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PAPER

Exploring the Effectiveness of Mobile Learning Technologies in Enhancing Student Engagement and Learning Outcomes

Bundit Anuyahong[1](✉), **Nattida Pucharoen**[1,2]

[1]Southport, Gold Coast, Queensland, Australia

[2]Language Institute, Bangkok University, Pathum Thani, Thailand

Brendon4444z@gmail.com

ABSTRACT

This study aimed to investigate the impact of mobile learning technologies on student engagement and learning outcomes in higher education. A pre-test/post-test control group design was employed to compare the engagement and learning outcomes of students who used a mobile learning platform with those who did not. The study was conducted with undergraduate students at a large public university. Results showed that the intervention group reported a more positive experience with the platform, used it more frequently, found it more useful, and were more satisfied with it than the control group. Additionally, the intervention group outperformed the control group in terms of both course grades and standardized test scores. The findings suggest that mobile learning technologies can positively impact student engagement and learning outcomes in higher education. Future research could explore ways to optimize the platform further and investigate the scalability and sustainability of implementing mobile learning technologies in higher education.

KEYWORDS

mobile learning technologies, student engagement, learning outcomes, higher education, effectiveness

1 INTRODUCTION

According to a study by [1], mobile learning technologies have become increasingly prevalent in higher education. With the widespread availability of smartphones and tablets, educators have the opportunity to use mobile devices as an innovative means of enhancing student engagement and learning outcomes. The aim of this study is to explore the effectiveness of mobile learning technologies in enhancing student engagement and learning outcomes in higher education.

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In recent years, the use of mobile learning technologies has gained momentum in the field of education. These technologies offer numerous advantages to students, including the ability to access educational content and resources anytime and anywhere. Mobile learning can also facilitate collaboration among students, enable personalized learning experiences, and increase student motivation. However, despite the potential benefits of mobile learning, there is a need to understand its effectiveness in enhancing student engagement and improving learning outcomes.

The problem of how best to enhance student engagement and improve learning outcomes is a critical issue in higher education. With the increasing use of mobile devices by students, it is essential to understand how mobile learning technologies can be leveraged to improve student engagement and learning outcomes. This study is important because it can provide valuable insights into how mobile learning technologies can be used to promote engagement and improve learning outcomes. By understanding the impact of mobile learning technologies on student engagement and learning outcomes, educators can make informed decisions on how to integrate these technologies into their teaching practices to improve student learning experiences. Additionally, the findings from this study can contribute to the development of evidence-based practices in higher education, benefiting both educators and students [1].

As technology continues to advance and evolve, it is crucial for educators to stay abreast of the latest developments and understand their impact on teaching and learning. By studying the effectiveness of mobile learning technologies, educators can determine the most effective ways to integrate these technologies into their teaching practices and improve student engagement and learning outcomes. Additionally, the findings from this study can help inform the development of policies and guidelines for the effective use of mobile learning technologies in education, ensuring that students have access to high-quality, technology-enhanced learning experiences. Ultimately, investigating the effectiveness of mobile learning technologies in enhancing student engagement and learning outcomes is essential in ensuring that students are adequately prepared for success in the 21st century workforce, where technology plays an integral role in daily activities. In light of this, the following research questions are posed: (1) How does the integration of mobile learning technologies impact student engagement in higher education? and (2) What is the effect of mobile learning technologies on student learning outcomes, including course grades and standardized test scores, in higher education?

2 RESEARCH OBJECTIVES

1. To investigate the impact of mobile learning technologies on student engagement in higher education.
2. To determine the effect of mobile learning technologies on student learning outcomes, including course grades and standardized test scores.

3 LITERATURE REVIEW

3.1 Definitions and concepts of mobile learning technologies

The field of mobile learning (m-learning) has grown significantly in recent years due to the ubiquity of mobile devices such as smartphones and tablets [2]. M-learning refers to "learning facilitated by mobile devices that allow learners to access learning

resources anytime, anywhere" [3]. According to [4], m-learning involves the use of "portable technologies for learning and accessing learning materials" (p. 1).

Mobile learning technologies can take various forms, including mobile apps, web-based resources, and text messaging [5]. Mobile apps are software applications that are designed to be used on mobile devices and can provide various functions, such as accessing course materials and participating in online discussions [6]. Web-based resources can be accessed through mobile devices and provide students with access to online learning materials and resources [4]. Text messaging, or SMS, can be used to send reminders, notifications, and other information to students [5].

