

## Research Article

# The effects of collaborative mobile learning approach on academic performance: The mediating role of social interaction, and learning motivation

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Recognizing the roles that English vocabulary, social interaction, academic performance, and learning motivation play in language learning can be useful in chiefly enhancing EFL language acquisition. This research explores the challenges that the pre-college EFL students encounter while expanding their word learning knowledge, communicating in the social setting, academically performing, and maintaining learning motivation. To address these challenges, the study explores how a collaborative mobile learning approach can be used to address the challenges and improve language learning for pre-college EFL students. A total of 326 students participated in the study. Data were collected by using a self-developed survey questionnaire with predefined questions to avoid inconsistency in responses. Using the PLS-SEM approach on the collected data, the study identified several significant relationships among the accepted collaborative mobile learning approach, social interaction, motivation to learn English, and the outcome knowledge of new English vocabulary. However, the experiment established that motivation to learn predicted the relationship between mobile collaborative learning and increases in effective vocabulary scores in English as well as academic performance. These significant findings show the essence of creating a spirit of collaboration and a learning environment that focuses on mobile learning, students, and their motivation for effective learning of EFL language goals among pre-college students. As such, this study has important implications for teaching and learning processes in general and valuable implications for the teaching and learning of EFL in particular, offering practical suggestions as to how the educational process could be improved for learners, educators, educational administrations, and policymakers.

Keywords: Academic performance; Collaborative mobile learning; English vocabulary knowledge; Social interaction; Student motivation

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## 1. Introduction

Mobile learning is transforming the process of learning the English language as a foreign language [EFL] in the field of teaching modifying the traditional EFL learning techniques (Ramalingam et al., 2022). The availability and use of mobile phones, especially smartphones and tablets has created the way for new approaches to language learning (Esra & Sevilen, 2021). Mobile learning

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utilizes technology that affords learners an individual and portable approach to acquiring languages, where they can acquire language resources, language applications, and multimedia information, whenever and from wherever wished (Gualtieri et al., 2021; Zhang et al., 2021). Mobile collaborative learning has become popular because it effectively facilitates shared learning experiences (Zhang, 2023). This research aims to establish the use of mobile devices for collaborative learning to improve English language ability, academic achievement in English, social relations, and the desire to learn English among pre-college students in China's Yunnan district (Belda-Medina, 2022). The scope of this research focuses on the identified challenges faced by students learning English as a foreign language. This relates to EFL vocabulary acquisition, academic performance, social relationships, and learning motivation. To this end, the study aims to examine the possible impact of MALL to alleviate these challenges notably (Herrera et al., 2023; Wen, 2021). Thus, the aim of the present research is to bring empirical insights to the field of EFL education integrating theory into practice. Moreover, it seeks to provide an appropriate guide to language facilitators and institutions who seek to foster improvement in language learning through the integration of mobile collaborative learning techniques.

Integrating mobile devices has received a lot of attention in use in learning environments in the recent past as a potential way of improving learning performance (Chen & Tu, 2021; Zakian et al., 2022). The use of mobile devices, such as smartphones and tablets, reveals new possibilities for the collaborative learning process and knowledge-sharing initiatives (Belda-Medina, 2022). It has been pointed out earlier that mobile devices have a positive impact on students' academic achievement and language acquisition when used to teach cooperative and interrelated activities (Krouska et al., 2022; Yu et al., 2022). Improving one's comprehension of the English language is another important goal in language learning as vocabulary in any language is considered to be the key aspect of communication (Bilgiç & Tekin, 2023). Mobile learning has been proposed as a pragmatic strategy for enriching vocabulary by integrating group learning and contextual learning activities (Herrera et al., 2023; Wen, 2021). Students can join group activities with a focus on the improvement of their vocabulary, use internet sources, and get immediate feedback on their smart devices. These activities help children in the growth and improvement of vocabulary skills (Kristiawan et al., 2022). Some scholars note possible overdependence on technology, which state that face-to-face communication may be reduced, leading to a lack of natural language usage. These findings are also supported by Chernova et al. (2022) and Ramalingam et al. (2022). There is still the question about the effectiveness of using mobile devices in the learning of EFL vocabulary which has its proponents and opponents. However, the increased usage of mobile learning applications and platforms by language learners is an indication of their possible attraction and usefulness in boosting the learning of new English vocabulary (Chernova et al., 2022; Salih & Omar, 2021). For educators and researchers to make sound decisions regarding the integration of mobile-assisted collaborative learning in EFL vocabulary, it is essential to explore and evaluate the advantages and disadvantages of mobile-assisted collaborative learning (Salih & Omar, 2021).

Another aspect of collaborative mobile learning is the purpose of social interaction among students (Criollo-C et al., 2021). Social interaction can be defined as the act of communicating as well as working with others to share information and receive constructive criticism (Whillans et al., 2021). It is recognized as one of the key aspects of high-quality learning environments (Curum & Khedo, 2021). Social connection leads to active participation encourages the sharing of ideas and improves the mastery of concepts among the learners (Tran, 2021). Research has indicated that increased social presence in Mobile Learning environments has a positive effect on learners' motivation, participation and performance (Asad et al., 2021; Tran, 2021). Collaborative mobile learning presents the learners with an opportunity to interact productively, explore ideas, and co-construct knowledge. This brings about a better understanding of the learning material and also increases the memory span of the information passed (Lim et al., 2019). Based on the literature review, improving social interaction in the context of MLE leads to increased motivation, participation, and achievement among students (Alismaiel et al., 2022). Some critics, however,

formulate concerns concerning distraction or improper usage of social facets in MLS, as they might divert students' attention from the learning objectives (Sholikah & Harsono, 2021). The continued discussion over the extent to which social interaction contributes to effective collaborative mobile learning requires additional identification of strategies to encourage beneficial social relationships while minimizing social risks. Hence, the purpose of this research is to examine how collaborative mobile learning strategies can enhance English vocabulary improvement so that students can enhance their language capabilities and communicative skills and also to contribute to the discussion on the integration of technology in language education by providing insights into the ongoing discussion.

