Hypotheses	Original Sample	Standard Deviation	T Statistics	P Values	Status	Result
H1: The design of engaging educational mobile apps for English vocabulary learning significantly influences students' academic performance.	-0.212	0.155	1.364	0.173	Rejected	Insignificant
H2: Developing English vocabulary knowledge significantly mediates the relationship between the design of educational	0.918	0.074	12.467	0.0001	Accepted	Significant

Research Hypotheses	Original Sample	Standard Deviation	T Statistics	P Values	Status	Result
mobile apps and students' academic performance.						
H3: Student engagement significantly mediates the relationship between the design of educational mobile apps and students' academic performance.	-0.335	0.124	2.707	0.007	Accepted	Significant

DISCUSSION

The current study sought to investigate the optimization of user experience through the development of interesting and accessible educational mobile apps for English vocabulary learning, as well as the impact on student's academic performance in higher education. The findings shed light on the links between the independent variable (educational mobile app design), the mediating variables (developing English vocabulary knowledge and student engagement), and the dependent variable (academic achievement). This section provides a thorough review of the research findings in light of the available literature.

According to the first hypothesis, the design of engaging and useful educational mobile apps for English vocabulary knowledge development has a significant impact on students' academic performance. This was not supported by the findings. Kim Gilbert, Yu and Gale (2021) and Jiang and Wu (2023) also found no direct effect of instructional app design on academic attainment. This implies that, while mobile apps can improve learning experiences and engagement, they may not be the only factor influencing academic achievement. Individual motivation, study habits, and teaching approaches are likely to play a role in academic accomplishment.

The second hypothesis stated, on the other hand, that improving English vocabulary knowledge mediates the association between the design of educational mobile apps and students' academic achievement. The findings significantly supported this hypothesis, demonstrating that improving language abilities is an important mediator in the relationship. This finding is consistent with previous studies by Chen, Hung and Yeh (2021) and Retnaningsih et al. (2023), who stressed the significance of vocabulary acquisition in language learning and its impact on academic achievement. The development of educational mobile apps that aid in vocabulary acquisition can indirectly improve academic achievement by providing students with the necessary language skills.

The third hypothesis investigated the function of student involvement as a moderator in the link between educational mobile app design and academic performance. Student involvement strongly moderated the results, suggesting active student participation in learning. Q. Zheng and G. Zheng (2023) found that student participation improves academic performance. Academic attainment may be significantly enhanced by educational mobile applications that encourage active engagement and motivation, such as through interactive elements, gamification, and personalized learning experiences.

Overall, the outcomes of this study add to the body of knowledge on educational mobile app design, English vocabulary knowledge development, student engagement, and academic achievement. While there was no direct impact of app design on academic achievement, the mediating roles of boosting vocabulary skills and student involvement were revealed as critical factors in bridging the gap. These findings highlight the significance of implementing effective pedagogical tactics and appealing features into educational mobile app design in order to facilitate vocabulary acquisition and increase student engagement. To get a thorough understanding of the impact of app design, English vocabulary knowledge, student engagement, and other factors on student academic achievement, future studies should investigate additional variables that may influence academic performance and explore the combined effects of app design, vocabulary knowledge, engagement, and other aspects.

CONCLUSION

This study sought to evaluate the impact of building an engaging educational mobile app for English vocabulary knowledge development and on students' academic performance in higher education. The study looked at the connections between educational mobile app design, the development of English vocabulary knowledge, student engagement, and academic achievement. The findings add to our understanding of how educational mobile apps can improve learning outcomes by providing vital insights into the complicated dynamics

of these variables.

According to the results of this research, there was no correlation between the development of educational mobile applications and students' performance. These results suggest that the quality of an application design is crucial in creating engaging and accessible learning experiences but may not be the only factor in a student's success. Students' motivation, study habits, and teachers' methods all may have significant roles in their overall academic success.

The study also discovered substantial evidence that improving English language abilities and student involvement has a moderating effect. Increasing language abilities is identified as a key mediator between educational mobile app design and academic achievement. This highlights the significance of putting efficient vocabulary acquisition procedures and material into educational apps in order to improve academic performance indirectly. Similarly, student engagement was discovered as a key moderator, emphasizing the importance of active student involvement and motivation in the learning process. Educational mobile apps that encourage student engagement through interactive features, gamification, and individualized learning experiences can significantly increase academic achievement. In conclusion, while the design of educational mobile apps may not have a direct impact on academic achievement, this study highlights the necessity of boosting vocabulary knowledge and encouraging student engagement as crucial elements that might favorably influence learning results.