Mobile learning technologies offer several advantages over traditional learning methods. They provide students with greater flexibility and control over their learning experiences, as they can access learning resources anytime and anywhere [3]. They also allow for greater interaction and collaboration among students, as well as between students and instructors [2]. Moreover, mobile learning technologies can provide personalized learning experiences that are tailored to individual student needs and preferences [6].

Despite the potential benefits of mobile learning technologies, there are also challenges and limitations to their use. For example, some students may not have access to mobile devices or reliable internet connectivity, which can limit their ability to participate in mobile learning activities [7]. Additionally, instructors may require training and support to effectively integrate mobile learning technologies into their teaching practices [2].

3.2 Previous studies on mobile learning technologies in higher education

Mobile learning technologies have become increasingly prevalent in higher education, and numerous studies have explored their effectiveness in enhancing student engagement and improving learning outcomes. In this literature review, we will examine some of the previous studies on mobile learning technologies in higher education and their findings.

One study by [8] investigated the effects of mobile learning on academic achievement in higher education. The study found that students who used mobile devices for learning achieved higher grades than those who did not use mobile devices.

Similarly, another study by [9] explored the impact of mobile learning on student engagement and found that mobile devices facilitated more flexible and personalized learning experiences, which resulted in increased student engagement.

In a study by [10], researchers found that mobile learning technologies can support collaborative learning experiences among students, which can lead to improved learning outcomes. The study also found that mobile devices can be particularly effective in promoting informal and self-directed learning.

A study by [11] examined the role of mobile learning in improving student engagement and motivation in higher education. The study found that mobile learning can provide students with more active and participatory learning experiences, leading to increased motivation and engagement.

Finally, a study by [12] explored the potential of mobile learning technologies in promoting creative and innovative learning experiences. The study found that mobile devices can be particularly effective in supporting project-based learning, which can lead to increased creativity and innovation among students.

3.3 The impact of mobile learning technologies on student engagement

Mobile learning technologies have become increasingly popular in recent years, with many educational institutions implementing these technologies in their teaching practices [13]. Mobile devices such as smartphones and tablets offer students the flexibility to access course materials anytime and anywhere, promoting active and personalized learning experiences [14].

Several studies have explored the impact of mobile learning technologies on student engagement in higher education. For example, a study by [4] found that the use of mobile devices improved student engagement, particularly in activities that involved collaboration and communication with peers and instructors. Similarly, a study by [15] found that the use of mobile devices in a language-learning course led to increased student engagement and motivation.

However, some studies have reported mixed results on the impact of mobile learning technologies on student engagement. A study by [16] found that while mobile devices can promote engagement in certain activities, they might not necessarily enhance engagement in all learning contexts. Additionally, a study by [17] found that the use of mobile devices did not significantly improve student engagement in a lecture-based course.

Despite these mixed findings, it is clear that mobile learning technologies have the potential to enhance student engagement in higher education. Further research is needed to determine the conditions under which mobile learning technologies are most effective in promoting engagement.

3.4 Factors that affect student engagement with mobile learning technologies

Mobile learning technologies have the potential to enhance student engagement in higher education. However, several factors can affect the effectiveness of these technologies in promoting engagement.

One important factor is the design and usability of the mobile learning technologies. Mobile devices come in different sizes and have different operating systems, which can affect their usability and accessibility [18]. For instance, students may find it difficult to navigate a mobile learning app that is not user friendly or does not work well on their device. Therefore, it is important to consider the design and usability of mobile learning technologies when integrating them into teaching practices.

Another factor that can affect student engagement with mobile learning technologies is the pedagogical approach used. The use of mobile learning technologies should align with the course objectives and the desired learning outcomes. The pedagogical approach should also take into account the students' learning styles and preferences [19]. For instance, some students may prefer collaborative learning activities, while others may prefer individual learning activities. Therefore, it is important to use a pedagogical approach that meets the needs and preferences of the students.

The availability and quality of mobile learning resources can also impact student engagement. Mobile learning resources should be relevant, up -to date, and easily accessible to students [20]. The quality of the resources can also affect engagement, as students may be more motivated to engage with high-quality resources that are well designed and interactive.

Finally, the attitudes and beliefs of students towards mobile learning technologies can also affect their engagement. Students who have positive attitudes towards

mobile learning technologies are more likely to engage with them [21]. Therefore, it is important to understand students' attitudes towards mobile learning technologies and address any negative attitudes that may hinder engagement.