Motivation for learning plays a crucial role in predicting the achievement of the students in language learning (Esra & Sevilen, 2021). Students' motivation could be described as a crucial factor that dictates their engagement and persistence in language learning activities (Shelton-Strong & Mynard, 2021). This is because different factors affect students' motivation, such as relevance, self-efficacy and social support when they are engaged in collaborative mobile learning (Togaibayeva et al., 2022). The study also supports the idea that students are more willing to engage in language learning activities and are more likely to succeed if they are motivated (Zou et al., 2022). Additionally, mobile learning encourages group work and togetherness among students, thus promoting a sense of belonging. Consequently, they can receive encouragement and social support in their academic endeavors (Sholikah & Harsono, 2021). Nonetheless, some scholars have argued that there are issues that may hinder the motivation of learners in mobile learning environments. The advantage of flexibility poses some challenges such as distractions and delays thus demotivating students to engage in any language learning activities (Alismaiel et al., 2022). Furthermore, the willingness and self-efficacy of students to use mobile devices for language learning can vary depending on the students' digital literacy and their experience in using the mobile devices for learning (Sholikah & Harsono, 2021; Zou et al., 2022). Still, with the increasing attention to collaborative mobile learning and its possible effect on language learning achievement, more theoretical studies are needed to understand the complex relationship between social interaction, learners' motivation and language acquisition results (Darvin & Norton, 2023; Zhang & Zou, 2022). To date, there is a research gap concerning the combination of these elements in CML (Gualtieri et al., 2021; Zhang et al., 2021).

Nevertheless, quantitative studies focusing on the nature of the relationships between collaborative mobile learning and language learning outcomes are scarce in the literature (Gualtieri et al., 2021; Zhang et al., 2021). Thus, to address the noted research gap, the current study applies a sound quantitative research methodology and gathers data from a diverse group of EFL pre-college students through a validated survey questionnaire. The purpose of this study is to explore and evaluate the effectiveness of collaborative mobile learning activities in enhancing social interactions and the engagement of pre-college EFL students as well as the overall enhancement of English vocabulary. Furthermore, it aims at enabling the effective application of integration of mobility in the EFL classroom.

## **2. Literature Review**

As mobile phones increase their use, and technology nowadays penetrates almost all areas of learning, the research aims to look at the potential of using these gadgets in learning languages (Hawamdeh & Soykan, 2021). These programs try to offer learners simple and fun methods for learning words by focusing on the unique features of mobile gadgets, like portability and the ability to interact with the user (Bacca- Acosta et al., 2022). These applications provide experiential and individualized learning solutions for learners based on multimedia media, gamification characteristics, learning environment and learning preference algorithms (Zhang, 2023). In this case, the study aims to determine the effectiveness of such apps in the context of vocabulary learning, the interest level of the learners and their general language improvement.

Due to the widespread use of mobile devices in learning environments and the increased use of innovative portable technologies, Sholikah and Harsono (2021) have explored the use of apps in m-learning environments as a way to improve the learning of foreign languages for pre-college students who speak EFL. In light of the effectiveness of vocabulary acquisition in learning a second language, scholars are studying the effectiveness of learner applications in complementing conventional methods (Sholikah & Harsono, 2021). In this research, the use of mobile learning applications to improve vocabulary proficiency is the focus, since the research is centered on developing language proficiency - and vocabulary in particular - through the use of mobile-based learning applications. In addition, the study aligns with the principles of CML and emphasizes interdisciplinary and contextual approaches to learning, interaction and social participation, and motivation of the students (Agwu & Nmadu, 2023; Shortt et al., 2023). A significant contribution will be made to language education in this study, particularly in terms of how mobile technology contributes to language learning. As part of this study, we will examine the relationship between mobile learning applications and other factors affecting language use, such as academic achievement, social interaction, and learning motivation.

The assessment of learning outcomes is the key factor for educational process (Fawns et al., 2021). The performance, cumulative records, and achievement tests all speak to the student's academic progress and skill level (Ricciardi et al., 2021). Teacher-student interactions, teaching approaches, learning environments, and students' backgrounds impact learning outcomes (Jovanović et al., 2021). Within the scope of the present study, the variable of interest, and academic performance, may refer to the measurable outcomes of students' educational achievements (Khan et al., 2021). The aforementioned outcomes form a solid starting point when evaluating the effectiveness of cooperative mobile learning in pre-university education (Cabrera & López-Quesada, 2022). Mobile learning interventions' effects on the learning achievements, that cover knowledge levels, skill, and critical thinking abilities are typically evaluated by performance on standardized tests (Chang et al., 2021). Enhancing the efficiency of the development of the English vocabulary means to develop, expand and properly use the vocabulary of a learner in English effectively (An et al., 2021). Reading, general language use or mastery, and comprehension can all be affected by one's level of vocabulary proficiency in language acquisition (Wei, 2021). Lexical knowledge can be described as the ability to comprehend a great number of various word forms and their respective meanings, nuances, and cases of usage (Vihman, 2022).

### **2.1. Role of Collaborative Learning Approach to Increase English Academic Performance**

Various studies have demonstrated that when group work is implemented, it can greatly affect a student's academic achievement in the English language (e.g. Khan et al., 2021). According to Chen et al. (2019), collaborative learning is essential for making students more active during the learning process and also encouraging direct interaction among learners themselves. It is also essential for identifying common tasks to be accomplished among learners. Moreover, these aspects are particularly beneficial when learning English since the ability to communicate and speak effectively plays a crucial role in the process (Karataş & Tuncer, 2020). Additionally, co-operative group work and peer tutoring were used in this study with positive effects on academic performance in different areas of learning, including language arts (Ehsan et al., 2019). As shown in these results, collaborative learning does not only improve language proficiency in academic English but also contributes to a productive learning environment (Chen et al., 2019).

Furthermore, Karataş and Tuncer (2020) argue that collaborative learning reflects sociocultural theory principles. According to this theory, learning occurs in social interactions, and cooperation with peers with more advanced knowledge can positively affect a learner's cognitive development (Khan et al., 2021). Having interactions as a way of practising the language, getting instant feedback, and accessing a greater variety of linguistic resources are all advantages of learning English as a second language (Karataş & Tuncer, 2020). Overall, findings suggest that cooperative learning to solve language-related problems can lead to enhanced confidence in using English in

different contexts and situations in addition to developing students' linguistic proficiency (Ehsan et al., 2019). Based on empirical evidence, these theoretical positions establish the importance of collaborative learning in improving English academic performance.

