

RESEARCH ARTICLE

Online Game-based Learning via LINE Application to Enhance Parts of Speech Skills of High School Students with Hearing Impairment in the 21st Century

Wiphasith Hiranrat¹ , Sakchan Luangmaneerote¹ , Boonlueo Nabumroong¹,
Nipon Pimbaotham¹ , and Suparat Walakanon^{2,*} 

¹Department of Computer Technology, Faculty of Agriculture and Technology, Rajamangala University of Technology Isan, Surin Campus, Surin 32000, Thailand

²Department of Linguistics, Faculty of Management Technology, Rajamangala University of Technology Isan, Surin Campus, Surin 32000, Thailand

*Corresponding author: Suparat Walakanon, suparat.wa@rmuti.ac.th

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Abstract

This study aimed to develop and evaluate an online game-based learning tool via LINE application to enhance English parts of speech skills among high school students with hearing impairments. The research objectives were to: (1) develop the online educational game, (2) assess its efficiency, (3) compare students' pre- and post-learning achievement, (4) examine students' learning progress, and (5) investigate the relationship between post-learning achievement and student satisfaction. The sample consisted of 27 high school students with hearing impairments from Surin School for the Deaf during the first semester of the 2024 academic year, selected through purposive sampling. Research instruments included the developed online game, pre- and post-tests, and a satisfaction survey. Data were analyzed using a dependent t-test, Pearson's correlation, percentages, and mean scores. The development process yielded 8 learning units and 109 online games. The system demonstrated high functionality, with an efficiency ratio of 1.46, exceeding McGuigan's criterion of 1.00. A significant improvement in students' post-test scores compared to pre-test scores was observed ($p < 0.05$). The average learning gain was 15.59%, which was lower than the hypothesized 50%. A significant positive correlation was found between student satisfaction and post-learning achievement ($p < 0.05$). These findings suggest that the developed online game-based learning tool effectively enhances English language skills among students with hearing impairments, offering insights into innovative educational approaches for this population.

1. Introduction

English is a global language and is essential for connecting ASEAN countries with the rest of the world (Wuttiwongsa, 2014; Yimon, 2014; Robrue and Bamrungratanakul, 2015). It is the primary language used for communication, building relationships, and creating mutual understanding between countries in various fields such as trade, business, politics, governance, and education when interacting with people of different nationalities, languages, and cultures (Wuttiwongsa, 2014; Yimon, 2014). At the individual level, individuals pro-

ficient in foreign languages, particularly English, gain a competitive advantage. Similarly, at the national level, countries with populations skilled in English are more likely to attract foreign trade and investment (Secretariat of the House of Representatives, 2013).

Despite 12 years of English education in schools as mandated by the Ministry of Education, when considering the English proficiency of Thai high school students based on the Ordinary National Educational Test (ONET) results for English notably in 2020 and 2021, it was found that out of 100 points, students had an average score of 29.20 and 29.73, respectively (National

Institute of Educational Testing Service, 2020, 2021). These results indicate that Thai students have relatively low proficiency in all four English language skills. However, if learners continue to lack knowledge and/or have insufficient English skills, it will affect their further education and work opportunities, leading to missed opportunities for cooperation or loss of benefits from the ASEAN Economic Community (Bureau of Policy and Planning, Office of the Permanent Secretary, Ministry of Interior, nd). This reflects the need for Thai students to improve their English language skills and increase their language competency to be on par with neighboring countries.

To improve the quality of English language teaching and learning activities, it is crucial to consider learning processes that allow students to exchange knowledge and collaboratively solve problems to achieve common goals. In the digital age and the New Normal lifestyle emerging in the COVID-19 era, social media has played a significant role in human life. Applications such as LINE, Facebook, WhatsApp, email, and Skype are widely used (Chaiyabutr, 2018; Thabkrong *et al.*, 2018). These media are not only communication tools through computer networks but are also applied in work environments for easy access by personnel, as seen in previous research that applied the LINE application in organizational work processes (Pitoonpong, 2017). Similarly, Thabkrong *et al.* (2018) and Tathong *et al.* (2019) applied the LINE application as a medium for presenting knowledge and organizing teaching and learning, respectively.

Meanwhile, educational information technology innovations have been continuously developed. This technology is used to create learning environments utilizing computers and communication networks as the primary means of presentation (Pooworawan and Numprasertchai, 2003). One interesting type of instructional media utilizing computer technology in the current era is online educational games (Game-Based Learning), which involve presenting games for teaching and testing (Supahuang and In-Udom, 2012). These games leverage computer technology and internet networks in their design and development (Nakasan and Nakasan, 2016) to differentiate them from general educational games. With multimedia presentation features, game players can listen to narrations and see both static and animated visuals, as well as interact with learners in real-time without limitations of place and time, which greatly stimulates interest (Supahuang and In-Udom, 2012). These characteristics make the learning experience more engaging for students.

However, online educational games still have rules, guidelines, and methods for players to follow, similar to general educational games. Players can play individually or in groups. Games are not only popular with kindergarten and primary school students but are also used with learners at all educational levels and in all subjects. Games help make learning fun, chal-

lenging, and exciting while reducing stress, resulting in faster learning and improved academic achievement (Tiantong, 2005).

Nevertheless, most online educational games are designed to cater to typical learners, overlooking students with hearing impairments. Although technology is currently being used to deliver content to this group of learners, it still does not fully meet their needs and align with their way of life (Arayawinyoo, 1999; Chinawong and Chinatangkul, 2013). This is because these learners have lost their hearing, which is an obstacle to learning, especially language learning, which develops more slowly than in typical individuals. This affects listening, speaking, reading, and writing skills. When they need to communicate, they express themselves through sign language and written language (Arayawinyoo, 1999; Saksiriphol, 2010).

However, communication through sign language for this group of individuals with disabilities is still a barrier when communicating with typical people, as most typical people do not understand sign language. Writing is a method that can convey thoughts to recipients more easily by using symbols, messages, and various characters (Arayawinyoo, 1999; Saksiriphol, 2010). However, writing is still a problem for this group of individuals with disabilities, such as writing sentences with mixed words and positions, inability to use vocabulary to create diverse sentences, and possible word or phrase switching in sentence construction (Arayawinyoo, 1999). This aligns with Thepud (2005), who analyzed the characteristics of errors in Thai writing by individuals with hearing impairments and found three main types of errors: grammatical errors, meaning communication errors, and spelling errors. These language limitations make communication and understanding difficult. If they are in a society that cannot accept this, it can further exacerbate problems (Namsaeng, 2015).