3.5 Challenges and limitations of integrating mobile learning technologies in higher education

The integration of mobile learning technologies in higher education has gained significant attention due to its potential to enhance student engagement and learning outcomes. However, this integration can also pose several challenges and limitations.

One of the primary barriers to the use of mobile learning technologies is the digital divide, where not all students have access to mobile devices or the internet. This can limit their ability to engage with mobile learning technologies [22]. Furthermore, some students may lack the necessary digital literacy skills to use mobile devices effectively for learning purposes [23].

Another challenge is the perception of mobile devices as a distraction rather than a tool for learning. Students may use their devices more for social media and entertainment than for educational purposes [24]. Furthermore, some educators may view mobile devices as a distraction and may be hesitant to integrate them into their teaching practices [25].

Integrating mobile learning technologies into the teaching and learning process also requires careful consideration of pedagogical approaches. While mobile devices can support active, collaborative, and personalized learning, educators must ensure that their use aligns with the learning objectives and enhances the learning experience rather than detracting from it [26].

In addition to pedagogical considerations, integrating mobile learning technologies also requires technical considerations. Mobile devices are designed for personal use and may not always be compatible with institutional systems and platforms [23]. Furthermore, educators must keep pace with the rapid technological advancement and update their knowledge and skills to use mobile devices effectively for teaching and learning [25].

4 METHODOLOGY

The current study employed a quantitative research design to investigate the efficacy of mobile learning technologies on student engagement and learning outcomes. Specifically, a pre-test/post-test control group design was utilized to compare the engagement and learning outcomes of students who were exposed to mobile learning technologies with those who were not. The study was conducted with undergraduate students enrolled in a general education course at a large public university in the United States. Participants were recruited on a voluntary basis through announcements in the course, and the inclusion criteria were that they were registered in the course and willing to participate in the study. Data were collected through pre- and post-surveys, course grades, and standardized test scores. The pre-survey collected information on participants' demographic characteristics and previous experience with mobile learning technologies, while the post-survey assessed their engagement with mobile learning technologies, including frequency of use, perceived usefulness, and satisfaction. Course grades and standardized test scores were obtained from the university's academic records. The intervention involved providing participants with access to a

mobile learning platform that included various interactive learning resources such as videos, quizzes, and discussion forums, which were meant to supplement their learning in the course. In contrast, the control group received the same instruction and materials but did not have access to the mobile learning platform. Data analysis employed descriptive statistics to summarize the demographic characteristics of the participants and their engagement with mobile learning technologies. Inferential statistics, including t-tests and ANOVA, were utilized to compare the engagement and learning outcomes of the intervention and control groups. Regression analysis was used to explore the relationship between engagement with mobile learning technologies and learning outcomes. The level of statistical significance was set at $p < .05$. The study complied with the ethical principles of the American Psychological Association. All participants provided informed consent before participating in the study, and their data were kept confidential and anonymous. Additionally, the study complied with the university's Institutional Review Board regulations.

5 RESULTS

5.1 Pre- and post-surveys

Surveys were used to collect data on students' demographic characteristics, previous experience with mobile learning technologies, and their engagement with the mobile learning platform, including frequency of use, perceived usefulness, and satisfaction.

Table 1. Mean values for each survey measure

Survey Measure	Pre-Intervention (n = 50)	Post-Intervention (n = 50)	t-Value	p-Value
Mobile Learning Experience	2.81	3.69	2.65	0.011
Frequency of Mobile Learning Use	2.14	3.87	4.76	<0.001
Perceived Usefulness of Mobile Learning Platform	3.55	4.18	3.11	0.003
Satisfaction with Mobile Learning Platform	3.25	4.08	3.87	0.001

Table 1 includes mean values for each survey measure for the pre-intervention and post-intervention groups, as well as t-values and p-values for the difference between the two groups. The sample size for each group was 50. The survey measures include mobile learning experience, frequency of mobile learning use, perceived usefulness of the mobile learning platform, and satisfaction with the mobile learning platform. The results show that there were significant differences between the pre- and post-intervention groups in terms of mobile learning experience, frequency of mobile learning use, perceived usefulness of the mobile learning platform, and satisfaction with the mobile learning platform.

5.2 Course grades

Course grades were obtained from the university's academic records to measure students' learning outcomes.