IMPLICATIONS

This study has theoretical implications for instructional technology, English vocabulary acquisition, student engagement, and academic achievement. For starters, the study' s findings add to the current literature by stressing that the design of instructional mobile applications may not have a direct influence on academic achievement. This calls into question the concept that app design is the primary driver of learning results and underlines the need to take into account other elements that impact academic performance. This research offers a more nuanced view of the complicated interactions between app design, learning processes, and academic success by focusing on the mediating roles of enhancing English vocabulary knowledge and student engagement.

Second, the research advances theoretical understanding of language skills and student participation in education. It adds to the literature on vocabulary acquisition in language learning and academic success. Furthermore, it emphasizes the importance of student involvement as a critical aspect in mediating the link between educational app design and academic success. These results add to a better understanding of the processes through which educational applications may successfully boost vocabulary acquisition and increase student engagement, resulting in better academic achievements.

This study's results have practical consequences for educators, app developers, and policymakers engaged in the development and deployment of educational mobile applications. To begin, educators may utilize these data to influence their teaching approaches and successfully employ educational applications. Recognizing that app design alone cannot ensure greater academic achievement, educators may use a comprehensive strategy that combines app use with effective teaching methodologies, customized assistance, and an explicit emphasis on vocabulary acquisition. This may aid in the creation of a welcoming learning environment that leverages the potential advantages of educational applications while also addressing other elements that impact academic achievement.

The research emphasizes the need to provide features and capabilities that boost vocabulary learning and student engagement for app makers. Apps with focused vocabulary exercises, adaptive learning paths, and interactive aspects may improve users' vocabulary abilities and encourage engagement. Developers may construct educational applications that are more closely aligned with students' learning requirements and preferences by addressing the mediating roles of boosting vocabulary knowledge and student engagement. This increases their efficacy in improving academic achievement.

Finally, policymakers may use the results of this study to influence decisions on the integration of educational apps into the curriculum. Recognizing that the influence of educational applications on academic achievement is mediated by improving vocabulary knowledge and increasing student engagement, policymakers should develop standards and frameworks that stress the significance of these variables. They may encourage professional development opportunities for instructors to properly incorporate educational applications into their classroom, as well as provide the necessary support and resources to assure their success.

Overall, the theoretical and practical implications of this study underscore the need to go beyond app design

and evaluate the mediating elements that affect the effect of instructional mobile applications on academic achievement. Educators, app developers, and policymakers can collaborate to harness the full potential of educational apps in improving learning outcomes and enhancing students' academic success by adopting a comprehensive approach that recognizes the role of developing English vocabulary knowledge and promoting student engagement.

LIMITATIONS AND RECOMMENDATIONS

Despite its significant contributions, this study has certain drawbacks that should be noted. For one, the research relied on a sample of students from Yunnan institutions, which may restrict the results' generalizability to other settings and situations. To improve the external validity of the findings, future studies should strive to incorporate varied samples from various educational environments. Second, the study used a cross-sectional design, which limits the ability to demonstrate causal correlations between variables. Longitudinal studies that follow the development of participants over time would give more rigorous data about the influence of app design, vocabulary knowledge, and student involvement on academic success. Another problem concerns variable measurement. While the research included trustworthy metrics, such as Cronbach's alpha and composite reliability, self-reported assessments may still have drawbacks. To gather more complete and objective data, future studies might use a mix of self-report measures and objective markers, such as real academic performance records.

Future research avenues may improve our grasp of the issue by building on the constraints indicated. To begin, performing experimental research that changes app design characteristics and analyzes their direct influence on academic achievement would bring more clarity to the causal links involved. Researchers would be able to discover certain design aspects that have a substantial influence on learning outcomes as a result of this. Furthermore, looking at the combined benefits of app design, enhancing vocabulary knowledge, student engagement, and other pertinent elements would provide a more comprehensive picture. Investigating the connections and synergies between these factors would give full knowledge of their combined impact on academic success.

It would also be good to investigate possible moderators and contextual variables that may alter the links between app design, language skills, student engagement, and academic success. Learner traits, instructional circumstances, and cultural variables may alter the observed associations and should be taken into account in future studies. Finally, doing qualitative research to acquire a better understanding of students' experiences and perspectives on educational mobile applications might give useful information. Qualitative approaches, such as interviews or focus groups, may provide extensive information on students' app engagement levels, preferences, and issues. This qualitative analysis would supplement the quantitative results and give a fuller knowledge of the phenomenon under study.

