

# Mobile-Assisted Language Learning to Support English Language Communication among Higher Education Learners in Thailand

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**Abstract:** The ability to use English has become essential for functioning in the 21st century; not only the basic skills (reading, writing, listening, and speaking) but broader skills in communication and collaboration will be necessary for future success in global environments. Digital transformation in learning via mobile devices helps create authenticity in English language education. They can interest and engage learners, both in and out of the classrooms, while promoting uninterrupted learning, especially during the COVID-19 pandemic. Moreover, advances in mobile applications and virtual learning environments have become important components of developing English language skills, allowing for asynchronous learning in convenient, flexible, and interactive environments on any of a learner's devices. This paper reports the results of using a mobile-assisted language learning interactive environment (MALLIE), a chatbot-based application, to support the development of English language communication skills. Quantitative data were acquired from 546 higher education learners in Thailand. The information was used for the exploratory factor analysis which shall serve as a baseline for innovation development. The study briefly examined the students' experiences with any type of mobile learning before focusing on the students' and a group of experts' ratings of the intervention in this study. Preliminary studies were conducted with 10 students and experts to identify factors they believed were most relevant for measuring the effectiveness of the MALLIE for English language learning in a virtual learning environment. Exploratory factor analysis of 70 variables extracted four factors with loadings that exceeded .30: MALL, VLE (virtual learning environment), 4Cs for the four basic components of language learning, and ELCS for English language communication skills; the factor loadings ranged between 0.55 and 0.81. Additionally, in-depth interviews were conducted to collect qualitative data, and the results of preliminary studies were used to design and develop the MALLIE application and test its learning effectiveness. Next, an opinion survey was administered related to a group of 105 students and experts regarding their acceptance of the MALLIE and their intentions to use it or something similar in the future; the main topics of the survey related to the perceived usefulness of the MALLIE, its ease of use, respondents' attitudes towards its use, peer influences on respondents' use, and respondents' use behaviour and intention to use. The aim of the study's surveys and analyses was to assess the effectiveness and efficiency of learning the English language via mobile language learning applications available for use on any device.

**Keywords:** Mobile-Assisted language learning, Virtual learning environment, English Language communication skill, Higher education, 21st-century learning, Digital disruption

## 1. Introduction

Learning in the 21st century is focused on learners using technology to promote skills for life, including English language communication skills (ELCS) (Dede et al., 2010; Fraga and Flores, 2018; Griffin and Care, 2014; Khlaisang and Songkram, 2019; Kukulska-Hulme, 2018; Tkach, 2017), which learners can acquire using mobile-assisted language learning (MALL) applications. Mobile devices with such applications installed grant learners access to learning resources without time or space limitations and provide rich, real-time experiences both inside and outside of class (Fraga and Flores, 2018; Kukulska-Hulme, 2018; Law et al., 2007). MALL applications improve language learners' achievement by developing their communication skills in listening, speaking, reading, and writing (Miangah and Nezarat, 2012; Ozer and Kiliç, 2018; Thongsri et al., 2019).

Researchers have examined MALL applications for non-native languages in terms of learning achievement, cognitive load, and acceptance of mobile learning tools and found greater student learning achievement, decreased cognitive load, and high acceptance and enjoyment of the learning tools (Ozer and Kiliç, 2018). MALL applications let learners set their learning goals and manage their own learning (Guodong and Xinghua, 2016; Humanante-Ramos et al., 2015). This integration of formal and informal learning into individual learning experiences using social networks, computer technology, and communication technology helps learners create their own learning experiences at their own convenience (Dabbagh and Fake, 2017; Miangah and Nezarat, 2012). Mobile applications have greatly expanded current language learning, teaching, and evaluation including foreign language learning. Balula et al. (2020) studied MALL in business English learning among undergraduates. They found that MALL can develop learners' ELCS. However, the writing skills still required further development. Additionally, Li (2023) explained MALL features that complement effective language learning which include

ubiquity, social interactivity, authenticity, multimodality, and motivation enhancement as well as attitude and acceptance towards MALL use, all of which contribute to learners' English language learning achievements (Ebadi and Raygan, 2023; Alhadiah, 2023).

However, knowledge content alone is not sufficient for life and work in the 21st century. The World Economic Forum's (2016) framework for 21<sup>st</sup>-century learning requires the integration of content knowledge and communication. This extends to promoting learners' knowledge, skills, and competencies, especially communication skills. Another important component is ELCS because English is a primary language for broad communication worldwide (Hameed et al., 2012; Ministry of Education, 2016; Newton et al., 2018; Sungjaisom, 2016). English language learning includes developing the four areas of listening, speaking, reading, and writing, together with communication and collaboration skills (Chang et al., 2018; Cresswell and Beutel, 2017; Hadinugrahaningsih et al., 2017; Khlaisang and Songkram, 2019). One strategy for promoting English language skills is using mobile technology to expose learners to English usage in virtual contexts, which increases English learning without limiting any exposure to the native or target language (Lan et al., 2013). In keeping with this concept, the focus of this research was developing a mobile-assisted language learning interactive environment (MALLIE) that incorporated a chatbot and the iReview web application and then evaluating participants' responses to the MALLIE.

With reference to the situations and need assessments regarding instructions to enhance ELCS, this study examined the effects of a MALLIE for supporting English language learning and communication among higher education learners in Thailand with the aim of developing 21st-century English language skills. The objectives are, firstly, to study the existing instruction landscape and factors influencing mobile application design for learning in virtual contexts to enhance ELCS among higher education learners in the 21st century. Secondly, it aims to develop and study the usage results of this mobile application in the areas of perceived usefulness, ease of use, using behaviour, peer influence, attitude to use, and intention to use.