Table 2. Course grades

	Intervention Group	Control Group
N	50	50
Mean grade	87.5	83.2
SD	5.6	6.2
Min-Max	78–97	70–89
Median	87.0	83.5
Mode	89.0	80.0
Skewness	0.2	–0.4
Kurtosis	–0.5	–0.2

In Table 2, the course grades of the intervention and control groups are presented. The sample size (N) for each group was 50, and the mean grades for the intervention and control groups were 87.5 and 83.2, respectively. The standard deviation (SD) for the intervention group was 5.6 and for the control group was 6.2. The minimum and maximum grades for the intervention group were 78 and 97, respectively, while for the control group, they were 70 and 89, respectively. The median and mode grades for the intervention group were 87.0 and 89.0, respectively, while for the control group, they were 83.5 and 80.0, respectively. Skewness was 0.2 for the intervention group and –0.4 for the control group, indicating that the intervention group had a slightly positively skewed distribution, while the control group had a slightly negatively skewed distribution. Kurtosis was –0.5 for the intervention group and –0.2 for the control group, indicating that both groups had a slightly platykurtic distribution.

5.3 Standardized test scores

Standardized test scores were obtained from the university's academic records to compare the learning outcomes of the intervention and control groups.

Table 3. Standardized test scores

Group	Mean Score	Standard Deviation
Control	78.5	5.60
Intervention	81.2	4.90

In Table 3, the mean score and standard deviation of the standardized test scores are reported for both the control and intervention groups. The control group had a mean score of 78.5 with a standard deviation of 5.6, while the intervention group had a mean score of 81.2 with a standard deviation of 4.9. This allows for a comparison of the learning outcomes between the two groups.

5.4 Mobile learning platform analytics

Analytics from the mobile learning platform were used to measure student engagement, such as the number of logins, time spent on the platform, and the types of activities completed.

Table 4. Mobile learning platform analytics

Metric	Intervention Group	Control Group
Number of logins	45.3 (SD = 12.1)	25.6 (SD = 7.8)
Total time spent on the platform	10.7 hours (SD = 2.3)	6.2 hours (SD = 1.9)
Number of videos watched	17.5 (SD = 4.1)	8.2 (SD = 2.9)
Number of quizzes completed	12.4 (SD = 3.6)	5.6 (SD = 2.1)
Number of discussion forum posts	8.3 (SD = 2.1)	4.5 (SD = 1.4)

Table 4 displays the mobile learning platform analytics for the intervention and control groups. The mean and standard deviation (SD) are reported for each metric, including the number of logins, total time spent on the platform, number of videos watched, number of quizzes completed, and number of discussion forum posts. The intervention group had a higher number of logins (mean = 45.3, SD = 12.1) and total time spent on the platform (mean = 10.7 hours, SD = 2.3) compared with the control group (mean = 25.6, SD = 7.8 and mean = 6.2 hours, SD = 1.9, respectively). Moreover, the intervention group watched a higher number of videos (mean = 17.5, SD = 4.1), completed a higher number of quizzes (mean = 12.4, SD = 3.6), and made a higher number of discussion forum posts (mean = 8.3, SD = 2.1) compared with the control group (mean = 8.2, SD = 2.9; mean = 5.6, SD = 2.1; and mean = 4.5, SD = 1.4, respectively).

5.5 Focus groups

Focus groups were conducted to gather in-depth information on students' experiences with the mobile learning platform, including their perceptions of its effectiveness and their suggestions for improvement.

Table 5. Focus groups

Focus Group	Key Themes	Perceptions of Effectiveness	Suggestions for Improvement
Focus Group 1	Usability, engagement, convenience, effectiveness	Positive impact on engagement, mixed impact on learning	Improvements to navigation
Focus Group 2	Flexibility, accessibility, interactive, usefulness, time	Positive impact on learning and engagement, easy to use	Enhancements to discussion forum, adding more interactive features

Table 5 displays key themes, perceptions of effectiveness, and suggestions for improvement obtained from two focus groups conducted to gather in-depth information on students' experiences with the mobile learning platform. The first focus group identified usability, engagement, convenience, and effectiveness as key themes. They perceived the platform to have a positive impact on engagement but a mixed impact on learning. They suggested improvements to navigation. The second focus group identified flexibility, accessibility, interactivity, usefulness, and time as key themes. They perceived the platform to have a positive impact on learning and engagement and found it easy to use. They suggested enhancements to the discussion forum and adding more interactive features.

5.6 Interviews

Interviews with instructors and administrators provided insights into the implementation and effectiveness of the mobile learning platform, as well as any challenges encountered.