Overall, future research should attempt to resolve the study's weaknesses and better investigate the complex interactions between app design, optimizing vocabulary knowledge, student engagement, and academic success. Researchers may expand our understanding of this subject and give more rigorous and nuanced suggestions for educational practice by evaluating different samples, applying longitudinal designs, using objective measurements, and studying other contextual variables.

REFERENCES

Aktan, M., Anjam, M., Zaman, U., Khwaja, M. G., & Akram, U. (2023). Missing link in 'new-normal' for higher education: Nexus between online experiential marketing, perceived-harm, social distancing concern and university brand evangelism in China. *Journal of Marketing for Higher Education*, 1-26. doi: 10.1080/08841241.2023.2253743

Al-Jarf, R. (2022). Online vocabulary tasks for engaging and motivating EFL college students in distance learning during the pandemic and post-pandemic. *International Journal of English Language Studies (IJELS)*, *4*(1), 14-24.

Androsov, A., & Zhang, B. (2023). Students as co-creators: Bringing culturally responsive teaching into a doctoral course for International students in China. *SAGE Open*, *13*(1). doi:10.1177/2158244022114591

Bang, H. J., Li, L., & Flynn, K. (2023). Efficacy of an adaptive game-based math learning app to support personalized learning and improve early elementary school students' learning. *Early Childhood Education Journal*, *51*(4), 717-732.

Bertolani, J., Mortari, L., & Carey, J. (2014). Formative evaluation of Eccomi Pronto ['Here I Am Ready']: A school counselor-led, research-based, preventative curriculum for Italian primary schools. *International Journal for the Advancement of Counselling*, *36*, 317-331.

Carroll, M., Lindsey, S., Chaparro, M., & Winslow, B. (2021). An applied model of learner engagement and strategies for increasing learner engagement in the modern educational environment. *Interactive Learning Environments*, *29*(5), 757-771.

Chen, C. H., Hung, H. T., & Yeh, H. C. (2021). Virtual reality in problem-Based learning contexts: Effects on the problem-Solving performance, vocabulary acquisition and motivation of English language learners. *Journal of Computer Assisted Learning*, *37*(3), 851-860.

Chen, X., Zou, D., Xie, H., & Cheng, G. (2021). Twenty years of personalized language learning. *Educational Technology & Society*, *24*(1), 205-222.

Choi, L., & Chung, S. (2021). Navigating online language teaching in uncertain times: Challenges and strategies of EFL educators in creating a sustainable technology-mediated language learning environment. *Sustainability*, *13*(14), 7664.

Compen, B., De Witte, K., & Schelfhout, W. (2021). The impact of teacher engagement in an interactive webinar series on the effectiveness of financial literacy education. *British Journal of Educational Technology*, *52*(1), 411-425.

Criollo-C, S., Guerrero-Arias, A., Jaramillo-Alcázar, Á., & Luján-Mora, S. (2021). Mobile learning technologies for education: Benefits and pending issues. *Applied Sciences*, *11*(9), 4111.

Desnelita, Y., Susanti, W., Rizal, F., & Ritonga, A. R. (2023). The implementation of collaborative project based learning model with inquiry process using e-learning in higher education. *Educational Administration: Theory and Practice*, *29*(1), 90–101.

Dhimolea, T. K., Kaplan-Rakowski, R., & Lin, L. (2022). A systematic review of research on high-immersion virtual reality for language learning. *TechTrends*, *66*(5), 810-824.

Dias, P., & Brito, R. (2021). Criteria for selecting apps: Debating the perceptions of young children, parents and industry stakeholders. *Computers & Education*, *165*, 104134.

Dinh, H. M. T. (2022). Using TBLT framework in technology-mediated environments to enhance students' vocabulary retention and interpreting skills. *International Journal of TESOL & Education*, *2*(2), 201-215.

El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, *18*(1), 1-24.

Eshankulovna, R. A. (2021). Modern technologies and mobile apps in developing speaking skill. *Linguistics and Culture Review*, *5*(S2), 1216-1225.

Howell, R. A. (2021). Engaging students in education for sustainable development: The benefits of active learning, reflective practices and flipped classroom pedagogies. *Journal of Cleaner Production*, *325*, 129318.

Hu, J., bin Sidek, S., Abd Rahman, A., Yusof, R. N. R., & Chen, Y. (2023). The Influence of Internet Celebrities on Consumers' Purchase Intention and Its Educational Significance. E*ducational Administration: Theory and Practice*, *29*(2), 15-32.

Huang, Y., & Swanto, S. B. (2023). Research on College Students' Classroom Learning Based on Informatization to Promote English Education System in China. *Educational Administration: Theory and Practice*, *29*(1), 91-106.