## 2. Literature Review

### 2.1 English Communication Skills in 21st-Century Higher Education Learning

Developing ELCS among a non-native-English-speaking nation's population—such as Thailand—has a crucial role in expanding the country's incorporation into world society. The process entails learning language rules and applying them appropriately (Byrne, 1990; Gabillon and Ailincal, 2013; Grabe, 2009; Harmer, 2001; Littlewood and William, 1995) and needs to focus not only on developing the four communication skills above but also collaboration and communication skills, which will create knowledge and work skills (Khlaisang, 2018; Vockley, 2007). Researchers have synthesised various learning components for promoting ELCS, including learning and understanding language rules and meanings, using them appropriately for the situation, and training students to practice the language they are learning; students in the studies cited above practiced in pairs or groups, and exercises combined language learning both in and outside of classrooms (Gabillon & Ailincal, 2013). In this study, the language learning skills consist of the set of skills that can assist learners to understand and produce appropriate and efficient spoken languages for communication. The four skills are listening, speaking, reading, and writing (English Language Communicative Skill). The focus is on individual learning development that can be integrated with the 21<sup>st</sup>-century skills concepts of communication and collaboration. The focal point is clear communication and collaboration that builds on knowledge to create tangible outputs. The assessments include (1) self-evaluations in terms of communication skills development (listening, speaking, reading, and writing), (2) analyzing behaviors and tracking digital footprints on communication skills development that exists in the system, and (3) analyzing the output that signifies their ability to integrate the skills. Application of technology for the development of English language learning takes various forms such as Computer Assisted Language Learning (CALL) which allows learners to learn and interact via computers. However, CALL poses problems wherein there is a gap between taught contexts and forms versus real-life practices. Therefore, Meihami (2023) involved situated learning in English language learning via CALL to help reduce the limitations. Aside from CALL, another technology used for English language learning is Mobile Assisted Language Learning (MALL). Shortt et al. (2023) reviewed literature that gamification in MALL can ignite learning motivation and enhance foreign language performance.

### 2.2 The use of MALL to Support ELCS

Mobile Assisted Language Learning (MALL) is learning via mobile devices that facilitates learning behaviours of those who have easy and convenient access to the internet, especially via personal mobile phones, smartphones, or Bring Your Own Device (BYOD) practices. The adoption of mobile applications has altered instructional

methods to fit learners of diverse age groups and levels from around the world (Kalogiannakis and Papadakis, 2020). MALL applications respond to student behaviour and have been accepted as suitable for language learning (Fryer et al., 2020). In particular, these applications can be used on students' existing mobile devices and feature flexible, interactive, and systematically organised learning with materials available online (Ally, 2009; Avenoglu, 2005; Ozdamli and Carvus, 2011; Kaewkiriya, 2010). In addition, the important components that enable learning are the instructor, the learner, the content, a flexible (including asynchronous) learning environment, and a method of evaluating learners' abilities (Chen, 2018; Gafni et al., 2017; Viberg and Gronlund, 2013; Wilken et al., 2016). The authors of one exploratory study found that students were satisfied with the mobile language learning application and reported positive experiences (Xu and Hu, 2020). Ebadi and Raygan (2023) studied the facilitating conditions, perceived ease of use, and perceived usefulness of applying MALL to English language learning. They found that perceived usefulness influenced perception towards MALL while facilitating conditions affected perceived ease of use. In addition, Alhadiah (2023) studied performance expectancy, facilitating conditions, hedonic motivation, and social influence toward acceptance of MALL among higher education English as a Foreign Language (EFL) learners. Structural equation modeling (SEM) found that performance expectancy, facilitating conditions, hedonic motivation, and social influence were indicators of the intention to use MALL.

### 3. Research Question

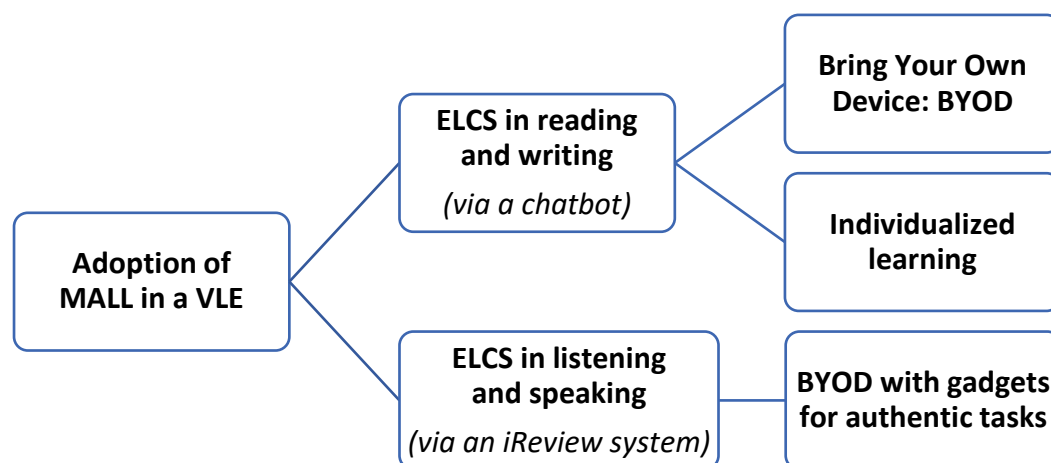
A virtual learning environment (VLE) is an online teaching and learning environment that is made available to students via their mobile devices or other available technologies for providing education resources. VLEs support mobile language learning via access to learning materials on portable devices, suitable learning content and activities, and effective measures for assessment and evaluation (Shi et al., 2010; Weller, 2007). This study examined the effects of a MALLIE for supporting English language learning and communication among higher education learners in Thailand with the aim of developing 21st-century English language skills. Specifically, the following research questions guided this study:

*RQ1. How well does the MALLIE support acquiring ELCS among higher education learners in Thailand?*

*RQ2. What factors contributed to the development of the MALLIE application to support ELCS among Thai higher education learners?*

*RQ3. How do Thai higher education learners feel about accepting a mobile application that supports ELCS?*

Figure 1 presents the conceptual framework for the study.



**Figure 1: Conceptual framework of a MALLIE for supporting ELCS**

### 4. Method

With regards to the literature review about the application of MALL in English language development, it shows that most studies focus on communication skills or one skill at a time. Therefore, this study adopts the R&D design to develop a mobile application for learning in virtual contexts to enhance ELCS for higher education learners in all 4 skills of listening, speaking, reading, and writing. The factors analysis will be used for innovation design prior to experimenting with learners. Furthermore, the information on technology acceptance will be

used for future application design. The research consists of 3 phases namely (1) English language learners' needs on the use of MALLIE, (2) Developing the MALLIE, and (3) MALLIE application findings.

The MALLIE for this study was developed in response to the needs of higher education English language learners in Thailand, and the results were subjected to exploratory factor analysis (EFA) and principal component analysis to check the suitability of the proposed components for the proposed language learning innovation. Qualitative data using person interview method were also collected from experts in education technology and higher education English teaching for more in-depth input.

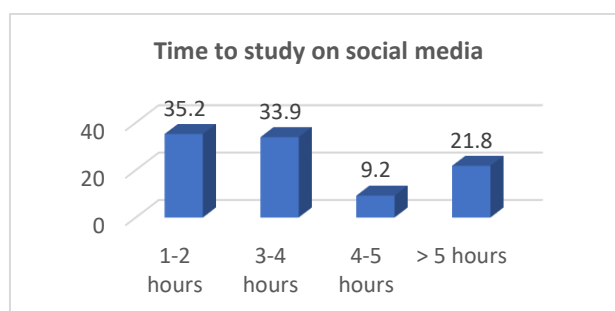
Next, the quantitative and qualitative data were synthesised to create the MALLIE, which consisted of an incorporated Facebook Messenger chatbot and the iReview web application. Students completed missions assigned by the chatbot related to reading and writing English, and after they completed the missions, they developed their listening and speaking skills in iReview; when the students had completed all the missions, their English skills were evaluated. In addition, the students were interviewed to collect in-depth qualitative data on their opinions of the MALLIE.

#### 4.1 Sample

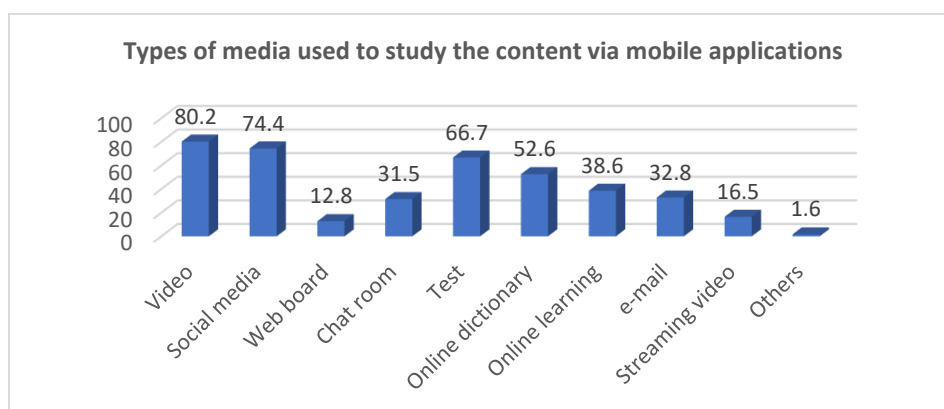
The sample for the quantitative data for this study consisted of 546 higher education learners from four regions throughout Thailand using a cluster sampling method. Table 1 presents their details, specifically, the number of learners with a smartphone, their ability to connect the device to the internet, their experience in learning with mobile applications (Table 1), their time spent studying via social media (Figure 2), and the types of media they used for mobile learning (Figure 3).

**Table 1: Participants' demographic information (n = 546)**

| Learners' Experiences                              | Yes  | No  |
|----------------------------------------------------|------|-----|
| 1. Learners with a smartphone for use              | 99.5 | 0.5 |
| 2. Ability to connect the device to the internet   | 99.6 | 0.4 |
| 3. Experience in learning with mobile applications | 100  | 0.0 |



**Figure 2: Participants' time spent studying via social media**



**Figure 3: Types of media students used to study online content**

## 4.2 Measurement

The research instruments for this study were a questionnaire to gather factors to incorporate into the system, lesson plans developed for the application, and an opinion survey on the acceptance of MALLIE for supporting ELCS in higher education learners. The factors students rated were the perceived usefulness of the MALLIE, its ease of use, the students' actual usage behaviour, the effects of peer influence, students' attitudes toward using the MALLIE, and their intention to use a future MALLIE.