## **2.2. Role of Collaborative Learning Approach to Develop English Vocabulary**

Several studies have examined how collaborative learning improves students' English academic achievement according to the literature (Wang, 2020). Aside from this, it is important to provide an analysis of previous research to investigate all possible definitions of collaborative learning, as well as how it can improve academic achievement (Namaziandost et al., 2020). Several studies have examined the impact of integrated communication practices on language learners' academic performance, and the results are encouraging (Ehsan et al., 2019). In accordance with this research, cooperative learning can enhance students' critical thinking skills and retain learning content when it involves group discussions, peer-contrary feedback, and activities such as problem-solving in groups (Namaziandost et al., 2020). As a result of collaborative learning activities and involvement, learners are more focused and engaged and therefore perform better on the material (Ehsan et al., 2019). This study aims to shed light on the factors that enhance English academic achievement and discuss the implications for language education arising from the above-mentioned studies.

Language acquisition involves expanding vocabulary, and combining learning methods helps to improve the level of English vocabulary. While terms can be limited, research on collaborative learning in vocabulary improvement must be reviewed to gain a full understanding of its benefits. There has been much research (Kamal et al., 2021; Namaziandost et al., 2020) examining how collaborative learning methodologies and methods affect learners' vocabulary attainment, including vocabulary assessments, word activities, and related vocabulary tests in pairs and with buddies. Increasing learners' cooperation can improve their lexical development by involving them in the learning process, encouraging them to respond to managers' proposals, and improving the learning environment (Lei & Medwell, 2021). As students use new terms in group tasks, they are more likely to recall and use those words when confronted with ordinary situations in everyday life (Vadivel et al., 2021). It is in this regard that the current work seeks to improve understanding of collaborative learning's effectiveness in enhancing English vocabulary, as well as what implications it has for language teachers, as will be shown by the critical analysis of previous research.

Scholars have continued to be intrigued by the effectiveness of collaborative learning methodologies of language instruction. Language learning outcomes can be greatly enhanced by working with others to raise English academic performance. Researchers have analyzed the correlation between collaborative learning and language learning outcomes in previous research studies (Lei & Medwell, 2021; Vadivel et al., 2021). The authors concluded that engaging in collaborative learning activities leads to extensive vocabulary usage that is positively correlated with academic performance. Creating a collaborative learning environment where learners can practice languages and comprehend new ideas is enhanced by interactive learning. It allows learners to learn from each other and improve collaboration in learning. This aids in the school's performance as well as the recognition of words and terms (Jeong, 2019). It is, therefore, intended to contribute to the existing knowledge about language education by providing a comprehensive investigation into the contribution of collaborative learning to both areas.

## **2.3. Role of Collaborative Learning Approach to Promote Social Interaction**

Mediating effects have been found in the relationship between collaborative M-learning and academic achievement or vocabulary gains (Nejad et al., 2022). A mobile technology-facilitated educational task involves communicating, talking, and collaborating among learners (Pawlak & Kruk, 2022). Hence, social interaction contributes to conceptual thinking, knowledge construction, social and emotional growth as well as the development of conceptual thinking (Shofiyyah et al., 2023) of a student. Throughout this study, social interaction serves as an intermediary between

collaborative mobile learning and academic achievement and proficiency in English vocabulary (Gholizadeh & Rahimi, 2023). A mobile learning intervention that facilitates student interaction can improve academic performance as well as vocabulary proficiency (bin Wan Daud et al., 2021). By exchanging ideas, discussing concepts, providing feedback, and collaborating, this can be achieved (Herrera-Pavo, 2021; Jeong, 2019).

#### **2.4. Role of Collaborative Learning Approach to Promote English Learning Motivation**

Student motivation mediates the relationship between collaborative mobile learning and academic performance or English vocabulary knowledge (Togaibayeva et al., 2022). Tshering (2024) defines motivation as the process that energizes, directs, and sustains a learner's behavior and engagement. The amount of effort, persistence, and academic performance of learners in education settings is significantly influenced by motivation, as outlined by Howard et al. (2021). This study explores the moderating role of motivation on the interactions between collaborative mobile learning and academic achievement and English vocabulary. Consequently, higher levels of motivation are associated with greater participation and greater commitment to learning (Bowden et al., 2021). As such, this can lead to improvement in academic achievement and the learning of vocabulary knowledge (Bowden et al., 2021; Kamal et al., 2021; Namaziandost et al., 2020).

#### **2.5. Research Objective and Research Hypotheses**

This present study aims to process an analysis between collaborative mobile learning and academic performance and the English vocabulary scores, between social interaction and English language learning motivation. The purpose of this research is to understand how collaborative mobile learning interventions impact academic performance as well as English vocabulary knowledge, in light of the mediator's social interaction and student learning motivation. The analysis of these intermediary factors provides insights into what are the essential aspects and processes that contribute to the effectiveness of mobile learning approaches for pre-university education. Several hypotheses are developed to be tested in the study as mentioned below. The conceptual model of the study was also presented in Figure 1.

H1. Collaborative mobile learning in pre-college education significantly impacts social interaction.

H2. Collaborative mobile learning in pre-college education significantly impacts student motivation.

H3. Collaborative mobile learning in pre-college education significantly impacts maximizing English vocabulary knowledge.

H4. Collaborative mobile learning in pre-college education significantly impacts academic performance.

H5. Social interaction significantly affects maximizing English vocabulary knowledge.

H6. Social interaction significantly affects academic performance.

H7. Student motivation significantly affects maximizing English vocabulary knowledge.

H8. Student motivation significantly affects academic performance.