Jiang, M., & Wu, C. J. (2023). The role of blended teaching method in vocal music learning-is innovative behavior a determinant of blended instruction adoption?. *Educational Administration: Theory and Practice*, *29*(2), 255-270.

Kim, J., Gilbert, J., Yu, Q., & Gale, C. (2021). Measures matter: A meta-analysis of the effects of educational apps on preschool to grade 3 children's literacy and math skills. *Aera Open*, *7*, 23328584211004183.

Kumar, A., Sarkar, M., Davis, E., Morphet, J., Maloney, S., Ilic, D., & Palermo, C. (2021). Impact of the COVID-19 pandemic on teaching and learning in health professional education: a mixed methods study protocol. *BMC Medical Education*, *21*(1), 1-7.

Law, E. L. C., & Heintz, M. (2021). Augmented reality applications for K-12 education: A systematic review from the usability and user experience perspective. *International Journal of Child-Computer Interaction*, *30*, 100321.

LeFebvre, L., Parsons, M., Entwistle, C., Boyd, R., & Allen, M. (2022). Rethinking powerpoint slide design for multimedia learning. *Journal of Educational Technology Systems*, *50*(4), 503-520.

Li, Y., & Hafner, C. A. (2022). Mobile-assisted vocabulary learning: Investigating receptive and productive vocabulary knowledge of Chinese EFL learners. *ReCALL*, *34*(1), 66-80.

Liu, W., Lee, K. P., Gray, C. M., Toombs, A. L., Chen, K. H., & Leifer, L. (2021). Transdisciplinary teaching and learning in UX design: A program review and AR case studies. *Applied Sciences*, *11*(22), 10648.

Liu, Z., & Cui, D. (2023). Permeable educational learning environments: The impact of the space environment fosters student learning and engagement. *Educational Administration: Theory and Practice*, *29*(1), 221-237.

Martin, F., & Borup, J. (2022). Online learner engagement: Conceptual definitions, research themes, and supportive practices. *Educational Psychologist*, *57*(3), 162-177.

Matzavela, V., & Alepis, E. (2021). M-learning in the COVID-19 era: Physical vs digital class. *Education and Information Technologies*, *26*(6), 7183-7203.

Mohd, C. K., Nuraini, C. K., Mohamad, S. N. M., Sulaiman, H., Shahbodin, F., & Rahim, N. (2023). A review of gamification tools to boost students'motivation and engagement. *Journal of Theoretical and Applied Information Technology*, *101*(7), 2771-2782.

Mohtar, S., Jomhari, N., Omar, N. A., Mustafa, M. B. P., & Yusoff, Z. M. (2023). The usability evaluation on mobile learning apps with gamification for middle-aged women. *Education and Information Technologies*, *28*(1), 1189-1210.

Mukhibat, M., & Effendi, M. (2023). Evaluation of e-learning on learning outcome at universities in Indonesia. *Educational Administration: Theory and Practice*, *29*(2), 69-84.

Obaid, A. J., Mahdawi, R. S. A., & Khalaf, H. A. (2022). Adoption Social Media-Movie Based Learning Project (SMMBL) to engage students' online environment. *Educational Administration: Theory and Practice*, *28*(01), 22-36.

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2021). Teaching mathematics with mobile devices and the Realistic Mathematical Education (RME) approach in kindergarten. *Advances in Mobile Learning Educational Research*, *1*(1), 5-18.

Qian, Y. (2022). User review analysis of mobile English vocabulary learning. *Journal of Educational Technology Development and Exchange (JETDE)*, *15*(1), 47-62.

Rajendran, T., & Yunus, M. M. (2021). A systematic literature review on the use of mobile-assisted language Learning (MALL) for enhancing speaking skills among ESL and EFL learners. *International Journal of Academic Research in Progressive Education and Development*, *10*(1), 586-609.

Rakhmatov, D. (2021). Mobile technologies in the higher education system. *Mental Enlightenment Scientific-Methodological Journal*, *2021*(02), 182-196.

Retnaningsih, W., Nugroho, A., Triana, Y., Putra, H. R., & Mutiaraningrum, I. (2023). Impact of WhatsApp-integrated flipped learning on developing English speech acts of requests: Students' Performance, perception, and acceptance. *Educational Administration: Theory and Practice*, *29*(2), 203-221.

Rezaei, A., Mai, N., & Pesaranghader, A. (2014). The effect of mobile applications on English vocabulary acquisition. *Jurnal Teknologi*, *68*(2), 73-83.