*Stage one: English language learners' needs regarding the use of MALLIE*

Section 4.1 details how the student sample's needs were obtained for their incorporation into the MALLIE; these data were analysed using EFA and Priority Needs Index (PNI) to refine the MALLIE. Additionally, qualitative data were collected from interviews with 15 higher education instructors with expertise in innovative mobile applications and ELCS in a Thai learning context. The data collected indicated that the learners in this study had experience in learning with mobile applications; therefore, the focus became designing the application to be suitable for studying English via mobile applications. It was also found that learners in this study used social media to study, and therefore, the MALLIE application was developed for access through retrieval- and rule-based chatbots in Facebook Messenger.

*Stage two: Developing the MAALIE*

The innovative MALLIE application was developed to support English language learners' acquisition of reading, writing, understanding, and speaking skills as well as 21st-century skills related to communication and collaboration. The system consisted of server- and client-side scripts. Figures 4 and 5 show schematic representations of the system architecture and the use cases, respectively.

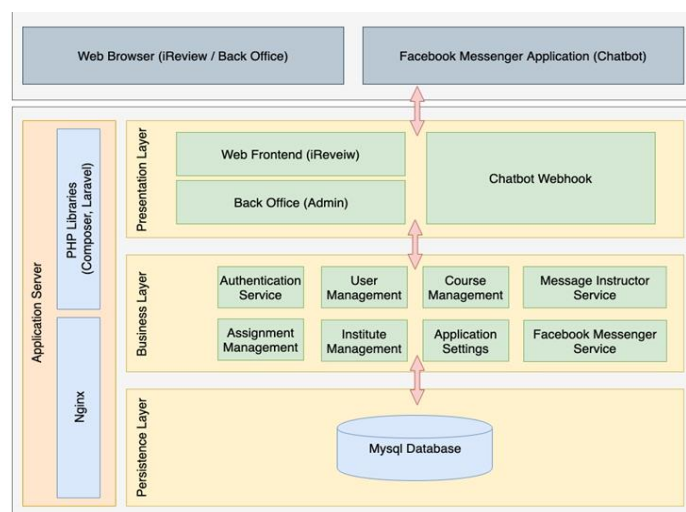


Figure 4: Schematic representation of the system architecture

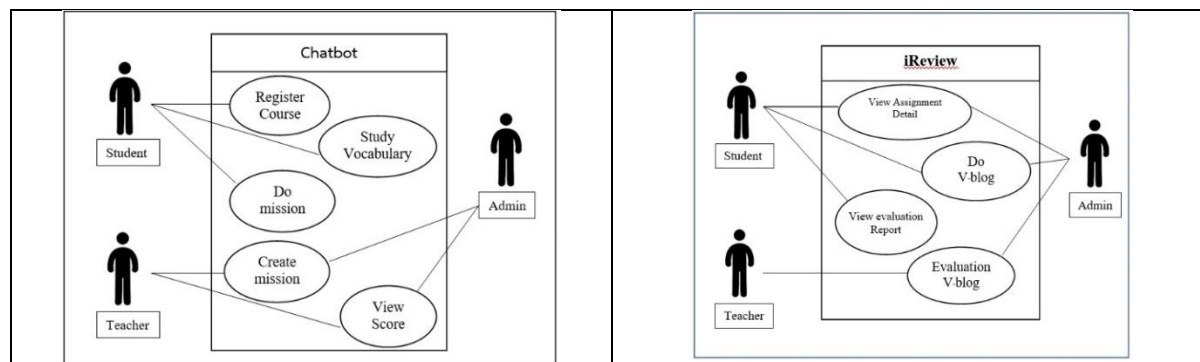
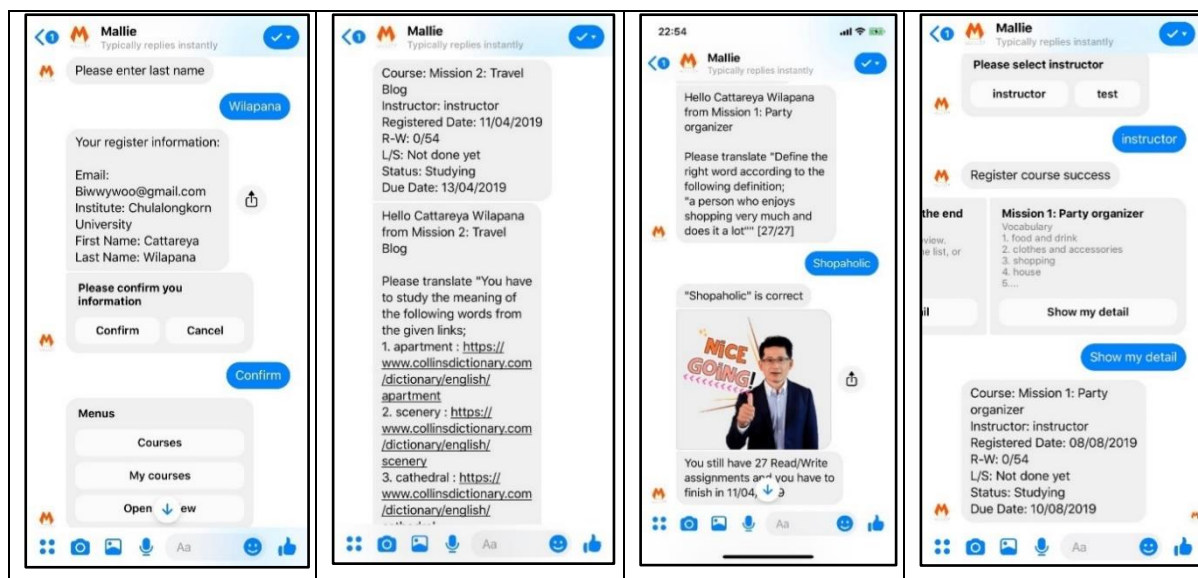


