Effects of Cloud-based Gamified Instruction Integrating Peer Assessment on Primary Students' English Writing and Critical Thinking

Norphealey Eang[a], Sirirat Petsangsri[b, *], John Morris[c]

[a] eang.norphealey@gmail.com, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, Thailand
[b] sirirat.pe@kmitl.ac.th, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, Thailand
[c] john.mo@kmitl.ac.th, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, Thailand
[*] Corresponding author, sirirat.pe@kmitl.ac.th

ABSTRACT

English writing and critical thinking are not only fundamental to academic success but also play a crucial role for the holistic development of primary students. This study investigated the effects of a cloud-based gamified instruction integrating peer assessment on primary student English writing and critical thinking. A pre- and post-test with a delayed pos-test research design was used; thirty-five grade sixth students participated in the study. The research instruments included writing and critical thinking tests. The data were analyzed using repeated measures ANOVA. There was a significant improvement writing from a pre-test through and post-test and delayed post-test (F = 853.76, p < 0.001). The F-value indicated a significant difference between pre- and post-test, but there was little difference between post- and delayed post-tests. The high effect size (η^2 = 0.96) confirmed the

effectiveness of the intervention on writing. Similarly, analysis also indicated a significant effect the intervention on the critical thinking improvement over time (F = 632.89, p < 0.001). The high effect size (η^2 = 0.95) emphasized the practical significance of the improvements across the three time points. This confirmed the positive effects of the cloud-based gamified instructional model on writing and critical thinking.

Keywords: cloud-based learning, critical thinking, English writing, gamification, peer assessment

Introduction

Developing writing and critical thinking skills is crucial for primary students as it forms the foundation for effective communication and cognitive development (Carlgren, 2013; Cheung, 2021). The ability to express thoughts coherently in written form and to analyze and evaluate information critically are essential skills that contribute to academic success and overall cognitive growth, i.e. helping students think, learn, and understand complex information, leading to increased proficiency in intellectual tasks (Asriati & Maharida, 2013; Carlgren, 2013).

However, addressing the challenges of enhancing these skills among primary students requires an innovative and effective instructional approach. Within the Thai educational context, we observed a pressing need to improve primary students' English writing and critical thinking. Despite the growing importance of English writing as a global language, Thai students face significant hurdles in mastering it. Ordinary National Educational Test scores (O-NET) from 2019 to 2023 revealed that the average score of sixth graders was below 50% (NIETS, 2019-2023). Moreover, research has highlighted specific difficulties in English writing among Thai students. Srimunta et al. (2020) found that the 6th-grade students struggled with vocabulary, idioms, grammar, writing mechanics, and idea organization. Wonglakorn and Deerajviset (2023) further confirmed these challenges, noting that the students also grapple with limited vocabulary, grammatical errors, and difficulty with organization. This underscored the persistent challenge in English language education in Thailand.

The problem lies in the need to improve primary student English writing and critical thinking skills through engaging and effective instructional methods (Mehta & Al-Mahrooqi, 2015; Miller et al., 2018). Traditional approaches to teaching these skills may not always fully engage students or motivate them to actively participate and learn effectively (Cheung, 2021).

Writing skills are traditionally taught in a face-to-face class (Jiang et al., 2021). Teachers and students usually meet for a set number of hours each week, and teachers work one-on-one with students to help them improve their writing skills (Magi & Mardeusz, 2013). In addition to receiving feedback from the teacher, students can share their work with classmates and see their comments (Wang et al., 2023). However, this method also has disadvantages; one is the lack of personal comments (Kemp & Grieve, 2014). In a traditional classroom setting, all students are given the same instructions and must complete the same assignments (Ammar & Spada, 2006). This can frustrate students who learn differently or struggle with a specific topic (Ammar & Spada, 2006). Therefore, there is a need to explore alternative methods that can effectively enhance writing and critical thinking skills.