A survey of high school students at the School for the Deaf in Surin Province found that communication problems are not limited to Thai writing alone but also occur similarly in English writing. Specifically, learners cannot construct sentences to convey meaning, and the grammatical forms used in written language are based on sign language. If these learners cannot write English sentences correctly, it results in test scores below the threshold, as evidenced by the reports of the Ordinary National Educational Test (O-NET) for English over the past two years (2020–2021) for Grade 12 students in the Special Education Administration Group (SES). Out of 100 points, the average English subject scores were 21.74 and 21.88, respectively (National Institute of Educational Testing Service, 2020, 2021). The acquisition of English language proficiency among hearing-impaired learners has become increasingly critical in contemporary society. As a lingua franca, English maintains its predominant status across multiple domains, including commerce, academia, international relations, and technological advancement. This significance is pre-

dominantly evident in the digital sphere, where approximately 80% of web content is primarily presented in English. The development of English language competency facilitates access to contemporary knowledge resources and enhances communicative capabilities, thereby expanding opportunities for international academic pursuit and professional engagement. Furthermore, it significantly augments the social integration capabilities of hearing-impaired individuals.

Research has demonstrated that enhanced English language proficiency correlates positively with career advancement and daily functional capabilities (Kumar, 2020; John et al., 2021). When systematically developed, these linguistic competencies enable hearing-impaired individuals to achieve professional autonomy and financial independence. The implications extend beyond individual benefits to encompass broader societal impacts, contributing to national human capital development while optimizing governmental resource allocation for disability support services. This educational investment represents a strategic approach toward fostering an inclusive, sustainable, and equitable society.

If these problems are not addressed, they will impact the future in the economic, social, and political dimensions. If relevant agencies prioritize developing appropriate learning for this group's needs to move towards creating jobs and futures, the resulting benefits will help the country reduce various burdens and decrease learning inequalities. If this group of individuals with disabilities receives improved quality of life, increased knowledge, skills, and abilities, it will enable them to pursue careers and support themselves. More importantly, the country will gain additional human resources to help develop the nation, while also helping the government save the budget in improving quality of life.

Given the English language skill problems of learners with hearing impairments, as well as the characteristics of educational games and the LINE application mentioned above, to help elevate English language skills and meet the needs and acceptance at the ASEAN level, the researcher deemed it appropriate to conduct research on learning through online educational games via the LINE application to enhance English language skills related to parts of speech for individuals with hearing impairments at the high school level in the 21st century and the New Normal lifestyle emerging in the COVID-19 era.

1.1 Research Objectives

1. To develop an online educational game via the LINE application to enhance English language skills related to parts of speech for upper secondary school students with hearing impairments in the 21st century.
2. To determine the efficiency of the developed online educational game.

3. To compare students' learning achievement before and after using the developed online educational game.
4. To study the learning progress of students who use the developed online educational game.
5. To examine the relationship between post-learning achievement and student satisfaction of hearing-impaired students who use the developed online educational game.

Research Hypotheses

1. The developed online educational game via the LINE application will have an efficiency meeting McGuigan's criterion (≥ 1.00).
2. Learners who use the developed online educational game via the LINE application will achieve significantly higher post-test scores than pre-test scores, at the .05 significance level.
3. Learners who use the developed online educational game via the LINE application will demonstrate a 50% increase in learning progress.
4. There will be a positive correlation between post-learning achievement and learner satisfaction with the developed online educational game via the LINE application, at the .05 significance level.

2. Related work

2.1 Educational Games and Online Educational Games

The concept of educational games has been explored by several scholars in the field of education. Phummun (2001) defines educational games as activities that enhance children's observational skills and cognitive development. These games feature simple rules and can be played individually or in groups. Building on this definition, Khemmanee (2016) characterizes educational games as instructional processes designed to help learners achieve specific objectives through rule-based, engaging, and challenging methods. To expand this concept, Moonkham and Moonkham (2002) describe educational games as learning arrangements where students engage with simple, rule-based games. These games not only foster a fun and cheerful atmosphere but also promote creativity and knowledge exchange. The games serve as a basis for discussion and learning outcome summarization. Therefore, educational games can be defined as learning tools with straightforward rules that simultaneously promote creativity, enjoyment, and collaborative learning.

The emergence of technology has led to the evolution of educational games into online formats. Online games

are internet-based, requiring players to install software on their computers and interact through servers where player data are stored. Tiantong (2002) emphasizes that computer educational games aim to reinforce content review in an exciting format, particularly motivating for young learners who require additional engagement. Combining these insights, we can conclude that online educational games are internet-connected activities without time or location constraints, playable individually or in groups. They feature clear rules and methods designed to capture learners' attention, alleviate boredom, and create an enjoyable learning environment.

To further categorize and utilize these games effectively, Tiantong (2002) has developed a classification system for educational games based on their usage characteristics and play methods. This system aids in selecting and designing games that align with specific learning objectives and target learner groups. Phiwma (2021) stresses the importance of integrating course content into these games while adhering to course objectives.

In the context of this research, three types of games—matching games, word-filling games, and sentence-arranging games—were selected for development as online educational games. The design of these games is crucial for stimulating interest and motivation, thereby enhancing learning effectiveness. Gee (2003) advocates for a progressive challenge approach in educational game design, emphasizing the importance of incrementally increasing difficulty levels to facilitate continuous skill development and learning engagement. The framework emphasizes that game design must carefully calibrate challenge levels to align with players' existing competencies. Excessive difficulty may impede the acquisition of fundamental skills, while insufficient challenge could stagnate skill progression. Therefore, optimal game design should incorporate scaffolded learning processes that enable players to maximize their learning potential and self-development capabilities through systematic progression. Moonkham and Moonkham (2002) propose a comprehensive set of guidelines for designing educational games:

1. **Game selection:** Choose games with clear objectives that are appropriate for the players' level and setting, with well-defined rules.
2. **Explanation of play and rules:** Clearly communicate the game name and rules, allowing for questions and providing demonstrations when necessary.
3. **Gameplay:** Ensure suitable locations, monitor the gameplay process, and observe players' behavior.
4. **Post-game discussion:** Facilitate discussions that link game experiences to learning objectives and summarize key takeaways.
5. **Evaluation:** Assess the learning outcomes achieved through the game.

Complementing these guidelines, Garriss et al. (2002) present a Game-based Learning Model comprising three main components:

1. **Input:** The integration of instructional content with game characteristics.
2. **Process:** A game cycle encompassing player decisions, desired behaviors, feedback systems, and motivational elements for sustained engagement.
3. **Outcome:** Learning results derived from players' reflections and inquiries post-gameplay.