Figure 5: Schematic representation of the use cases for (left) chatbot and (right) iReview

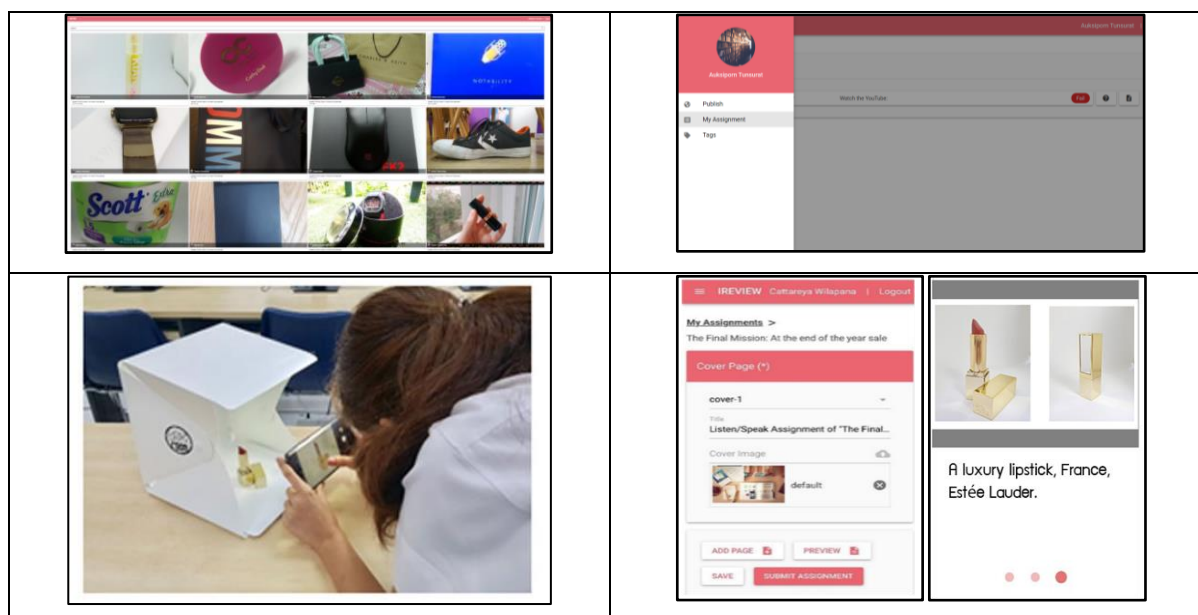
The two subsystems of the developed MALLIE were the Facebook Messenger chatbot and iReview, an Android application. Via the chatbot, instructors presented students with learning missions using media such as pictures,

videos, and website links in order to stimulate learners' knowledge acquisition. The chatbot also displayed the learners' progress in the form of their learning status, their completed missions, and their upcoming due dates (learning progress; Figure 6).



**Figure 6: The study chatbot system showing, from left to right, interaction with learners, their learning missions, positive reinforcement, and their learning progress**

The iReview system, an Android mobile application, allows learners to create video blogs (vlogs) of their work via avatars as well as create text and image content (Figure 7). Learners' completed work is sent to the iReview back office for evaluation, and students receive ratings of Pass; Reject, which returns the work to the student for revision; or Fail, which necessitates repeating the assignment.



**Figure 7: Overview of iReview**

#### *Stage three: MALLIE application findings*

A group of 105 higher education learners from both public and private higher education institutions participated in the MALLIE trial for developing 21st-century ELCS. Before beginning the MALLIE trial, learners' ELCS was tested using the three missions for vocabulary level B1 according to the Common European Framework of Reference for Language standard (Cambridge, 2019). After finishing the learning process, learners completed a self-assessment, and a rubric was completed for them as well. Table 2 presents the self-assessment and rubric ratings for the participants in the MALLIE condition.

Table 2: Demographic information of the MALLIE innovation learners (n = 105)

| Variable                             | Detail                         | Frequency | Percentage |
|--------------------------------------|--------------------------------|-----------|------------|
| Gender                               | Male                           | 32        | 30.5       |
|                                      | Female                         | 73        | 69.5       |
| Year                                 | Year 1                         | 9         | 8.6        |
|                                      | Year 2                         | 16        | 15.2       |
|                                      | Year 3                         | 55        | 52.4       |
|                                      | Year 4                         | 24        | 22.9       |
|                                      | Year 5                         | 1         | 1.0        |
| Subject Field                        | Science                        | 54        | 51.4       |
|                                      | Humanities and Social Sciences | 51        | 48.6       |
| University type                      | Public                         | 51        | 48.6       |
|                                      | Private                        | 54        | 51.4       |
| GPA                                  | Lower than 3.01                | 41        | 39.0       |
|                                      | 3.01 – 4.00                    | 60        | 57.1       |
| MALL using experience                | Yes                            | 21        | 20.0       |
|                                      | No                             | 84        | 80.0       |
| Number of subjects studying via MALL | 1 subject                      | 35        | 41.7       |
|                                      | 2 subjects                     | 18        | 21.4       |
|                                      | 3 subjects                     | 27        | 32.1       |
|                                      | 4 subjects                     | 4         | 4.8        |