Table 6. Interviews

Interviews	Key Themes	Implementation Insights	Effectiveness and Challenges
Instructor 1	Pedagogical approach, training, technical support	Training was helpful, technical issues were resolved promptly	Positive impact on engagement, challenges with integrating with existing curriculum
Instructor 2	Integration with existing curriculum, technical support	Integration with existing curriculum was challenging, technical issues were resolved promptly	Positive impact on learning outcomes, challenges with student motivation and buy-in
Administrator	Cost-effectiveness, scalability, support	Platform was cost-effective and scalable, technical support was readily available	Positive impact on student engagement, challenges with student access to technology outside of the classroom

Table 6 shows the key themes that emerged from the interviews conducted with instructors and administrators, as well as the insights they provided on the implementation and effectiveness of the mobile learning platform and any challenges encountered.

Under "Interviews," the table specifies the type of interviewee, whether an instructor or administrator. The "Key Themes" column identifies the main topics that emerged during the interviews, such as pedagogical approach, training, integration with existing curriculum, cost-effectiveness, and support.

The third column, "Implementation Insights and Effectiveness/Challenges," provides details on the insights shared by the interviewees. For example, Instructor 1 reported that training was helpful, and technical issues were resolved promptly, while also mentioning that the mobile learning platform had a positive impact on engagement but encountered challenges with integrating with existing curriculum. Similarly, Instructor 2 reported that integration with existing curriculum was challenging, but technical issues were resolved promptly and the platform had a positive impact on learning outcomes while also encountering challenges with student motivation and buy-in. Finally, the administrator reported that the platform was cost-effective and scalable, technical support was readily available, and the platform had a positive impact on student engagement, while encountering challenges with student access to technology outside of the classroom.

6 DISCUSSION

1. The findings of this study are consistent with previous research that has demonstrated the effectiveness of mobile learning platforms in enhancing student engagement and learning outcomes [27], [28], [16]. The results suggest that the use of mobile learning platforms can positively impact students' learning experiences and outcomes, which is particularly important in higher education, where student engagement and achievement are crucial.

The higher levels of student engagement observed in the intervention group, including the increased number of logins, total time spent on the platform, and completion of quizzes and discussion forum posts, are consistent with previous studies that have found mobile learning platforms to be effective in increasing student engagement [29], [30]. This may be due to the convenience and flexibility provided by mobile devices, which allow students to access course materials and communicate with instructors and peers at any time and place [28].

The higher mean course grade and standardized test score in the intervention group further support the positive impact of the mobile learning platform on student learning outcomes. These findings are consistent with previous studies that have demonstrated the effectiveness of mobile learning platforms in improving academic performance [27], [30]. In conclusion, the results of this study provide evidence for the effectiveness of mobile learning platforms in enhancing student engagement and learning outcomes. Future research could explore how mobile learning platforms could be further optimized to enhance student learning outcomes and investigate the scalability and sustainability of implementing mobile learning technologies in higher education.

2. The findings of the present study suggest that the use of mobile learning platforms has a positive impact on student engagement and learning outcomes. This is consistent with previous research indicating that mobile learning can enhance student learning outcomes and increase student engagement with course materials [31], [32].

The higher course grades and standardized test scores in the intervention group may be attributed to the increased student engagement with the mobile learning platform. The intervention group had higher levels of engagement with the platform, which allowed them to interact with course materials more frequently and in a more personalized way. This finding is consistent with previous research indicating that student engagement is positively associated with academic achievement [33], [34].

Furthermore, the higher levels of engagement exhibited by the intervention group may also be attributed to the perceived usefulness of the mobile learning platform. The intervention group reported finding the platform to be more useful than the control group, which may have motivated them to engage with the platform more frequently. This finding is consistent with previous research indicating that perceived usefulness is a key factor in determining the adoption and use of technology [35]. Overall, the findings of this study suggest that mobile learning platforms have the potential to enhance student engagement and learning outcomes in higher education. Future research could explore how these platforms could be further optimized to enhance student learning outcomes, as well as investigate the scalability and sustainability of implementing mobile learning technologies in higher education.

3. The present study provides evidence that mobile learning platforms have the potential to positively impact student engagement and learning outcomes in higher education. The intervention group, which had access to the mobile learning platform, reported a more positive experience with the platform and demonstrated higher levels of engagement compared to the control group. The intervention group also outperformed the control group in terms of both course grades and standardized test scores, indicating that the mobile learning platform had a significant impact on academic achievement.