2.2 LINE Application in Educational Context

The LINE application, primarily known as a free platform for chat and video calls on smartphones and computers, has found innovative applications in education. Beyond its basic functions of messaging, image sharing, and video calls, LINE has proven valuable for business and educational purposes. As Kuljitjuewong (2013) notes, the platform allows for efficient promotion and customer communication through its Official Account feature, which has been adapted for educational use.

2.3 Related Studies

Recent studies have explored the effectiveness of both online games and the LINE application across various educational contexts, demonstrating their versatility and potential to enhance learning outcomes. In nursing education, Tathong et al. (2019) found high learning outcomes and satisfaction levels among students when LINE was integrated into a course on nursing care.

Similarly, Polhan et al. (2019) showed the efficacy of using LINE to deliver an educational program on inhaler use for asthma patients, resulting in significantly improved symptom control. The application of online games in secondary education was examined by Panthasen et al. (2020), who developed games to promote creative internet use among students. Their study revealed excellent quality in both the learning management plan and the games, with significant improvements in learning achievement.

Boonthawee and Sonsilphong (2021) extended this research to high school students, creating online games to enhance problem-solving skills. Their findings indicated significant improvement in these skills and high levels of student satisfaction with the game-based learning approach.

In early childhood health education, Sirisawat et al. (2021) compared traditional booklets with a LINE-based application for educating parents about children's oral health. While both methods increased knowledge, the LINE application proved more effective in promoting positive health care behaviors.

Finally, in higher education administration, Kongjai and Thathong (2022) developed an automated notification system using LINE for university staff, which improved activity participation and planning efficiency. Collectively, these studies highlight the potential of online games and the LINE application to enhance learning outcomes, promote specific skills, and improve communication and engagement across a wide spectrum of educational settings, from early childhood education to university-level administration.

3. Materials and Methods

3.1 Population and Sample

This study focused on students with hearing impairments at Surin School for the Deaf during the 2024 academic year. The population comprised all upper secondary or equivalent students at the school. Using purposive sampling, a sample of 27 students was selected for the research.

3.2 Research Instruments

The study employed four primary instruments:

1. Online educational games
2. Pre-test
3. Post-test
4. Learner satisfaction assessment forms

3.3 Experimental Design

The research adopted a One-Group Pretest-Posttest Design (Tiantong, 2002). The development and efficiency evaluation of the instruments followed the AD-DIE Model (Seel and Glasgow, 1998), consisting of five phases: Analysis, Design, Development, Implementation, and Evaluation.

3.4 Development of Online Educational Games

1. **Analysis Phase:** The research team conducted a comprehensive needs analysis by reviewing literature on English language use among upper secondary learners with hearing impairments. This analysis revealed significant deficiencies in English language skills within this group. The team then defined learner characteristics, focusing on upper secondary students as a critical demographic for national development. Content analysis yielded eight learning units covering parts of speech: Noun, Pronoun, Verb, Adverb, Adjective, Preposition, Conjunction, and Interjection.

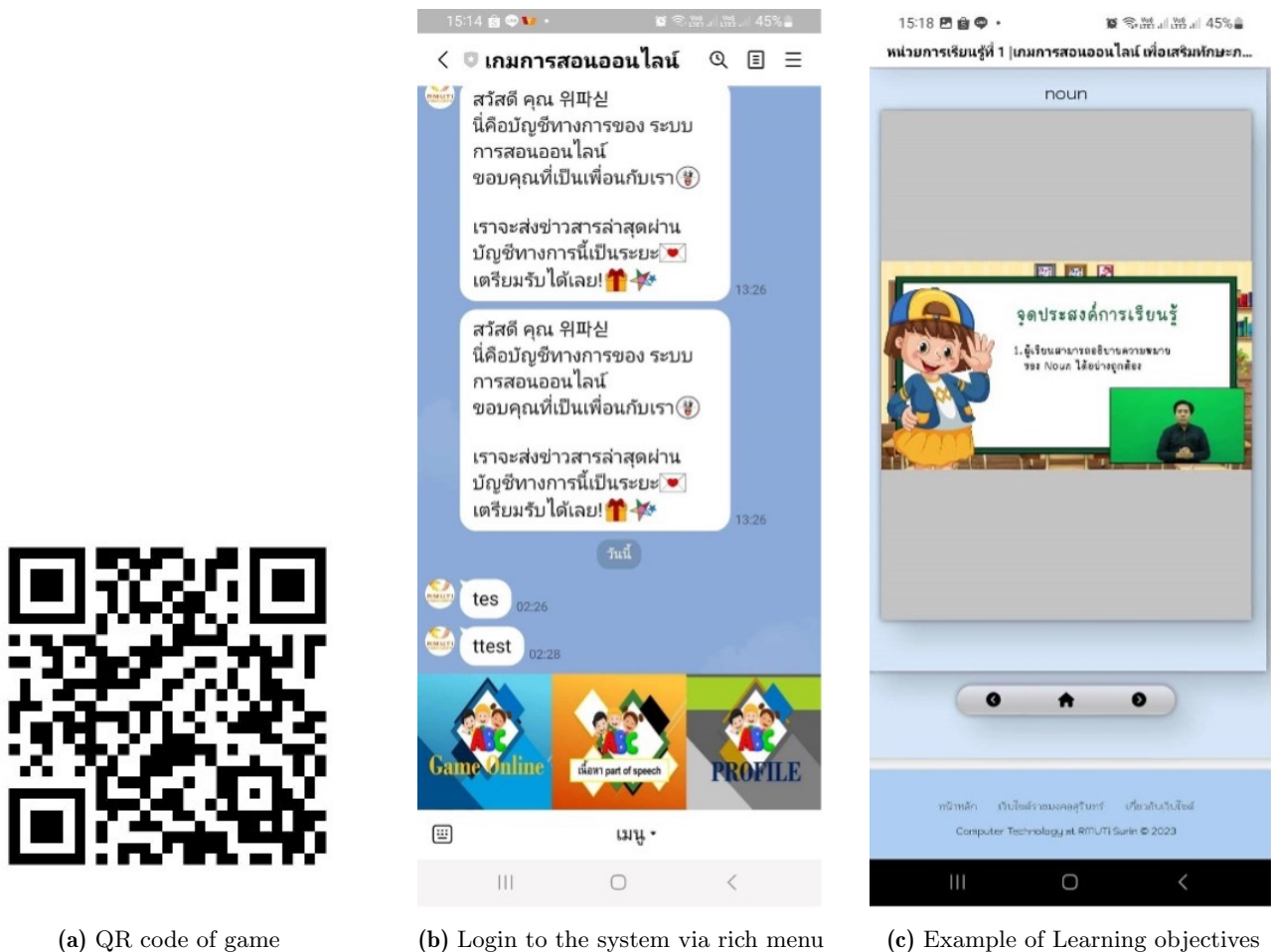
2. **Design Phase:** Based on the analysis, 115 learning objectives were formulated. The team then designed 109 educational games, including matching, fill-in-the-blank, and sentence arrangement activities, following (Moonkham and Moonkham, 2002) game design principles. These games were designed for cross-platform compatibility (smartphones and personal computers). Additional design elements included LINE rich menus, storylines, instructional videos, and system flowcharts.
3. **Development Phase:** The development phase involved creating the learning management system using PHP, HTML, and SQL. Games were developed using Scratch, while Canva was employed for lesson content creation. LINE OA rich menus were integrated to enhance user communication. A formative evaluation was conducted with non-sample learners, yielding positive satisfaction results.
4. **Implementation Phase:** The developed system was deployed on a computer network (URL: <http://www.ecpthai.com/game/>) and through a LINE Official Account (@094iiorp). A comprehensive user manual was prepared to facilitate usage.
5. **Evaluation Phase:** Three experts in educational technology and methodology evaluated the online educational games, rating them at a good level for quality and accuracy.