### Instruments and procedure

For this study, learners worked on developing listening and reading skills and vocabulary by completing exercises using the chatbot and an online dictionary (Collins) in each mission (Figure 8). The students then worked on developing their writing and speaking skills by creating a product review; they were allowed to create a vlog using their own images or avatars to represent themselves (Figure 9), and their works were scored. In addition, in-depth interviews were conducted with instructors and learners to gauge their intent to use other MALLIE applications based on the technology acceptance model (Davis, 1989). This model describes the main factors in accepting technology, including its perceived usefulness and perceived ease of use, which directly affect the (3) intention to use and (4) usage behaviour.

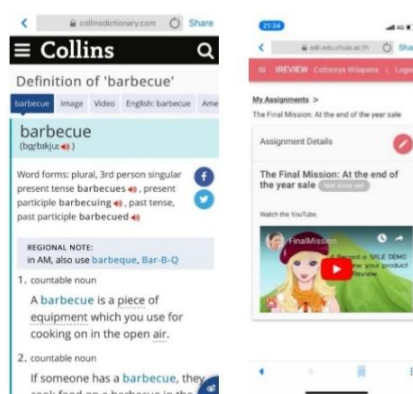


Figure 8: How MALLIE develops listening and speaking skills

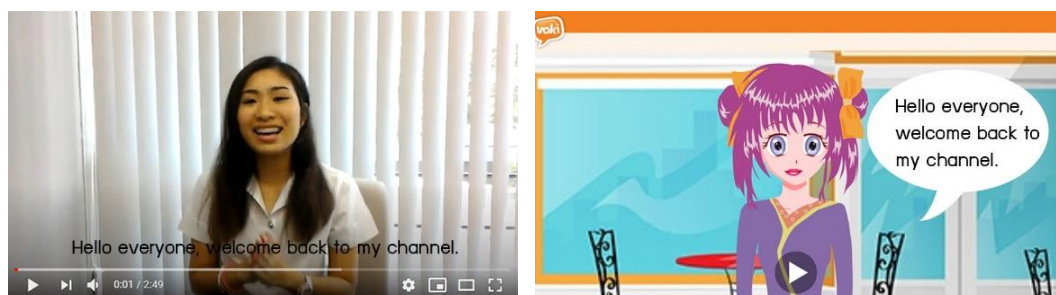


Figure 9: Sample vlog product review (left) and sample vlog with user's avatar rather than the real image (right)

## 5. Research Findings

The results of this study on an innovative mobile application to support ELCS among higher education English language learners in Thailand can be summarised under each research question as below.

### 5.1 Research Question 1

The ability of the MALLIE application to promote ELCS in higher education students was evaluated separately for the chatbot, iReview, and the back office, using an EFA of the quantitative data from 546 learners who had experience in using MALL and the qualitative data collected from interviews with 15 experts. The system has three distinctive features for promoting ELCS: a Facebook Messenger chatbot with exercises that teach vocabulary and grammar (Figures 3 and 5); iReview, an app that develops listening and speaking skills by having students create vlogs (Figures 4 and 6); and the back office system through which the instructors create and set up learning activities. Figure 10 graphically displays how the back office system tracks and displays students' progress.

 Figure 10 shows the back-office interface of the MALLIE application. The top section displays a chatbot interface with a message from 'Mallie' about a 'Mission 2: Travel Blog' assignment. The middle section shows a form for creating a mission, including a description, vocabulary list, and questions. The bottom section shows a table of student progress.
 

| Name                   | Registered Date | R-W   | L/S           | Status   |
|------------------------|-----------------|-------|---------------|----------|
| Parupong Bupakosum     | 02/09/2019      | 2/20  | Fail          | Fail     |
| Kritiya Jaimun         | 02/09/2019      | 20/20 | Pass          | Studying |
| Chonnikarn Tamme       | 02/09/2019      | 20/20 | Not done yet  | Studying |
| Thanyasiri Vnidsumanon | 02/09/2019      | 20/20 | Not check yet | Studying |
| Thipakorn Thongpan     | 02/09/2019      | 20/20 | Pass          | Studying |

Figure 10: Back-office setup for vocabulary details, showing (above) exercises and (below) student progress

## 5.2 Research question 2

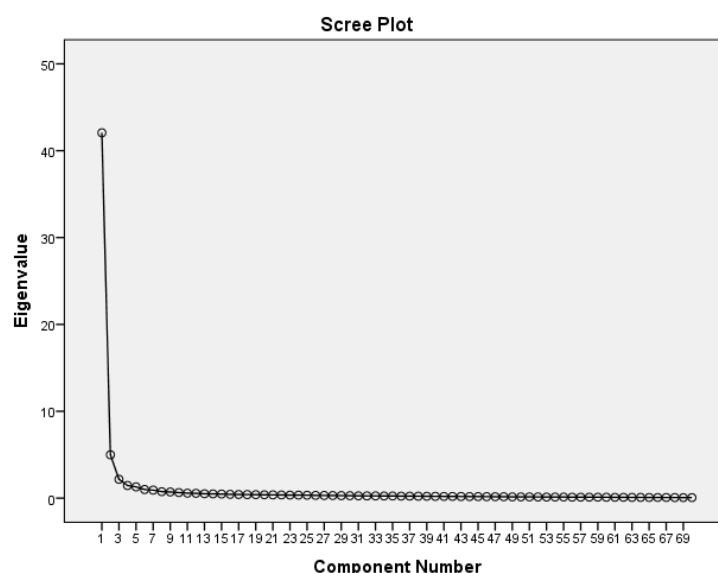
Table 3 presents the EFA results for the factors that contributed to the design and development of the MALLIE application for supporting ELCS in higher education learners, which incorporated the quantitative EFA and qualitative interview data. The system was designed in accordance with the analysis results.