Integrating with peer assessment and gamification, cloud-based learning presents a promising avenue for addressing these challenges. Using digital platforms and game elements, cloud-based gamified instruction can create an interactive and engaging learning environment, that motivates students and enhances their participation in learning activities (Abe, 2020). Furthermore, integrating peer assessment into this instructional model fosters a collaborative and supportive learning community, allowing students to provide feedback to their peers and engage in a reflective learning process (Kumar et al., 2023). This approach was expected to positively impact writing and critical thinking skills, as it encouraged active participation, problem-solving, and reflection, which are essential components of effective learning.

Besides compromising interaction between teachers and students in a cloud-based learning environment, instructional activities need to be designed to grab student engagement and motivation. Gamifying learning activities is just one exact way to accomplish that. Gamification is not just intended to provide students with fun and enjoyment. Azmi et al. (2016) stressed that gamification is a powerful tool to boost motivation among students and significantly impacts student enthusiasm and engagement. Like the cloud-based application whose positive results make fame in education, gamification has also been widely adopted in many fields of education in recent decades (Ahmed, 2021; Chans & Castro, 2021; Lam et al., 2018; Park & Kim, 2021). For instance, Lam et al. (2018) conducted research in which 72 participants participated in improving argumentative writing. The study demonstrated favorable learning outcomes for the students when gamification was adopted.

When using games for instruction, students learn more quickly and achieve higher levels of learning than when they are not engaged in game-based activities (Ahmed, 2021; Aljraiwi, 2019). In a study by Plass et al. (2013), it was found that students who played educational games showed an increase in academic achievement, including standardized test scores and grades, as

well as non-cognitive skills such as problem-solving, teamwork and perseverance.

Driven by the need to enhance English writing and critical thinking among primary students in Thailand and inspired by the potential of cloud-based gamified instruction with peer assessment, we investigated its impact. By exploring the potential benefits of this innovative instructional model, we sought to contribute to the ongoing efforts to enhance primary education and promote the development of essential skills among young learners. The integration of cloud-based learning, peer assessment, and gamification was expected to provide a practical and effective approach to improving writing and critical thinking skills, addressing the identified research problems and contributing to the advancement of innovative instructional strategies in primary education.

Literature Review

Writing Skills

Writing is one of the four key language skills, along with speaking, listening, and reading (Miller et al., 2018). It involves sub-skills - spelling, punctuation, and grammar (Daffern et al., 2017). In academia, writing is a form of communication that teachers use to share their knowledge with students and for students to share their thoughts and ideas with their teachers (Hubackova et al., 2011). Students also use writing to reflect on and deepen their understanding of the subject matter (Flores & Brittain, 2003). Writing is an integral part of the learning and it can help students better understand the material they are studying (Ammar & Spada, 2006). For instance, research in mathematics education highlighted how writing prompts students to reflect on their work, clarify their thinking, and connect between different concepts, fostering a deeper level of comprehension (Flores & Brittain, 2003).

Writing requires creativity, imagination, and the ability to articulate thoughts and ideas clearly (Wang, 2012). By honing their writing skills, students can develop their ability to think critically and solve problems related to analyzing and synthesizing information, constructing logical arguments, and effectively communicating their ideas (Mehta & Al-Mahrooqi, 2015). Writing can stimulate cognitive processes that are crucial for learning. Research has shown that writing activate the frontal cortex, a brain region associated with creativity and higher-order thinking (Longcamp et al., 2016). This suggested that writing activities can potentially enhance student critical thinking abilities. In EFL study, where students may face challenges in expressing complex ideas in a foreign language, writing can serve as a valuable

tool for promoting both language acquisition and cognitive development (Jiang & Kalyuga, 2022).

In EFL at the primary level, teachers often face challenges such as student lack of vocabulary, writing anxiety and mother tongue interference, which can hinder effective writing instruction (Jashari & Fojkar, 2019). Additionally, writing is recognized as a complex skill that requires the integration of various linguistic components, making it a challenging task for young learners (Bae & Lee, 2012; Chicho, 2022). Effective teaching strategies, such as the use of peer feedback, have been shown to improve writing accuracy and fluency over time (Mohamed et al., 2023).

Thai Student English Writing Skills

Despite the increasing importance of English as a global lingua franca, Thai students continue to face significant challenges in developing their English skills. Based on NIETS data from 2019-2023, the average score of the O-NET of grade sixth, ninth, and twelfth students was less than fifty percent, as shown in Figure 1 (NIETS, 2019-2023).