3.5 Pre-test and Post-test Development

The development of assessment instruments proceeded through three main stages:

1. **Initial item development:** 272 multiple-choice items were constructed based on content analysis, with each item containing four options. These items were aligned with 8 learning units and 115 learning objectives.
2. **Content validation:** Subject matter experts reviewed and validated all items to ensure their alignment with the intended objectives.
3. **Quality assessment:** A pilot study was conducted to analyze three key aspects (Tiantong, 2005):
 - Difficulty level (P): Acceptable range between 0.20 and 0.80.
 - Discrimination power (D): Minimum acceptable value of 0.20.
 - Reliability: Minimum coefficient of 0.60 required.

This analysis resulted in 218 items meeting the quality criteria, with an overall reliability coefficient of 0.98. These items were then divided into equivalent pre-test and post-test sets.



(a) QR code of game

(b) Login to the system via rich menu

(c) Example of Learning objectives

Figure 1. Examples of online teaching games via LINE application. (Continued on next page)

3.6 Satisfaction Assessment Form

The researchers adapted Tiantong (2005) media quality assessment form to create a 5-level Likert scale satisfaction survey. The survey evaluated six aspects: lesson content, multimedia elements, typography and color scheme, assessment methods, lesson management, and online game management.

3.7 Data Collection Procedure

The data collection process followed the procedure below:

1. Official permission was obtained from the director of Surin School for the Deaf.
2. The research team provided a comprehensive orientation on the online educational games to the 27 participants and their teacher.
3. During the first semester of the 2024 academic year, participants engaged with the online educational games independently, under the supervision of the research team and the instructor. The learning process followed these steps:

- Learners accessed the system via the LINE Official Account.
- For each unit, learners read the objectives and completed the pre-test before accessing content and games.
- After completing all games in a unit, learners took the post-test.
- Upon finishing the entire course, learners completed the satisfaction survey through LINE.

3.8 Data Analysis

The collected data underwent the following analyses:

1. Efficiency evaluation of the online educational games using McGuigan's criterion: post-test scores/pre-test scores (Tiantong, 2005).
2. Learning achievement analysis using dependent *t*-test statistics to compare pre-test and post-test scores (Wongrattana, 2009).
3. Calculation of relative gain scores:

$$\text{Relative Gain} = \frac{\text{Post-test score} - \text{Pre-test score}}{\text{Full score} - \text{Pre-test score}} \times 100$$