**Table 3: Factor analysis results for the MALLIE design and development**

| Factor | Eigen value | Variable (Number) | Factor loading | Variance (%) | Cumulative variance (%) |
|--------|-------------|-------------------|----------------|--------------|-------------------------|
| 1      | 42.06       | 37                | 0.55 - 0.81    | 60.09        | 60.09                   |
| 2      | 4.99        | 17                | 0.63 - 0.76    | 7.13         | 67.22                   |
| 3      | 2.17        | 11                | 0.62 - 0.76    | 3.10         | 70.32                   |
| 4      | 1.45        | 5                 | 0.61 - 0.65    | 2.08         | 72.39                   |

Note: Mobile assistant learning language (MALL)<sup>[1]</sup>, virtual learning environment (VLE)<sup>[2]</sup>, collaboration & communication skills for 21<sup>st</sup> Century Learners (4Cs)<sup>[3]</sup>, and English language communication skill (ELCS)<sup>[4]</sup>.

The means for the 70 items extracted through EFA were between 3.62 and 4.11, with standard deviations between 0.76 and 0.97. Factors were then extracted using PCA and orthogonal varimax rotation. The 70 extracted variables loaded under four distinct factors that weighed more than 0.30 ( $p < .05$ ), aligning with the research objective. Figure 11 presents the scree plot of the factor eigenvalues.



**Figure 11: Scree of the EFA factor eigenvalues**

In terms of the four factors, Factor 1 had 37 variables with factor weights between 0.55 and 0.81 and an eigenvalue of 42.06. It consisted of variables related to the instructor, the learner, the suitability of the content, the learning environment, and assessments, and therefore, this factor was named MALL. It comprised variables 1–35. Factor 2 had 17 variables with factor weights between 0.63 and 0.76 and an eigenvalue of 4.99. It consisted of variables related to access to mobile learning devices and the suitability of the MALLIE content, learning activities, and testing. Factor 2 comprised variable numbers 43–59 and was named VLE. Factor 3 encompassed 11 variables with factor weights between 0.62 and 0.76 and an eigenvalue of 2.17. It consisted of basic reading, writing, understanding, and speaking skills as well as 21st-century skills in collaboration and communication. The factor was composed of variable numbers 60–70 and was named the 4Cs for the four main language learning skills. Factor 4 had five variables with factor weights between 0.61 and 0.65 and an eigenvalue of 1.45. These variables related to enhancing English vocabulary, speaking, listening, reading, and writing skills and were therefore named ELCS. It comprised variable numbers 38–42.

### 5.3 Research Question 3

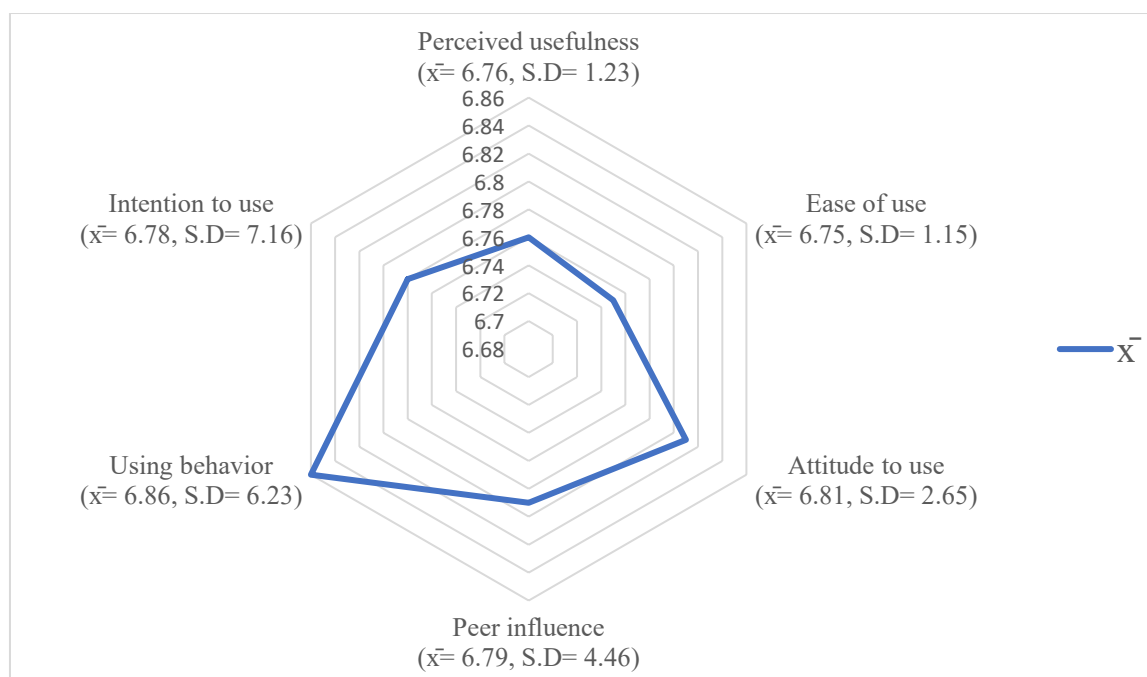
Research question 3 entailed examining how the study respondents accepted or conceived of acceptance and how they promoted using innovation in developing and accepting a mobile application to support ELCS among higher education learners. The survey topics included (1) perceived usefulness, (2) ease of use, (3) using behaviour, (4) peer influence, (5) attitude to use, and (6) intention to use.