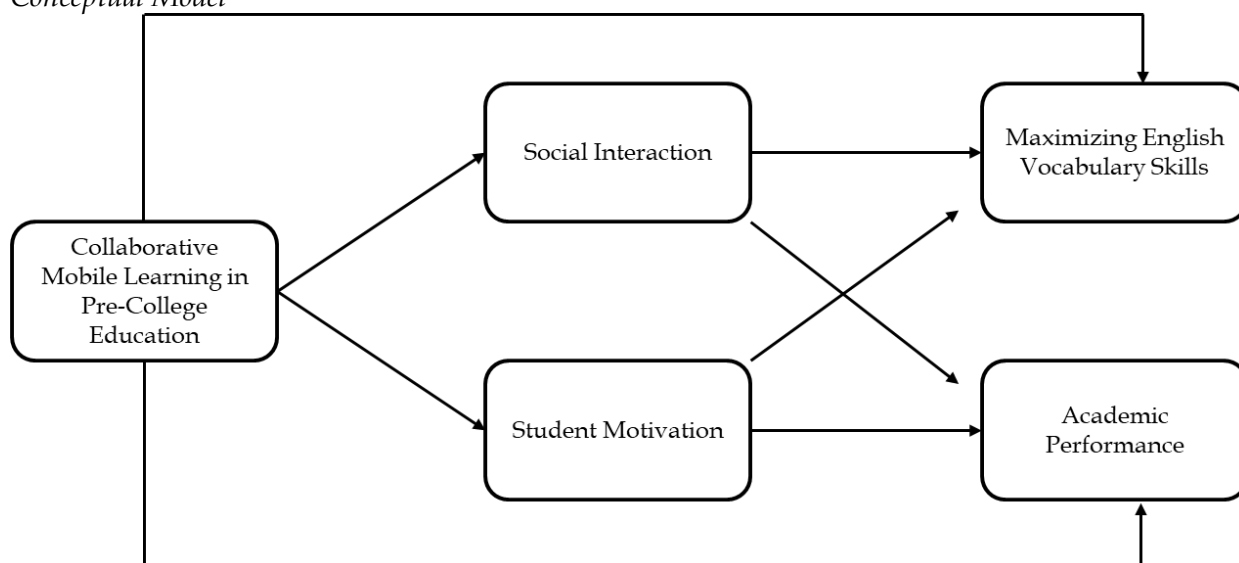
H9. Social interaction significantly mediates the relationship between collaborative mobile learning in pre-college education and maximizing English vocabulary knowledge.

H10. Social interaction significantly mediates the relationship between collaborative mobile learning in pre-college education and academic performance.

H11. Student motivation significantly mediates the relationship between collaborative mobile learning in pre-college education and maximizing English vocabulary knowledge.

H12. Student motivation significantly mediates the relationship between collaborative mobile learning in pre-college education and academic performance.

Figure 1  
Conceptual Model



### 3. Method

#### 3.1. Research Design

The study aims to assess the various factors that surround EFL pre-college students from Yunnan Minzu University. In this study, structural equation modeling, one of the methods for determining relationships between variables in relational studies (Fraenkel & Wallen, 2009), was used. The structural equation model demonstrates and tests relationships between a dependent variable and an independent variable (Tabacknick & Fidell, 2013).

#### 3.2. Participants

Pre-College EFL Students' Study Attitudes, Anxiety, and Achievement: A Study of Yunnan Minzu University Students of 326 participants. The targeted study participants were self-selected using convenience sampling done by the researcher, and they included educators with diverse fields and academic backgrounds. Before data collection was conducted, the corresponding ethical clearance was sought from the relevant institutional human research ethics committee. All participants agreed to take part in the survey and signed a consent form to that effect before the study was conducted.

#### 3.3. Data Collection Tool

Data was collected using an online survey questionnaire as this method provided a comprehensive way of measuring the various constructs of interest. The performance of students and their subject knowledge development were evaluated based on several validated measuring scales. Thus, the questions formed the basis of the research questionnaire which was divided into sections with each section containing questions that were pertinent to a given variable that was significant to the research study. The following scales were utilized in the construction of the scale: 1) Collaborative Mobile Learning (Liu, 2016), 2) Social Interaction (Sun et al., 2022), 3) Student Motivation (Purnama et al., 2019), 4) English Vocabulary Knowledge (Rezaei et al., 2014), and 5) Academic Achievement (Wang et al., 2022). The reliability coefficients of the scale have been presented in the findings.

#### 3.4. Data Analysis

Data analysis was done through the use of Partial Least Squares Structural Equation Modeling which is internationally accepted to be more appropriate in exploratory research. In using PLS-SEM, was chosen because of its suitability in dealing with a small sample size and could also be

used in both formative and reflective constructs. The analysis was divided into two namely, Measurement Model Assessment and Structural Model Assessment. First, the convergent validity and internal reliability were assessed according to factor loadings, composite reliability, and AVEs values.

In the second analysis, the fit of the structural model to different segments of the model as hypothesized was investigated. Further, the path coefficients were tested for significance using 500 bootstrap samples, and the goodness of fit coefficients such as R-squared and f-squared for the model and the relationships between the variables were computed to establish the extent of the interactions. Having a well-coordinated structure of the framework helped in accustoming every data point in a way that shed light on learning factors, impacts, and approaches of EFL pre-college students.

#### 4. Findings

The Cronbach's Alpha coefficients reflect the internal consistency and reliability of the measures of the study that were used. As Cronbach's Alpha coefficients of all the variables in this study were above .70, all the variables were found to possess satisfactory levels of internal consistency. The reliability coefficient of the variable "Academic Performance", calculated using the Cronbach's Alpha test, was .736; there is an average level of confidence and reliability of the measuring scale concerning the academic performance in the context of the given study. They have done this in such a manner that the items or measures used in evaluating academic performance are reliable in representing this dimension.

The variable Collaborative Mobile Learning in Pre-College Education accrued a Cronbach's Alpha coefficient of .854, which reveals internal compatibility at a very high level. This means, that the scale used for the assessment of collaborative mobile learning in pre-college education is adequate and fair in evaluating this concept. Likewise, the variable labelled as "Development of English Vocabulary Knowledge" possesses a Cronbach's alpha of 0.822, which suggests that it is a reliable assessment scale that can be used to test the knowledge of English vocabulary. This means that the items or measures applied for assessing language abilities have acceptable internal reliability and provide a credible estimate of this construct.

In analyzing data collected from the variable "Social Interaction", Coefficient Alpha was .842, indicating that the scale possesses a reasonable amount of reliability within the sample. This means that the scale used in measuring social interaction can be considered valid and reliable in their assessment of the construct within the context of the study. Lastly, for the variable *student learning motivation*, Cronbach's Alpha of it is .860. The Cronbach's Alpha coefficient was calculated as .860, implying the internal consistency and dependability of the data that was collected. This means that the scale developed and used to measure this dimension of student motivation is reliable and valid in the sense that it produces consistent measurements of the dimension in question.