Figure 1

O-NET Results of Grade 6 from 2019-2023
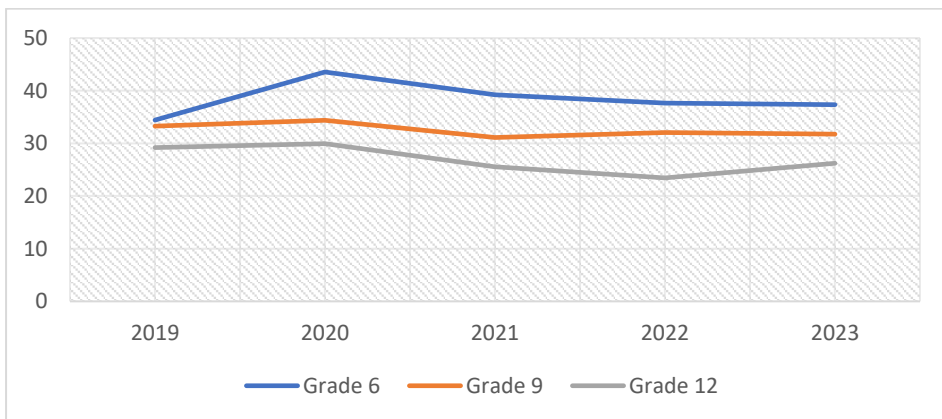
The consistently low scores on the English proficiency test, remaining below 50 for half a decade, revealed a disheartening reality: a vast majority of Thai students in grades 6th to 12th failed to grasp even the most basic English language skills. This alarming trend painted a bleak picture of the current teaching methods, which appeared utterly ineffective in preparing students for the assessment. The future of English language proficiency in Thailand

seems shrouded in uncertainty, with little hope for improvement in sight (NIETS, 2019-2023).

Similarly, Srimunta et al. (2020) stated that the English writing ability of Thai 6th grade students was poor. Most students faced challenges in several key areas of writing, including vocabulary use, idioms, grammar structure, writing mechanisms, and the ability to compile ideas meaningfully (Srimunta et al., 2020). Wonglakorn and Deerajviset (2023), who investigated the effect of collaborative process writing approach on Thai secondary students, reported that students often encountered challenges in writing, including lacking vocabulary, poor grammar, and difficulty with organization.

Writing Evaluation

The criteria used to assess writing skills differ based on the levels of the students, particularly when working with foreign language learners who may have different goals in writing. This assessment serves both learning and grading purposes. Research suggest that language acquisition often progresses from a focus on foundational elements like grammar and vocabulary towards complex language use, including style and creative expression (Krashen, 1982). Therefore, beginner-level students, the focus is often on grammar and vocabulary acquisition, while more advanced students are more concerned with creativity and style (McCarthy, 2013).

However, it is essential to recognize that language development is not always linear, and learners at all levels engaged with various aspects of language simultaneously (Cameron & Larsen-Freeman, 2007). Thus, teachers should adopt a dynamic approach to instruction and assessment that acknowledges the interconnectedness of these skills and tailors their practices to the individual needs and strengths of each learner.

Elimelech and Aram (2020) studied 129 young EFL students (mean age = 5.7 years) promoting writing skills, where spelling was one of the assessment criteria. A fundamental ability to spell basic words correctly was considered an essential part of writing (Daffern et al., 2017); it shows that students had the ability to think about the structure of language and how words were put together (Daffern et al., 2017). It also demonstrated student knowledge of the conventions of writing and attention to detail.

Grammar is another important criterion when assessing writing skills (Daffern et al., 2017): it includes sentence structure, verb tense and pronoun use. Correct grammar shows that a student has a command of the language and can communicate effectively (Daffern et al., 2017). On the other hand, grammatical failures can sometimes hinder clear communication.

While sentence structure is a component of grammar, it also plays a crucial role in establishing coherence and clarity in writing. Therefore, it

warrants separate consideration during assessment. Well-constructed sentences facilitate smooth reading and comprehension, whereas poorly structured sentences can disrupt the flow of ideas and hinder understanding.