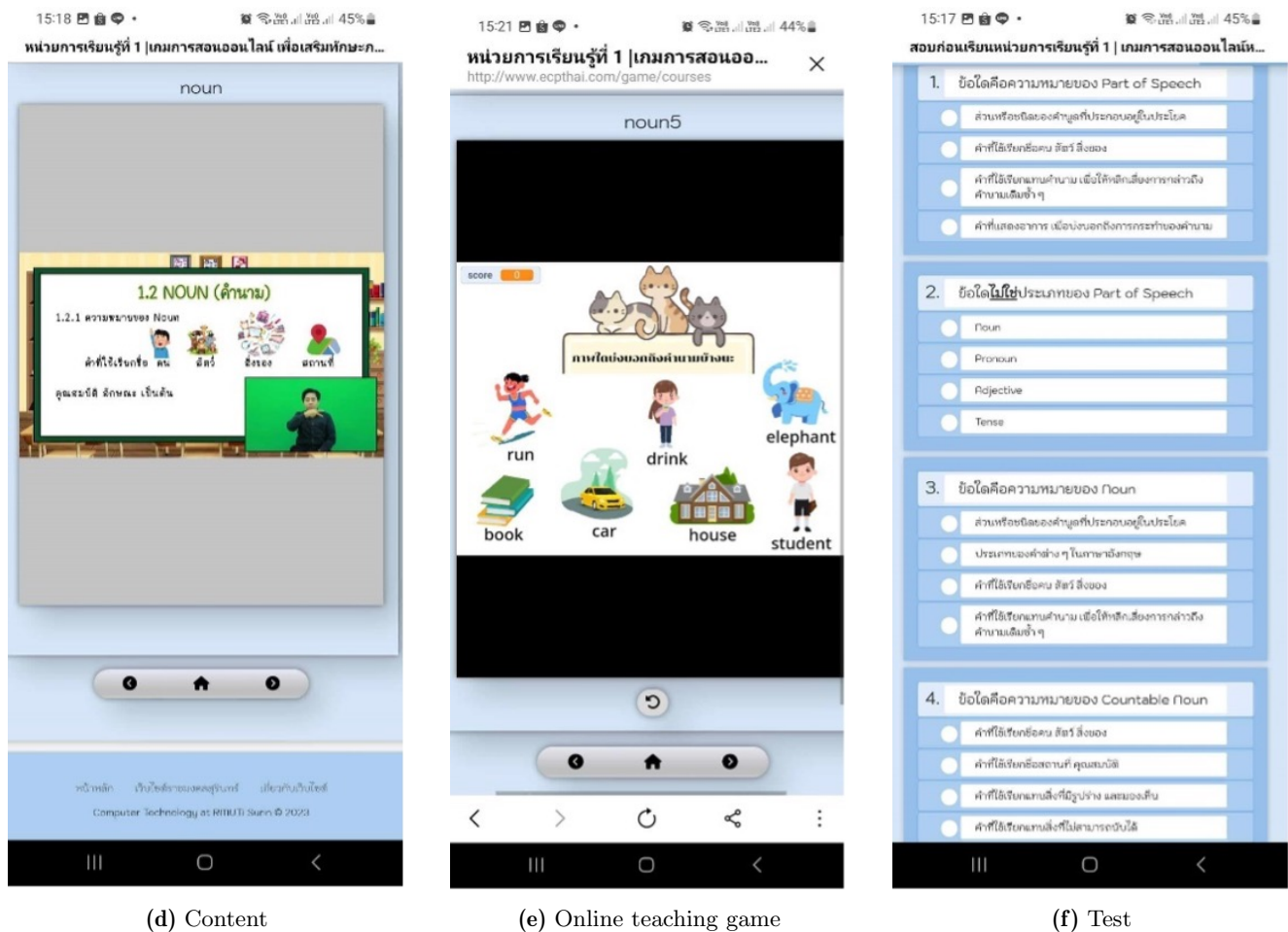


Figure 1. Examples of online teaching games via LINE application. (Continued)

(Archwamety and Tangdhanakanond, 2008). These scores were interpreted using Kanjanawasee (2009) development levels. The relative gain score criteria is shown in Table 1.

4. Pearson's correlation coefficient was used to analyze the relationship between post-learning achievement and learner satisfaction (Vanichbun-cha, 2006).

This comprehensive methodology ensured a rigorous approach to developing and evaluating online educational games for upper secondary students with hearing impairments, with a focus on improving English language skills through engaging, interactive content.

Table 1. Relative gain score criteria compared to development levels (Kanjanawasee, 2009).

Relative Gain Score	Development Level
76-100	Very High
51-75	High
26-50	Medium
0-25	Low

4. Experimental Results

4.1 Development of Online Educational Games via the LINE Application

The development of online educational games via the LINE application to enhance English skills related to parts of speech resulted in 8 learning units, 109 online educational games, and a system that effectively meets user needs, as shown in Figures 1a–1f.

4.2 Efficiency of the Online Educational Games

Analysis of scores from 27 learners showed that the average score from the pre-test was 29.52 points (out of a total of 115 points), and the average score from the post-test was 43.15 points. The efficiency ratio of the developed online educational games was 1.46, which is higher than McGuigan's criterion of 1.00. This demonstrates the success in developing effective educational materials that promote learning. Additional details are shown in Table 2.

Table 2. Results of determining the effectiveness of on-line teaching games

Test Type	Number of Learners (N)	Total Score	$\bar{x}$	Efficiency Ratio
Pre-test	27	115	29.52	1.46
Post-test	27	115	43.15	

4.3 Comparison of Pre- and Post-Learning Achievement

The study revealed that the 27 learners who used the online educational games showed a statistically significant difference in learning achievement. The average pre-test score was 29.52 points ($SD = 5.54$), while the average post-test score increased to 43.15 points ($SD = 15.52$). The p -value was less than .001 ($p < .05$), as detailed in Table 3. Therefore, it can be concluded that the use of online educational games resulted in significantly higher post-learning achievement compared to pre-learning levels.

Table 3. Comparison of learning achievement before and after learning with online teaching materials.

Test Type	Number of Learners (n)	$\bar{x}$	S.D.	df	t	sig
Pre-test	27	29.52	5.54	26	-4.343	.000*
Post-test	27	43.15	15.52			

*Statistically significant at the 0.05 level

4.4 Learning Development of Students

Analysis of scores from all 27 learners showed that the average pre-test score was 29.52 points and the average post-test score was 43.15 points. This yields an average score difference of 13.63 points between the post-test and pre-test, indicating higher post-test performance. However, when calculating the relative gain score, learners demonstrated an average improvement of 15.59%. This corresponds to a low level of overall learning development, which did not align with the hypothesis. Details are shown in Table 4.

4.5 Relationship Between Post-Learning Achievement and Learner Satisfaction

A Pearson product-moment correlation coefficient was computed to assess the relationship between learners' satisfaction and their post-learning achievement scores. The analysis revealed a moderate positive correlation between the two variables ($r = .456$, $df = 25$, $p = .017$), which was statistically significant at the $\alpha = .05$ level. The positive value of the correlation suggests that higher levels of satisfaction with the online educational

games are associated with higher post-learning achievement scores. However, it is important to note that correlation does not imply causation, and other factors may influence this relationship. These findings suggest a significant interplay between learner satisfaction and academic performance in the context of online language learning for students with hearing impairments. Further research may be warranted to explore the causal mechanisms underlying this relationship. Detailed results of the correlation analysis are presented in Table 5.

5. Discussion

The research findings can be summarized and discussed in relation to the initial hypotheses as follows:

5.1 Efficiency of the Developed Online Educational Games

The online educational games developed via the LINE application demonstrated an efficiency ratio of 1.46, surpassing McGuigan's efficiency criterion (≥ 1.00). This high efficiency can be attributed to the games' effective design and presentation, which successfully integrated game design principles with systematic instructional design. This approach aligns with the recommendations of Laohajaratsang (2002); Pooworawan and Numprasertchai (2003); Wayo et al. (2020) who emphasize the importance of clear instructional system design in online teaching content. The games' emphasis on utilizing appropriate technology and tools for learners with hearing impairments, including clear content presentation through concise text, images, and videos with sign language interpretation, contributed significantly to their efficiency.

5.2 Impact on Learning Achievement

Statistical analysis revealed that learners who studied with the developed online educational games via the LINE application showed significantly higher post-test achievement scores compared to pre-test scores at the .05 level. This improvement in learning outcomes can be attributed to several factors:

1. The games' ability to create interest and motivation in learning.
2. Their accessibility, allowing learners to review and learn additional content as needed.
3. The integration of various media types that cater to the specific needs of learners with hearing impairments.

Table 4. Learning development scores of the sample group.