The measuring scales of the study have strong internal consistency, as seen by the high Cronbach's Alpha values for all variables (see Table 1). These findings provide confidence regarding the dependability of the measurement instruments used to evaluate academic performance, collaborative mobile learning, English proficiency, social interaction, and students' motivation.

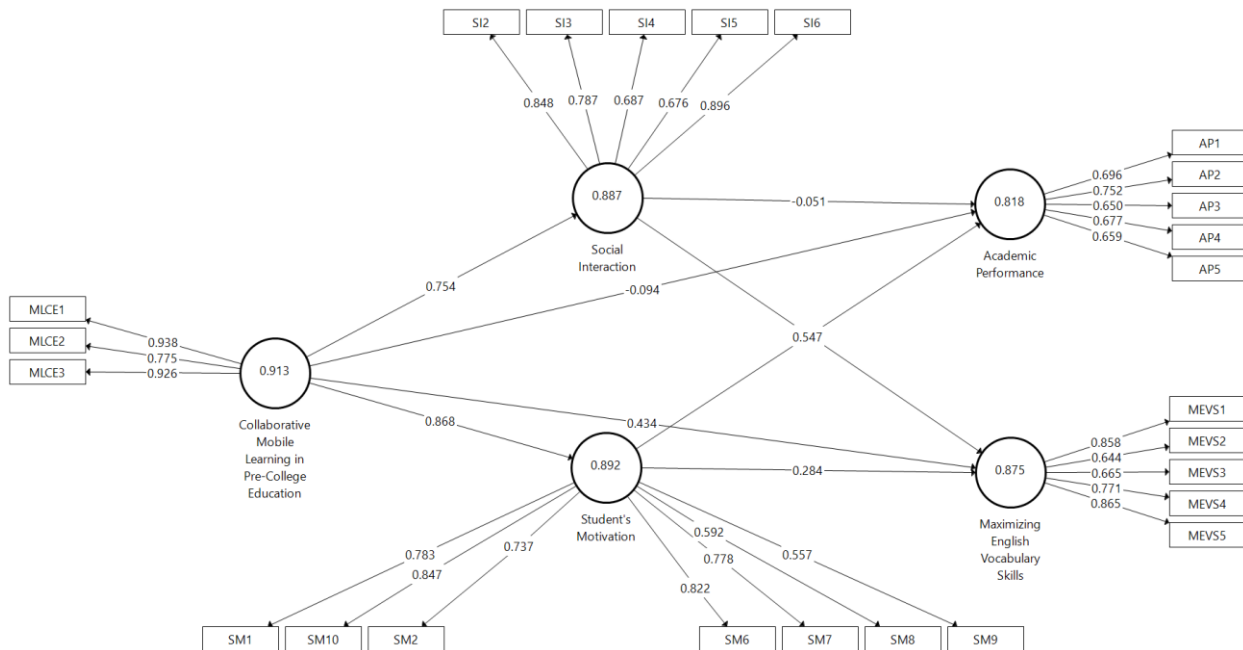
Table 1  
*Cronbach's Alpha for Scale Reliabilities*

	<i>Cronbach's Alpha</i>
Academic Performance	.736
Collaborative Mobile Learning in Pre-College Education	.854
Development of English Vocabulary Knowledge	.822
Social Interaction	.842
Student Learning Motivation	.860



In the findings section, the pattern of factor loadings is presented, which outlines the relationship between each item and factors. These loadings point out the degree and significance of the link where higher values suggest a tight connection. In addition, composite reliability measures the internal consistency of each variable in the proposed model. As the values of composite reliability increase, it means that there is higher reliability and consistency in measuring the underlying construct. In addition, the average variance extracted [AVE] measures the share or proportion of the total variance that is attributed to the items about the construct. Higher AVE values suggest that the components within the construct are more converging (see Figure 2).

Figure 2  
Measurement Model



Overall, the findings indicate that the measurement scales utilized in the study have high reliability and validity (see Table 2). The factor loadings, composite reliability, and AVE values provide assurance that the measurement model used to assess academic performance, development of English vocabulary knowledge, collaborative mobile learning in pre-college education, social interaction, and student learning motivation is consistent and accurate.

The HTMT ratios shed light on the discriminant validity of the various components of the study. A ratio smaller than 0.85 is believed to be suggestive of good discriminant validity, implying that the constructs are distinct from one another. In this study, the HTMT ratios between the constructs are often less than 0.85, showing adequate discriminant validity. Collaborative Mobile Learning has a lower ratio than all other constructs (Academic Performance, Development of English Vocabulary Knowledge, Social Interaction, and Student Learning Motivation), indicating that these constructs are unique and independent of one another.

Likewise, the HTMT ratios for the Development of English Vocabulary Knowledge and all other variables are less than 0.85, showing high discriminant validity. The ratios of Social Interaction to all other dimensions, as well as Student Learning Motivation to all other constructs, meet the criterion of excellent discriminant validity. These findings indicate that the measuring paradigm of the study adequately differentiates between the constructs of Academic Performance, Collaborative Mobile Learning, Development of English Vocabulary Knowledge, Social Interaction, and Student Learning Motivation. The HTMT ratios support the reliability and validity of the measuring model used in the study by demonstrating their distinctiveness and discriminant validity (see Table 3).

Table 2  
*Reliability and Validity Confirmation*

<i>Factor</i>	<i>Original Sample</i>	<i>Composite Reliability</i>	<i>AVE</i>
Academic Performance			
AP1	0.696	0.818	0.503
AP2	0.752		
AP3	0.650		
AP4	0.677		
AP5	0.659		
Development of English Vocabulary knowledge			
MEVS1	0.858	0.875	0.587
MEVS2	0.644		
MEVS3	0.665		
MEVS4	0.771		
MEVS5	0.865		
Collaborative Mobile Learning in Pre-College Education			
MLCE1	0.938	0.913	0.779
MLCE2	0.775		
MLCE3	0.926		
Social Interaction			
SI2	0.848	0.887	0.614
SI3	0.787		
SI4	0.687		
SI5	0.676		
SI6	0.896		
Student Learning Motivation			
SM1	0.783	0.892	0.545
SM10	0.847		
SM2	0.737		
SM6	0.822		
SM7	0.778		
SM8	0.592		
SM9	0.557		

Note. AVE: Average Variance Extracted.