Content is another criterion when assessing student writing (Miller et al., 2018). In any academic level, be it primary, secondary, or tertiary, when assessing writing skills, content is always on the list (Miller et al., 2018). The content refers to the overall topic of the writing as well as the supporting details and examples used (Miller et al., 2018). Content needs to be relevant to the purpose and 'stay on topic' throughout the essay; it also uses specific and concrete examples to support any claims or points (Miller et al., 2018).

When writing, it is critical to be coherent (Faradhibah & Nur, 2017). Coherence measures how well the writing holds together, acting as the glue that connects ideas and ensures a smooth flow from one section to the next (Faradhibah & Nur, 2017). Without coherence, writing can feel disjointed and confusing. Several factors contribute to coherence in writing, including sentence structure, paragraph structure, organization and transitions (Faradhibah & Nur, 2017). These factors are related to grammar presented earlier, but they cover a broader scope.

Sentence structure significantly impacts coherence (Christina, 2021). It influences how easily readers can follow the writer's train of thoughts. Choppy or run-on sentences can be obscure the connections between ideas, making comprehension challenging. Similarly, paragraph structure is also crucial for coherence (Christina, 2021) Effective paragraph structure involves clear organization, ensuring a logical arrangement of ideas whin each paragraph. Each paragraph should begin with a topic sentence that introduces the main idea, followed by supporting sentences that elaborate on and develop this idea. Additionally, transition – words or phrases that connect ideas within and between sentences and paragraphs – are essential for guiding the reader smoothly from one point to the next. The transitions signal the relationship between ideas, enhancing the overall flow and coherence of the text.

Enhancing Writing through Cloud-Based Instruction, Peer Assessment and Gamification

In the past, writing was often seen as a skill best taught through rote memorization and practice (Jiang et al., 2021). However, research has shown that students learn to write best when they are engaged in authentic writing tasks that are meaningful to them (Abe, 2020). Writing instruction, therefore, needs to focus on helping students develop their writing and providing them with opportunities to write and engage with their peers' writing (Double et al., 2018).

Cloud-based instruction has been commonly adopted in education and confirmed to be effective (Maulidah & Aziz, 2020). This approach offers numerous advantages, including accessibility, flexibility, personalized learning and the integration of technology. It allows learners to learn from home, at their own pace, and in a personalized manner (Anggrawan & Jihadil, 2018). The use of multimedia, interactive elements and assessment tools enhances the learning experience, making it more engaging and effective (Jiang et al., 2021). Zahro (2019) highlighted that the incorporation of these elements in the Moodle e-learning platform led to increased student engagement, motivation and overall academic performance. Additionally, cloud-based learning promotes self-directed learning and active engagement (Anggrawan & Jihadil, 2018). However, challenges, such as the need for reliable internet access, technological literacy, and the lack of immediate feedback should be considered (Ja'ashan, 2020).

In recent years, online collaborative writing has become an increasingly widely used method for students to learn and improve writing skills, as it allows them to orient themselves to peer understanding of organizational aspects of writing (Abe, 2020). Another study found that cloud-based instruction was more effective than traditional instruction, when teaching writing skills to students with different learning styles (Van Waes et al., 2014). For instance, a study on online writing found that students with different learning styles, such as active and reflective learners, approached writing tasks differently (Van Waes et al., 2014). Reflective learners focused more on theoretical sections, whereas active learners engaged more with practical tasks (Van Waes et al., 2014). This adaptability allowed students to engage with material in a way that suited their learning preferences, enhancing their overall progress (Van Waes et al., 2014).

Peer assessment has also been increasingly adopted for teaching writing skills (Wang et al., 2023); it is an active learning approach used in an instructional environment, where students are involved in doing things and think about what they are doing (Kumar et al., 2023). It is also a practical and effective approach to teaching writing skills, especially in a cloud-based learning environment (Wang et al., 2023). Chang et al. (2020), who developed a peer assessment approach incorporated into VR activities for fifth-grade students, indicated that peer assessment encouraged the students to reflect on the quality of work and the criteria for evaluation. Such reflection led to deeper understanding of their own work and areas for improvement (Chang et al., 2020). The combination of reflection and providing feedback can promote cognitive awareness (Chang et al., 2020). Todd and Hudson (2007) used peer evaluation with 57 undergraduate students to improve their writing skills: students who participated in the peer evaluation improved their writing skills and ability to comment constructively. Landry et al. (2015) designed a

peer assessment activity, with clear direction for graduate students and showed that the students received useful feedback that improved their writing (Landry et al., 2015).