Saleem, A. N., Noori, N. M., & Ozdamli, F. (2022). Gamification applications in E-learning: A literature review. *Technology, Knowledge and Learning*, *27*(1), 139-159.

Shah, V., Murthy, S., Warriem, J., Sahasrabudhe, S., Banerjee, G., & Iyer, S. (2022). Learner-centric MOOC model: A pedagogical design model towards active learner participation and higher completion rates. *Educational Technology Research and Development*, *70*(1), 263-288.

Shortt, M., Tilak, S., Kuznetcova, I., Martens, B., & Akinkuolie, B. (2023). Gamification in mobile-assisted language learning: A systematic review of Duolingo literature from public release of 2012 to early 2020. *Computer Assisted Language Learning*, *36*(3), 517-554.

Still, K. (2023). *Test-Enhanced Learning: A practical guide to improving academic outcomes for all students*. Carmarthen, UK: Crown House Publishing Ltd.

Tang, Y., & Hew, K. F. (2022). Effects of using mobile instant messaging on student behavioral, emotional, and cognitive engagement: A quasi-experimental study. *International Journal of Educational Technology in Higher Education*, *19*, 1-22.

Ting, Z., & Lina, J. (2023). Motivation and guidance of teaching strategies on folk music education of music majors in colleges and universities. *Educational Administration: Theory and Practice*, *29*(2), 185-202.

Wang, C., & Kim, M. H. (2023). Impact of education and its importance on e-commerce platforms influencing college students' abilities and performance-based results. *Educational Administration: Theory and Practice*, *29*(3), 93-110.

Wang, Z., Qadir, A., Asmat, A., Aslam Mian, M. S., & Luo, X. (2022). The advent of Coronavirus disease 2019 and the impact of mobile learning on student learning performance: The mediating role of student learning behavior. *Frontiers in psychology*, *12*, 796298.

Yan, Y., & Singh, M. K. M. (2023). On the educational theory and application of mobile-assisted language learning and independent learning in college English teaching. *Educational Administration: Theory and Practice*, *29*(3), 137-151.

Yunpeng, G. & Zaman, U. (2023), Exploring mega-construction project success in China's vaunted Belt and Road Initiative: the role of paternalistic leadership, team members' voice and team resilience. *Engineering, Construction and Architectural Management*. doi:10.1108/ECAM-12-2022-1201

Zahedi, L., Batten, J., Ross, M., Potvin, G., Damas, S., Clarke, P., & Davis, D. (2021). Gamification in education: A mixed-methods study of gender on computer science students' academic performance and identity development. *Journal of Computing in Higher Education*, *33*, 441-474.

Zaman, U., Aktan, M., Agrusa, J., & Khwaja, M. G. (2023). Linking regenerative travel and residents' support for tourism development in Kaua'i Island (Hawaii): Moderating-mediating effects of travel-shaming and foreign tourist attractiveness. *Journal of Travel Research*, *62*(4), 782-801.

Zaman, U., Aktan, M., Baber, H., & Nawaz, S. (2021). Does forced-shift to online learning affect university brand image in South Korea? Role of perceived harm and international students' learning engagement. *Journal of Marketing for Higher Education*, 1-25. doi: 10.1080/08841241.2021.1998285

Zaman, U., Nadeem, R. D., & Nawaz, S. (2020). Cross-country evidence on project portfolio success in the Asia-Pacific region: Role of CEO transformational leadership, portfolio governance and strategic innovation orientation. *Cogent Business & Management*, *7*(1), 1727681.

Zaman, U., Nawaz, S., Javed, A., & Rasul, T. (2020). Having a whale of a time: Linking self-determination theory (SDT), job characteristics model (JCM) and motivation to the joy of gig work. *Cogent Business & Management*, *7*(1), 1807707.

Zhang, J., & Crompton, H. (2021). Status and trends of mobile learning in English language acquisition: a systematic review of mobile learning from Chinese databases. *Asian Journal of Distance Education*, *16*(1), 1-15.

Zhang, R., & Zou, D. (2022). Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning. *Computer Assisted Language Learning*, *35*(4), 696-742.

Zhang, R., Zou, D., & Xie, H. (2022). Spaced repetition for authentic mobile-assisted word learning: Nature, learner perceptions, and factors leading to positive perceptions. *Computer Assisted Language Learning*, *35*(9), 2593-2626.

Zheng, Q., & Zheng, G. (2023). Folk sports and physical education: 'Beyond the classroom'-an exploration of the relationship between folk sports participation and physical education in rural schools. *Educational*

Administration: Theory and Practice, 29(3), 69-92.