Q<sup>2</sup> predict value of 0.561 shows moderate predictive accuracy. The model's independent variables explain this percentage of the dependent variable's variance. Higher Q<sup>2</sup> predict values indicate greater model fit and predictive capability. The root mean square error [RMSE] of 0.054 assesses the residuals between observed and anticipated values. A lower RMSE suggests a better model-data fit. In this case, the model's RMSE of 0.054 indicates reasonable accuracy.

Table 3  
*HTMT Criterion for Discriminant Validity*

	1	2	3	4	5
Academic Performance					
Collaborative Mobile Learning in Pre-College Education	0.688				
Maximizing English Vocabulary Knowledge	0.342	0.883			
Social Interaction	0.342	0.877	0.766		
Student Motivation	0.331	0.754	0.822	0.784	

Note. 1: Academic Performance; 2: Collaborative Mobile Learning in Pre-College Education; 3: Maximizing English Vocabulary Knowledge; 4: Social Interaction; 5: Student Motivation.

The mean absolute error, or MAE, is 0.069. Like RMSE, lower MAE indicates better accuracy and a closer fit between projected and observed data points. In this investigation, the model's predictions differ by 0.069 on average. The model's Q2 predict value of 0.561 indicates moderate predictive accuracy. RMSE and MAE values of 0.054 and 0.069 indicate that the model's predictions are close to the observed data points. These findings show how well the predicted model performed (see Table 4).

Table 4  
Model Fitness Values

Q <sup>2</sup> predict	RMSE	MAE
0.561	0.054	0.069

R-square values show how much of the dependent variable's variance is explained by the model's independent variables. Higher R-square values suggest a greater link between independent and dependent variables. In this study, the R-square value for *academic performance* is 0.183, indicating that the independent factors can explain 18.3% of academic performance variance. Academic performance is moderately related to independent variables. *Development of English vocabulary knowledge* has an R-square value of 0.843, indicating that independent variables explain 84.3% of English vocabulary knowledge variance. The model's independent variables explain a lot of the variance in language skills, as seen by the high R-square value. The independent factors explain 56.8% of the variance in *social interaction*, according to the R-square value of 0.568. The independent variables and social contact have a moderate-to-strong association.

Finally, the R-square value for *student motivation* is 0.753, indicating that independent factors of the study explain 75.3% of student motivation. This shows that the independent factors are important in understanding and predicting student motivation. R-square values show how much independent variables explain dependent variable variances (see Table 5). The results show that the independent variables explain academic performance, English vocabulary, social interaction, and student motivation. The relationship between them ranges from moderate to strong.

Table 5  
R-Square Co-efficient of Determination

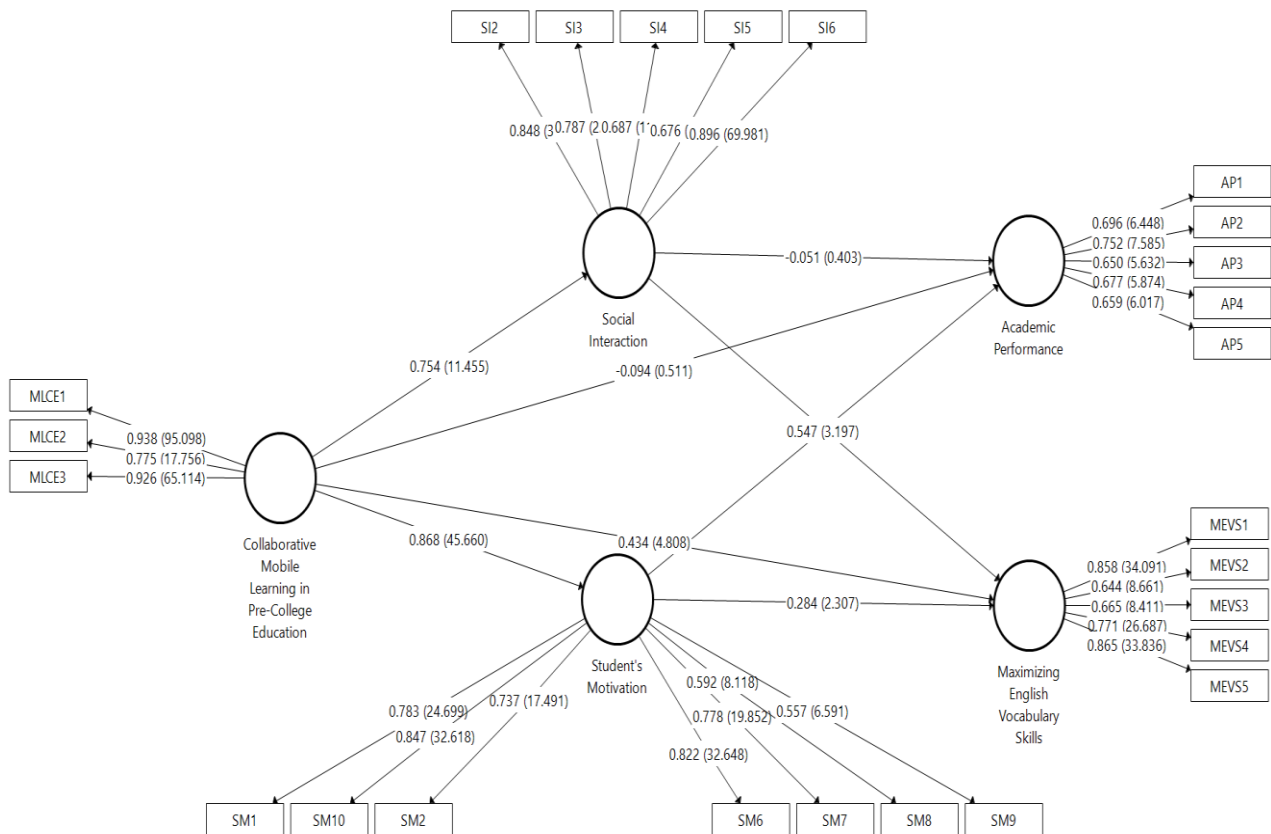
Variable	R-square
Academic Performance	0.183
Development of English Vocabulary Knowledge	0.843
Social Interaction	0.568
Student Learning Motivation	0.753

Hypothesis 1: Pre-college collaborative mobile learning greatly affects social interaction. The original sample value is 0.754, suggesting a high positive influence. The STDEV is 0.066, indicating modest data variability. Additionally,  $p < .001$  and 11.335  $t$ -statistic indicate a highly significant association. These studies show that collaborative mobile learning improves social interaction.