Student no.	Score (out of 115 points)		difference	Relative Gain Score (%)	Student No.	Score (out of 115 points)		difference	Relative Gain Score (%)
	Pre- learning	Post- learning				Pre- learning	Post- learning		
1	32	57	25	30.12	16	26	32	6	6.74
2	28	66	38	43.68	17	33	63	30	36.59
3	30	36	6	7.06	18	30	53	23	27.06
4	40	40	0	0.00	19	29	32	3	3.49
5	32	84	52	62.65	20	26	60	34	38.20
6	30	37	7	8.24	21	32	50	18	21.69
7	37	26	-11	-14.10	22	22	31	9	9.68
8	28	36	8	9.20	23	22	31	9	9.68
9	30	36	6	7.06	24	45	38	-7	-10.00
10	35	27	-8	-10.00	25	25	31	6	6.67
11	31	33	2	2.38	26	23	17	-6	-6.52
12	31	36	5	5.95	27	27	43	16	18.18
13	25	49	24	26.67					
14	20	53	33	34.74					
15	28	68	40	45.98					
Average						29.52	43.15	13.63	15.59

Table 5. Results of correlation analysis between learner satisfaction and learning achievement of learners who studied with the developed online teaching games.

	Post-learning Achievement Score	Learner Satisfaction with the Games	Sig.
Post-learning Achievement Score	1	.456	.017*
Learner Satisfaction with the Games	.456	1	

*Statistically significant at the 0.05 level

These findings align with previous research by Tathong et al. (2019); Polhan et al. (2019); Sirisawat et al. (2021); Sungkasrisombut et al. (2022); Kongjai and Thathong (2022), which highlight the effectiveness of integrating social media applications with teaching materials to enhance learning efficiency. Additionally, studies by Panthasen et al. (2020); Phutrakul et al. (2021); Boonthawee and Sonsilphong (2021); Sungkawadee and Sittiwong (2024) confirm that learners using educational games show improved academic achievement. This aligns with the research findings of Chajernsuk et al. (2020) and Thaluang and Rungsoongnern (2024), which suggest that in developing electronic or computer-based media, the focus should be on integrating multiple types of media such as audio, graphics, animations, and text. This approach creates novelty and interest beyond traditional text or books, making learning more effective. It helps attract attention and makes the learning process more engaging.

5.3 Learning Development Progress

While the study hypothesized a 50% increase in learning development, the empirical results indicated a moderate

learning gain of 15.59%, suggesting room for further optimization of the learning intervention. Detailed analysis revealed varying patterns of development among participants, including instances of differential progress in relative development scores. These outcomes point to several areas for consideration, including content comprehension patterns, game difficulty calibration, temporal parameters, and the interaction between learners and game mechanics.

These findings underscore the inherent complexities in developing educational games for learners with hearing impairments, who experience distinct cognitive processing and perceptual challenges compared to typical learners (Arayawinyoo, 1999). A significant observation emerged regarding test performance: participants consistently scored below 50% of the maximum possible score in both pre- and post-tests. This underperformance can be attributed to the absence of sign language support in the assessment instruments, creating a substantial barrier to test item comprehension and information accessibility. The results highlight the critical importance of adapting assessment formats to accommodate the specific needs of learners with hearing impairments, ensuring they can demonstrate their true capabilities without linguistic barriers impeding their performance.

5.4 Correlation Between Post-Learning Achievement and Learner Satisfaction

The research found a positive correlation between learner satisfaction and post-learning achievement, with a correlation coefficient (*r*) of .456, significant at the .05 level (*p* < .05). This finding supports the hypothesis and underscores the importance of developing high-quality educational games that can enhance both learning experiences and long-term educational efficiency. As

Khonngandee and Nganman (2024) note, creating an enjoyable and interesting learning environment can lead to higher academic achievement.

In conclusion, this study demonstrates the potential of online educational games in improving learning outcomes for students with hearing impairments. However, it also highlights the need for careful consideration of individual learner needs and abilities when designing such educational tools. As Sittiwong and Namoungon (2021) suggest, presenting information through videos combined with text can greatly stimulate learners' interest. Future research should focus on developing adaptive game difficulty levels and exploring ways to address the unique challenges faced by learners with hearing impairments in digital learning environments.

6. Recommendations for Further Research

For future studies, researchers should conduct a comprehensive needs assessment and interest analysis specifically tailored to students with hearing impairments. This approach would ensure that game development truly addresses the unique requirements of this target group. The assessment could involve a combination of visual surveys, sign language interviews, and observational studies to capture the nuanced preferences and challenges faced by learners with hearing impairments in parts of speech acquisition. By understanding the specific visual, cognitive, and cultural aspects that resonate with students with hearing impairments, developers can create more engaging and effective educational games.

Another promising avenue for research is the integration of emerging technologies such as Augmented Reality (AR) or Virtual Reality (VR) in game development for students with hearing impairments. These technologies offer immersive visual experiences that could be particularly beneficial for visual learners. For instance, AR could be used to overlay sign language explanations or visual representations of grammar concepts onto real-world objects, enhancing contextual learning. VR environments could simulate real-life scenarios where students practice using parts of speech in context, potentially improving both comprehension and retention. Researchers should explore how these technologies can be optimized to support the unique learning styles of students with hearing impairments while ensuring accessibility and ease of use.

These recommendations aim to enhance the effectiveness of game-based learning for English language acquisition among students with hearing impairments, leveraging both an in-depth understanding of learner needs and cutting-edge technology to create more impactful educational experiences.

7. Conclusion

This study examined the effectiveness of online educational games implemented through the LINE application for learners with hearing impairments. The findings reveal significant implications for digital game-based learning in special education contexts. Notably, the developed games demonstrated high efficiency according to McGuigan's criterion, establishing their viability as an educational tool. Statistical analysis indicated significant improvements in post-test achievement scores, with a positive correlation emerging between learner satisfaction and academic achievement.

The implementation outcomes revealed both opportunities and considerations in educational game design for special needs learners. While the overall effectiveness metrics were promising, the varying levels of learning progress among participants highlighted the importance of incorporating adaptive learning mechanisms. This finding underscores the necessity for differentiated instruction and personalized learning pathways in educational game design.

Furthermore, the strong correlation between satisfaction and academic achievement emphasizes the crucial role of quality game design in educational outcomes. The integration of engaging and appropriately challenging game elements appears to enhance learner motivation and sustained engagement, potentially contributing to more effective long-term skill development. These results suggest that thoughtfully designed educational games can create an environment conducive to sustained learning and skill acquisition.

This research contributes to the expanding field of digital game-based learning in special education, particularly for learners with hearing impairments. The findings emphasize the importance of considering individual learner characteristics, accessibility requirements, and pedagogical objectives in game design and implementation. As educational technology continues to evolve, this study provides valuable insights for developing more inclusive and effective learning environments. The results offer empirical evidence to inform future educational practices and technological innovations in special education, particularly in the context of game-based learning interventions.