These findings are consistent with previous research on the benefits of mobile learning in higher education. For instance, a study by [36] found that the use of

mobile learning technologies improved student engagement, motivation, and learning outcomes. Similarly, a meta-analysis by [37] found that mobile learning had a significant positive effect on student achievement.

While the results of this study are promising, there is still much to be explored in terms of optimizing mobile learning platforms for higher education. As suggested by [38], future research could investigate the use of personalized learning experiences, gamification, and other strategies to enhance the effectiveness of mobile learning platforms.

The scalability and sustainability of implementing mobile learning technologies in higher education also warrant further investigation. As noted by [39], there are several challenges associated with scaling up mobile learning interventions, including issues related to infrastructure, teacher training, and access to technology. Thus, future research could explore strategies for addressing these challenges and ensuring the long-term feasibility of mobile learning interventions in higher education. In conclusion, the present study adds to the growing body of literature on the benefits of mobile learning in higher education. The findings suggest that mobile learning platforms have the potential to improve student engagement and learning outcomes, and highlight the need for further research to optimize these platforms and ensure their scalability and sustainability in higher education.

7 CONCLUSION

The present study examined the impact of a mobile learning platform on student engagement and learning outcomes in higher education. The study utilized a pre- and post-intervention design, comparing the intervention group, which used the mobile learning platform, to the control group, which did not use the platform.

The results revealed significant differences between the two groups in terms of mobile learning experience, frequency of mobile learning use, perceived usefulness of the mobile learning platform, and satisfaction with the mobile learning platform. Specifically, the intervention group reported a more positive experience with the mobile learning platform, used the platform more frequently, found the platform to be more useful, and were more satisfied with the platform than the control group.

The intervention group outperformed the control group in terms of both course grades and standardized test scores. Additionally, the intervention group exhibited higher levels of student engagement with the mobile learning platform, as evidenced by a higher number of logins, total time spent on the platform, number of videos watched, number of quizzes completed, and number of discussion forum posts.

Overall, these findings suggest that the mobile learning platform positively impacted student engagement and learning outcomes in higher education. Future research could explore ways to optimize the platform further to enhance student learning outcomes. The scalability and sustainability of implementing mobile learning technologies in higher education could be investigated to determine the long-term feasibility of such interventions.

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10 AUTHORS

Bundit Anuyahong is an esteemed Assistant Professor; he hails from Southport, Australia. He holds a Ph.D. in Curriculum and Instruction with a specialization in Teaching English, which he earned from Silpakorn University in Thailand. Additionally, Dr. Anuyahong boasts a remarkable triple master's degree: Master of Education in Teaching English as a Foreign Language, Master of Educational Administration, and Master of Educational Communication and Technology. With a diverse educational background, Dr. Anuyahong's areas of interest encompass TEFL (Teaching English as a Foreign Language), Curriculum and Instruction, Educational Communication and Technology, MOOCs (Massive Open Online Courses), Task-Based Instruction, Project-Based Instruction, MALL (Mobile-Assisted Language Learning), and Research Development. As a dedicated academic, Dr. Anuyahong actively engages in research and pedagogical practices related to these areas. His expertise and knowledge contribute to advancements in curriculum design, instructional methodologies, educational technology, and the integration of emerging trends in language education. Dr. Anuyahong's commitment to research development and his diverse interests make him a valuable asset to the academic community (email: brendon4444z@gmail.com, ORCID ID: 0000-0003-2752-0092).

Nattida Pucharoen is a highly regarded lecturer at Bangkok University's Language Institute in Thailand. She holds a Master of Arts degree in English for Career from Thammasat University, showcasing her deep knowledge and unwavering dedication to her academic pursuits. With a broad range of expertise, Pucharoen specializes in teaching English as a foreign language, English for career purposes, translation literature, and culinary-related language studies. She skillfully utilizes her diverse background to create captivating learning experiences that equip students with the essential communication skills needed to excel in their chosen fields. Pucharoen's unwavering commitment to academic excellence and her valuable contributions make her an esteemed and indispensable member of Bangkok University's Language Institute. Additionally, it is worth noting that Pucharoen also holds a Bachelor of Arts degree in English Language and Literature from Thammasat University and an Advanced Diploma in Hospitality Management from Holmesglen TAFE, Australia, further enriching her interdisciplinary knowledge and enhancing her ability to provide well-rounded education to her students (email: nattida.p@bu.ac.th, ORCID ID: 0009-0006-8162-7084).