Hypothesis 2: Pre-college collaborative mobile learning motivates students. 0.868 is the original sample value, showing a significant positive influence. STDEV is 0.020, indicating low data variability. The high  $t$ -statistic of 43.826 and  $p < .001$  imply a highly significant link. These findings strongly suggest that collaborative mobile learning boosts student motivation.

Hypothesis 3: Pre-college collaborative mobile learning develops English vocabulary knowledge (see Figure 3). The original sample value (O) is 0.434, indicating a modest positive influence. STDEV is 0.087, indicating moderate data variability. In addition,  $p < .001$  and 4.972  $t$ -statistic indicate a highly significant link. These results support the idea that collaborative mobile learning boosts English vocabulary.

Figure 3  
Structural Model



Hypothesis 4: Pre-college collaborative mobile learning improves academic performance. The original sample value (O) is  $-0.094$ , showing a weak negative influence. STDEV is  $0.182$ , indicating data variability. With a  $p$ -value of  $.606$ , the  $0.517$   $t$ -statistic is not significant. Therefore, the study cannot prove that collaborative mobile learning improves academic performance.

Hypothesis 5: Social interaction greatly impacts English vocabulary knowledge. The original sample value is  $0.259$ , indicating a moderate positive influence. STDEV is  $0.106$ , indicating considerable data variability.  $2.452$  is a significant  $t$ -statistic with a  $p$ -value of  $.015$ . These findings support the idea that socializing boosts English vocabulary.

Hypothesis 6: Social engagement greatly impacts academic performance. O, the original sample value, is  $-0.051$ . STDEV is  $0.127$ , indicating data variability.  $0.398$  is a non-significant  $t$ -statistic. Thus, social engagement does not greatly affect academic performance.

Hypothesis 7: Student motivation boosts English vocabulary knowledge. The original sample value [O] is  $0.284$ , indicating a moderate positive influence. STDEV is  $0.119$ , indicating moderate data variability.  $2.387$  is a significant  $t$ -statistic with a  $p$ -value of  $.017$ . These findings support the idea that student motivation boosts English vocabulary.

Hypothesis 8: Student motivation strongly impacts academic performance. O is  $0.547$ , showing a positive influence. STDEV is  $0.172$ , indicating considerable data variability. The results show that the  $p$ -value for the hypotheses was  $.002$  and the  $t$ -statistic was  $3.186$ , so the relationship was significant.

Hypothesis 9: Collaborative mobile learning in pre-college education improves English vocabulary knowledge through social engagement.  $0.474$  is the original sample value, showing a moderate positive mediating impact. STDEV is  $0.147$ , indicating moderate data variability. With a  $p$ -value of  $.001$ , the  $3.217$   $t$ -statistic indicates a highly significant mediating association. These findings strongly suggest that social interaction mediates the association between collaborative mobile learning and English vocabulary improvement.

Hypothesis 10: Pre-college collaborative mobile learning and academic performance are significantly mediated by social contact.  $-0.038$  indicates a weak negative mediating impact. STDEV is  $0.104$ , indicating moderate data variability.  $0.366$  is a non-significant  $t$ -statistic. Thus, social contact does not significantly moderate the association between collaborative mobile learning and academic performance.

Hypothesis 11: Student motivation moderates the association between collaborative mobile learning in pre-college education and English vocabulary improvement.  $0.247$  is the original sample value, indicating a weak positive mediating effect. STDEV is  $0.105$ , indicating considerable data variability. The  $t$ -statistic of  $2.354$  and  $p$ -value of  $.019$  indicate a mediated link. These data suggest that student motivation mediates the association between collaborative mobile learning and English vocabulary improvement.

Hypothesis 12: Pre-college collaborative mobile learning and academic performance are considerably mediated by student motivation.  $0.195$  is the original sample value, showing a weak positive mediating effect. STDEV is  $0.092$ , indicating moderate data variability. The  $t$ -statistic of  $2.132$  and  $p$ -value of  $.034$  indicate a mediated link. These findings suggest that student motivation mediates the association between collaborative mobile learning and academic performance.

These precise data illuminate the relationships between variables, helping in understanding how collaborative mobile learning, social engagement, and student motivation affect English vocabulary knowledge and academic performance (see Table 6).

## 5. Discussion

The study utilized collaborative mobile learning in pre-college education, ND sought to compare the English academic performance, as well as explore the roles of social interaction and student learning motivation that underpinned it. Using the information derived from the results and contextualizing it with other recent research, patterns concerning these factors can be identified. These results prove that: integrating mobile learning during pre-college education increases students' social interaction (H1); and participant motivation (H2). The findings are in line with research on collaborative learning and the use of mobile learning that underscore the effectiveness of student active engagement and motivation (Güler et al., 2022). Through collaborative mobile learning, students get to share with their friends, engage in expansive discussions, and achieve social relationships hence enhanced motivation.

Additionally, learning more via wireless mobile was found to have a positive impact on students' knowledge of English vocabulary (H3). This research supports earlier studies indicating that resources in m-learning are useful for language learning and vocabulary boost (Guo et al., 2020). Mobile device usage means that learners can use interactive language aids and engage in language exercises at any time of their convenience anytime on location, these are effective in building up the learners' vocabulary. This study, therefore, failed to establish a direct influence of collaborative mobile learning on English academic performance (H4). Contrary to the literature, this study revealed that ML negatively influenced academic performance as highlighted in the previous research (Liu et al., 2023). Education performance is a multifaceted concept that encompasses enrollment patterns, characteristics of learners, as well as the teaching strategies used in the classroom and school (Acar, 2023). Due to such findings, it may be indicated that while collaborative mobile learning may not directly impact students' academic performance, there may be other variables that influence the relationship between the two.