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Credit Authorship Contribution Statement

Wiphasith Hiranrat: Conceptualization, Methodology, Writing – original draft, Software. **Suparat Walakanon:** Conceptualization, Methodology, Writing – review & editing. **Sakchan Luangmaneeerote:** Formal analysis, Software. **Nipon Pimbaotham:** Data curation, Investigation. **Boonlueo Nabumroong:** Software.

Declaration of Competing Interest

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

Declaration of Generative AI and AI-Assisted Technologies

The authors acknowledge the use of artificial intelligence (AI)-assisted tools during the preparation of this manuscript. AI tools were employed to support language refinement and editorial tasks. All content produced or assisted by AI was subsequently reviewed, revised, and validated by the authors, who take full responsibility for the accuracy, integrity, and originality of the work presented.

References

- Arayawinyoo, P. (1999). *Education for children with special needs*. Waenkaew, Bangkok.
- Archwamety, T. and Tangdhanakanond, K. (2008). Cumulative relative gain score vs. chronological equivalence score. *Journal of Research Methodology*, 21(1):1–20. <https://jrmarchive.vichai.edu.net/issues/vol21-no1-2008.html>.
- Boonthawee, P. and Sonsilphong, S. (2021). The development of game-based learning with on-line dialogue system to enhance problem-solving skill in design and technology subject of grade 11th students. *Journal of Educational Technology and Communications*, 4(12):67–81. <https://so02.tci-thaijo.org/index.php/etcedumsujournal/article/view/249818>.
- Bureau of Policy and Planning, Office of the Permanent Secretary, Ministry of Interior (n.d.). Study report on opportunities and impacts of the ASEAN economic community on the ministry of interior (technical report). Technical report, Ministry of Interior. http://www.law.moi.go.th/pdf/asean_final.pdf.
- Chaiyabutr, W. (2018). Media campaign through distance education. *Journal of Educational Communications and Technology*, 13(14-15):4–13. https://oet01.stou.ac.th/documents/pdf/ECT_Journal_Vol14-15.pdf.
- Chajernsuk, N., Rodcheng, P., Lelapipitpat, C., and Saenboonsong, S. (2020). The comparison of grade 3 students learning achievement using animation media in adventures in the technology world at Wat Inkanlaya School. *Journal of Applied Informatics and Technology*, 2(2):104–115. DOI: 10.14456/jait.2020.8.
- Chinawong, P. and Chinatangkul, S. (2013). Learning organization model of schools for the deaf in Thailand. *Silpakorn Educational Research Journal*, 5(2):73–85. <https://so05.tci-thaijo.org/index.php/suedureasearchjournal/article/view/26222>.
- Garris, R., Ahlers, R., and Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, 33(4):441–467. DOI: 10.1177/1046878102238607.
- Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment (CIE)*, 1(1):1–4. DOI: 10.1145/950566.950595.
- John, S., Gurario, S., and Halepota, J. A. (2021). The role of English language skills in career growth: A study of perceptions and strategies used to improve English language skills by graduate and undergraduate students of Karachi, Pakistan. *Global Social Sciences Review*, 6(1):346–355. DOI: 10.31703/gssr.2021(VI-I).35.
- Kanjanawasee, S. (2009). *Classical test theory*. Chulalongkorn University, Bangkok, 6th edition.
- Khemmanee, T. (2016). *Teaching science: Knowledge for effective learning process management*. Chulalongkorn University, Bangkok, 20th edition.
- Khonngandee, P. K. and Nganman, S. (2024). Creating a learning environment that supports student development. *Journal of Educational Management and Research Innovation*, 6(2):471–482. <https://so02.tci-thaijo.org/index.php/jemri/article/view/268363>.
- Kongjai, T. and Thathong, A. (2022). Development of a notification system for automatic events and appointments through the LINE application. *Mahidol R2R e-Journal*, 9(2):32–45. DOI: 10.14456/jmu.2022.14.
- Kuljitjuewong, S. (2013). LINE - communicating format on the creativity of smartphone: Benefits and limits of application. *Executive Journal*, 33(4):42–54. <https://so01.tci-thaijo.org/index.php/executivejournal/article/view/80877>.
- Kumar, P. (2020). English for career development. *Tathapi (UGC Care Journal)*, 19(35):292–299.