#### Part 1: Basic information on the respondents

The questionnaire respondents consisted of 105 higher education students and the person interviews were collected from five students and five instructors, of whom seven respondents (70%) were female. All five students were in their second year, three studying humanities and social sciences and two studying science and technology. Each student had prior experience in mobile learning, with studying via mobile applications for more than 5 hours per week and two for 4.5 hours per week.

#### Part 2: Opinion survey on the acceptance and the possibility of using MALLIE

The opinion survey on the acceptance of and intention to use the MALLIE to support ELCS among higher education English language learners consisted of six main topics for assessment: (1) perceived usefulness of the MALLIE, (2) ease of use, (3) learners' use behaviour, (4) peer influence, (5) attitudes toward using, and (6) intention to use the MALLIE. The results are summarised in Figure 12.



**Figure 12: Trends in using innovation**

The findings depicted in Figure 12 indicate that these 10 interviewees accepted the MALLIE for supporting ELCS development in all six dimensions and reported a high possibility that they would use this mobile application in the future. The perceived usefulness of the MALLIE received the highest score, 6.76 out of 7; it also helped learners achieve successful learning sooner than expected, and it was easy to use, with an average ease of use score of 6.89 out of a possible total 7 points. Additionally, 6.89 was the students' average rating for their use behaviour as well as for whether using the application was fun and enjoyable and whether they would use the application with a group of friends. The students rated their intention to recommend the MALLIE to other people with a score of 6.88. The interview results also indicated positive opinions of the MALLIE for English language learning ( $p < .05$ ), aligning with the research objective.

## 6. Conclusion and Discussion

Today, the effective sustainability of English language skills must incorporate 21st-century technologies including mobile devices that are convenient to carry, easy to use, flexible, and always online for improving language knowledge and skills (Chen and deNoyelles, 2013; Gezgin et al., 2018; Wai et al., 2018). In this study conducted

among higher education learners, most had experienced learning through mobile devices, and their most popular device was a smartphone. The study results for the MALLIE development aligned with related literature from the following four perspectives. First, MALLIE is a ubiquitous technology that allows learning without limits, encouraging communication with other learners as well as encouraging tailored, personal learning (Kim and Kwon, 2012; Martin and Ertzberger, 2013). Second, MALLIEs are mobile applications and thus are available on any mobile device, enhancing their access (Ozdamli and Cavus, 2011). Third, MALLIEs are flexible and allow for learners' self-paced learning activities (Kumar and Jayachandran, 2019). Lastly, a MALLIE emphasises and encourages interactivity and knowledge sharing among users (Hwang et al., 2015). The results align with Ebadi and Raygan (2023) who studied the factors of facilitating conditions, perceived ease of use, and perceived usefulness of MALL in English language learning. They found that perceived usefulness influenced perception towards MALL while facilitating conditions influenced perceived ease of use. This is also true in another research that mentions that facilitating conditions, hedonic motivation, and social influence are significant indicators of the intention to use MALL among learners (Alhadih, 2023).

The learning protocol in the MALLIE consisted of four steps: active reading, listening to vocabulary, review, and interactive writing and speaking. The chatbot facilitated interactive activities among learners for developing their writing and reading skills, and iReview encouraged the development of more effective and productive listening and speaking skills. Our findings supported those of Abdi and Makiabadi (2019) and Nejati et al. (2018) that organised learning using a MALL with a language application develops students' listening and speaking skills; learners studying with the MALL had greater skills than the control groups in those authors' studies. In addition, learning with MALL can support cooperative, collaborative, active, constructive, creative, and social learning (Kim and Kwon, 2012; Bii, 2013; Iftene and Vanderdonckt, 2016), which can increase students' motivation to learn well beyond the limitations of learning in normal classrooms (Lan, 2015; Gafni et al., 2017; Hsiao et al., 2017; Lin and Hwang, 2018).

The MALLIE proposed in this study helped develop ELCS in a group of Thai higher education English language learners by delivering tailored learning experiences via their mobile devices, nearly entirely smartphones. A Facebook Messenger chatbot developed the 4Cs (for communication skills) of ELCS: listening, speaking, reading, and writing. A separate application, iReview, integrated students learned English language skills to expand their 21st-century communication and collaboration skills. Notably, however, some students in this study did not have previous experience in learning through MALL or in VLEs. Instructors need to incorporate the potential knowledge deficits among such populations and develop learning materials that offer new learners in-depth information on how to navigate online learning systems.

This study highlights the innovation's feature to benefit learners in terms of convenience of time and space as well as the appropriate individual learning rate. This attends to and supports personalized learning. Nonetheless, for future research, a Delphi method might be used to examine the effectiveness of the application from the perspectives of MALL experts. Moreover, more information can be acquired as qualitative data from interviews or inquiring the learners to gain more insights. This may contribute to understanding the needs for design and development in English language instruction, as highly efficient innovation development can benefit from considering both quantitative and qualitative data.

#### *Disclosure statement*

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