Based on the findings, social connection revealed that collaborative mobile learning has a positive and significant correlation with English vocabulary improvement (H9) and that student learning motivation is a mediator between collaborative mobile learning and improved English vocabulary (H11). These findings are in line with work done regarding social function and motivation in language acquisition (Bahrawi, 2023). Neither of these two aspects can be overlooked: while social interaction enables learners to practice and receive feedback on their

[Insert Table 6 Here]

language skills, motivation is a pivotal factor that helps learners sustain their effort as well as stay interested. In the promotion of language skill development, it is evident that mediating effects that focus on social interaction and learners' motivation within a collaborative mobile learning environment are significant (Fareen, 2024; Galegane & Ntereke, 2022). The research did not find mediating effects of social contact (H10) or student motivation (H12) in the relationship between collaborative mobile learning and English academic performance. Consequently, another study implies that other parameters like, for instance, specific approaches to learning, specific learning behaviours or certain forms of additional support may play a larger role in terms of the student performance or grades. Therefore, to enhance the understanding of these dynamics, future studies could examine other variables that help to explain the relationship between collaborative mobile learning and achievement.

In conclusion, the findings of the present study complement existing research about collaborative mobile learning by underlining the importance of social interactions as well as students' motivation in enhancing their English vocabulary knowledge. It stresses the necessity of creating educative programs that will enhance the frequency, intensity, and duration of social interactions and positive motivational effects for L2 learners in mobile collaborative learning contexts. The results reveal the need for educational actors to embrace new paradigms in technologies in an approach to teaching that involves group work, social interaction, and motivation. Mobile technology can also be used to enhance the learning and teaching process of the English language and also enhance the learning environment to be effective and more appropriate.

## 6. Conclusion

This research aims to explore the factors of collaborative mobile learning and the impact of social interaction, student motivation and academic performance in the context of EFL pre-college education. The findings present positive implications of collaborative mobile learning on social interaction and students' motivation, indicating the usefulness of this approach as an educational model. Moreover, this paper also demonstrates that social contact and student motivation can mediate the relationship between collaborative mobile learning and improving English vocabulary knowledge.

It is important to note, nonetheless, that in this study, the impact of collaborative mobile learning on English academic performance was not found to be statistically significant in a direct way. This means that other factors affect academic achievement in English other than collaborative mobile learning. Firstly, educators and policymakers should understand the importance of adopting engaging mobile learning theories and practices in pre-college education. Mobile technology integrated with a collaborative learning context might encourage communication and motivational aspects within learners while instructors might help in improving the students' English vocabulary knowledge. Second, the outcomes indicate that to become effective, educational interventions should consider the roles of social interaction and motivation of students. Opportunities for meaningful social interactions and increasing intrinsic motivation may enhance the effectiveness of collaborative m-learning and language-learning outcomes. This research is limited. The study focused on EFL pre-college students; hence, the findings may not be generalized to other students' categories. Likert scale questionnaires and data collected at a specific time may distort outcomes and restrict the possibilities of cause-and-effect relationships. Presumably, to provide more solid evidence for the associations between the variables under study, future research can employ longitudinal methods and performance assessments.

This research contributes to the existing literature by providing insights into the complex relationship between collaborative mobile learning, social interaction, students' motivation, and academic accomplishment. These findings underscore the need for formulating educational approaches that promote learners' interaction, cooperation, and engagement. The goal is to develop engaging and effective learning environments that allow students to acquire the necessary

English vocabulary and, in the process, possibly boost academic performance in other subject areas in pre-college education.

## 7. Theoretical and Practical Implications

Mobile technology may be effectively used by English teachers to enhance motivation, positive interaction, and an effective learning environment. This paper suggests that teachers can enhance students' English vocabulary knowledge and potentially their academic performance through the incorporation of meanings and mobile technology and activities. These potentially beneficial implications may help guide the development of education applications and methods to take full advantage of the numerous opportunities mobile collaborative learning offers.

This work also stresses the significance of social relatedness and student activation in the learning process. For example, in breaking down physical and virtual learning settings, English educators may focus on giving opportunities for meaningful social interactions among students. This is where sharing work in projects, group discussions and peer assessment activities may be valuable. Further, enhancing students' interest and promoting language learning can be organized by addressing the student's learning needs and concerns, empowering them, and creating an encouraging educational environment.

The research also recommends exploring other attributes that may determine or influence academic performance. This research did not establish any significant effects of collaborative mobile learning on academic achievement, implying that it may be other factors such as learning preferences or facilitating conditions may be more critical. This generates areas for future research in these elements and how they are interconnected with collaborative mobile learning in future.

In conclusion, the practical implications of this study are relevant to educators and decision-makers in that they provide insight into how to get the best out of social engagement, collaborative use of mobile technologies and motivation of students. This will help to enhance students' performance in their classes and enhance their knowledge of English vocabulary. These theoretical relations contribute further to the enhancements of the above-stated factors, providing insights into the process that forms the basis of future research in educational psychology and mobile-assisted language acquisition.

## 8. Limitations and Future Recommendations

First of all, this research focused only on pre-college education, hence limiting its generalization. Studying with different ages and educational levels may also help understanding the study variables. Second, the research relied only on self-report measures and social desirability as well as recollection biases could have influenced the results. Performance-related assessments or practice teaching examinations could be employed in future research to enhance data quality. Perhaps, the integration of self-report data with more objective assessments may increase the reliability and validity of the findings as well as shed more light on the associations between variables. This research also had the disadvantage of cross-sectional design which eliminated causality to a certain extent. Longitudinal research may therefore consider temporal patterns and causality relationships. A longitudinal approach would explain how factors influence each other as time goes on.

Besides, mobile learning collaboration, contact, and student motivation were also investigated concerning English vocabulary and academic achievement. Other variables that help in mediating or moderating these interactions may be present. Thus, to enhance the comprehensibility of language learning results, such factors as learning styles, cultures, and skills may be explored. Last of all, this study also examined the impact of collaborative mobile learning towards English vocabulary and overall English academic performance. For additional information on the way that collaborative mobile learning influences English language competency, future studies might employ speaking listening and writing.



**Author contribution:** All authors have made sufficient contributions to the study and agree with the results and conclusions.

**Data availability:** The data supporting the findings of this study are available upon request. Interested researchers may contact the corresponding author for access to the data.

**Declaration of interest:** The authors declare that no competing interests exist.

**Ethical declaration:** All subjects who participated in the study have given their consent for participation, for both collection and analysis of the data. No additional ethical approval was needed.

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