- Laohajaratsang, T. (2002). *Designing e-Learning: Principles of designing and creating web for teaching and learning*. Aroon Printing, Bangkok.
- Moonkham, S. and Moonkham, O. (2002). *19 learning management methods for knowledge and skill development*. Phappim, Bangkok, 2nd edition.
- Nakasan, N. and Nakasan, C. (2016). Game: Innovation for creative education. *Romphruek Journal of the Humanities and Social Sciences*, 34(3):159–162. <https://so05.tci-thaijo.org/index.php/romphruekj/article/view/82421>.
- Namsaeng, W. (2015). The development of an on-line lexicon for hearing impaired persons. Master's thesis, Information Technology, Suranaree University of Technology. <http://sutir.sut.ac.th:8080/sutir/handle/123456789/5832>.
- National Institute of Educational Testing Service (2020). Summary of ordinary national educational test (O-NET) results for grade 12, academic year 2020. Technical report, National Institute of Educational Testing Service. http://www.newonetestresult.niets.or.th/AnnouncementWeb/PDF/SummarONETM6_2562.pdf.
- National Institute of Educational Testing Service (2021). Summary of ordinary national educational test (O-NET) results for grade 12, academic year 2021. Technical report, National Institute of Educational Testing Service. http://www.newonetestresult.niets.or.th/AnnouncementWeb/PDF/SummaryONETM6_2563.pdf.
- Panthasen, S., Kantathanawat, T., and Innoi, S. (2020). The online game based learning for creative using the internet of grade 8. *Journal of Industrial Education*, 19(1):25–34. <https://ph01.tci-thaijo.org/index.php/JIE/article/view/239928>.
- Phiwma, N. (2021). Learning management using game-based learning by integrating computer game technology. *Journal of Humanities and Social Sciences, Rajapruk University*, 7(Special):1–15. <https://so03.tci-thaijo.org/index.php/rpu/article/view/257367>.
- Phummun, P. (2001). *Developing quality of pre-primary students towards academic achievements*. Waenkaew.
- Phutrakul, N., Juntiya, T., Panyasi, S., Kakaew, J., Teach, C., and Sriprom, S. (2021). The development of English vocabulary recognition ability by using educational game for Matthayomsuksa 3 students in Wat Rai-Khing Wittaya School. *Academic Journal of Phetchaburi Rajabhat University*, 11(3):91–97. <https://journal.pbru.ac.th/admin/upload/article/8285-2022-01-04.pdf>.
- Pitoonpong, S. (2017). Applying application Line in working process: A case study of Sahapalittapan Panich Company Limited. Master's thesis, Department of Digital Marketing Communication, Bangkok University. <http://dspace.bu.ac.th/bitstream/123456789/3440/6/smith.pito.pdf>.
- Polhan, P., Wattanakitkrileart, D., and Pongthavornkamol, K. (2019). The effects of education and inhaler skills program through Line application on symptom control among asthmatic patient. *Journal of The Royal Thai Army Nurses*, 20(3):93–103. <https://he01.tci-thaijo.org/index.php/JRTAN/article/view/233089>.
- Pooworawan, Y. and Numprasertchai, S. (2003). *ICT for Thai education*. SE-ED Education, Bangkok.
- Robrue, M. and Bamrungratanakul, L. (2015). The desired characteristics of the graduates in the field of English for business communication. *Panyapiwat Journal*, 7(2):221–231. <https://so05.tci-thaijo.org/index.php/pimjournal/article/view/38501>.
- Saksiriphol, D. (2010). The development reading and spelling skill of students with hearing impairment in Pratom Suksa III through mind map with sign language. Technical report, Special Education Department, Faculty of Education, Srinakharinwirot University. <https://ir.swu.ac.th/bitstreams/2788378d-47da-4791-b7ab-0633cafd76e1/download>.
- Secretariat of the House of Representatives (2013). Question No. 948 R. by a member of the house of representatives: Language proficiency and Thailand's readiness for the ASEAN economic community (AEC). Technical report, Secretariat of the House of Representatives. https://web.parliament.go.th/question_asean/files/file_20180822065722_0.pdf.
- Seel, B. and Glasgow, Z. (1998). *Making instructional design decisions*. Merrill, Upper Saddle River, NJ, 2nd edition.
- Sirisawat, M., Sakunsin, A., and Radaket, N. (2021). Effect of using the for fun dental health booklet and for fun application on knowledge and behavior of early childhood parents in oral and dental health care. *Journal of Sakon Nakhon Hospital*, 24(3):12–22.
- Sittiwong, T. and Namoungon, S. (2021). The effect of using multimedia electronic books on portable computers for high school students. *Journal of Education and Innovation*, 23(1):156–166. https://so06.tci-thaijo.org/index.php/edujournal_nu/article/view/211129.
- Sungkasrisombut, K., Machara, S., Promsri, M., and Panit, N. (2022). Development of health education and health counseling model using LINE

- official account application for mothers in caring for infants with premature births. *Regional Health Promotion Center 9 Journal*, 16(2):623–641. <https://he02.tci-thaijo.org/index.php/RHPC9Journal/article/view/257597>.
- Sungkawadee, R. and Sittiwong, T. (2024). Development of metaverse learning ecosystem to promote self-directed learning of university students. *Journal of Education and Innovation*, 26(2):57–69. https://so06.tci-thaijo.org/index.php/edujournal_nu/article/view/267034.
- Supahuang, R. and In-Udom, W. (2012). The development of instructional games on web entitle the data communication for Mathayomsuksa IV students Khon Kaen Wittayayon II school. *Journal of Education Graduate Studies Research, Khon Kaen University*, 5(3):81–86. <https://so02.tci-thaijo.org/index.php/EDGKKUJ/article/view/50582>.
- Tathong, B., Sritarapipat, P., and Kaewkhieo, B. (2019). Effect of teaching method for using LINE application based - learning on learning outcomes and satisfaction of the student nurses in nursing care of persons with health problems I course of Boromara-jonani College of Nursing, Chai Nat. *Boromara-jonani College of Nursing, Uttaradit Journal*, 11(1):155–168. <https://he01.tci-thaijo.org/index.php/unc/article/view/183140>.
- Thabkrong, S., Nualcham, P., Wirote, N., and Duangchan, P. (2018). Effect of using LINE applications health media to diabetic knowledge and understanding of schools' staff. *Journal of Nursing, Siam University*, 19(36):78–87. <https://he01.tci-thaijo.org/index.php/nursingsiamjournal/article/view/146005>.
- Thaluang, C. and Rungsoongnern, P. (2024). The study results of perception and satisfaction of elementary school students with 2D animation cartoon: Primal hunter. *Journal of Applied Informatics and Technology*, 6(2):242–261. <https://ph01.tci-thaijo.org/index.php/jait/article/view/254452>, DOI: 10.14456/jait.2024.14.
- Thepud, S. (2005). An error analysis in the writing of standard Thai by 6th grade deaf students at Set-sathian school. Master's thesis, Linguistics, Mahidol University. DOI: 10.14457/MU.the.2005.22.
- Tiantong, M. (2002). *Teaching and learning materials for courseware design and development for computer-assisted instruction*. Department of Computer Education, Faculty of Technical Education, King Mongkut's Institute of Technology North Bangkok, 1st edition.
- Tiantong, M. (2005). *Teaching and learning materials for courseware design and development for computer-assisted instruction*. Department of Computer Education, Faculty of Technical Education, King Mongkut's Institute of Technology North Bangkok, 2nd edition.
- Vanichbuncha, K. (2006). *Statistical Analysis: Statistics for Management and Research*. Department of Statistics, Faculty of Commerce and Accountancy, Chulalongkorn University, Bangkok, 8th edition.
- Wayo, W., Charoennukul, A., Kankayan, C., and Khonyai, C. (2020). Online learning under the COVID-19 epidemic: Concept and applications of teaching and learning management. *Regional Health Promotion Center 9 Journal*, 14(34):285–298. <http://digital.nlt.go.th/dlib/items/show/18867>.
- Wongrattana, C. (2009). *Techniques for Using Statistics in Research (Revised Edition)*. Taineramitkij Inter Progressive, Nonthaburi, 11th edition.
- Wuttiwongsa, N. (2014). Motivational strategies: Enhancing English language skills. *Executive Journal*, 34(1):89–97. <https://so01.tci-thaijo.org/index.php/executivejournal/article/view/81096>.
- Yimon, Y. (2014). The use of English in the careers of Thai graduates in Bangkok. *Panyapiwat Journal*, 5(2):191–204. <https://so05.tci-thaijo.org/index.php/pimjournal/article/view/20177>.