Peer assessment in primary schools enhanced academic outcomes, promoting self-reflection and critical thinking. Studies indicated that involving them in setting criteria led to more reliable feedback (Leenknecht & Prins, 2018). Peer assessment at primary level led small to medium improvements in academic performance across levels (Li et al., 2020), with positive impacts on test scores when combined with training and rubrics (Sanchez et al., 2017). However, successful implementation required careful planning and teacher guidance, especially for weaker students (Mohamed et al., 2023). Teachers need to allocate extra time to train students in peer assessment techniques to help them understand their levels and what needs to be done (Mohamed et al., 2023). Effective teacher guidance involves providing clear instructions, creating structured rubrics, and offering continuous support to help students navigate the complexities of peer assessment (Sanchez et al., 2017). Additionally, teacher guidance enhanced validity of peer assessments by guiding students on which aspects to focus on and how to provide constructive feedback (Mohamed et al., 2023). Training students in assessment literacy and using digital tools further improved the reliability and effectiveness of peer assessment (Li et al., 2020).

Learning writing can be tedious and boring, especially when it is online (Anggrawan & Jihadil, 2018). However, there are ways to make writing learning more fun and engaging, for example using gamification (Pingmuang & Koraneekij, 2022). Gamification uses game-like elements in more formal contexts (Pingmuang & Koraneekij, 2022). This includes features such as points, badges, leaderboards and progress bars (Pingmuang & Koraneekij, 2022). Incorporating these elements into writing tasks can make them more enjoyable and motivating (Pingmuang & Koraneekij, 2022).

Gamification was confirmed to be effective at all educational levels, particularly in primary education. Research indicated that gamification significantly enhanced primary learning outcomes across various subjects. For instance, the integration of gamification in primary English teaching had positive effects on vocabulary, grammar and comprehensive language abilities (Wen, 2023). In primary school mathematics, gamification increased students' motivation and interest, addressing the limitations of traditional teaching methods and promoting better understanding of mathematical concepts (Liu, 2023).

Critical Thinking

Critical thinking is one of the 21st-century 4Cs skill sets - communication, collaboration, creativity and critical thinking (Khoiri et al., 2021). Critical thinking skills refer to the ability to analyze, evaluate and reflect on one's thinking to improve it carefully and systematically (Lai, 2011). Ennis (2011) stated that critical thinking was reasonable and reflective thinking focused on deciding what to believe or do. In simple terms, critical thinking evaluates thoughts and ideas and leading to logical conclusions (Lai, 2011). Critical thinking typically includes the following steps (Duron et al., 2006; Lai, 2011):

1. identifying and defining the problem or question at hand,
2. gathering relevant information and data,
3. evaluating the evidence,
4. drawing reasonable conclusions and
5. communicating the results

Various model and frameworks have been developed to foster and assess critical thinking. One is the M6 Learning Model, comprising of six steps: initial skill focus, concept justification, problem identification, idea presentation, evaluation and conclusion (Susandia et al., 2020). Additionally, several standardized assessment are available, including the California critical thinking skills test (Facione et al., 1994), Watson-Glaser critical thinking appraisal (Watson, 1980) and Cornell critical thinking test (Ennis et al., 2005).

In our study, we used the Cloud-based Gamified Instruction (CGI) integrating peer assessment model to trigger student critical thinking. The model was designed with careful review of pedagogical theories and with young learners as its core. Detail of the model can be found at (Eang, 2024).

Fostering Students' Critical Thinking

Developing critical thinking has been a significant educational issue (Lai, 2011). Many educators believe that teaching critical thinking is essential for preparing students for 21st century challenges (Khoiri et al., 2021). With the abundance of information available at one's fingertips, it can be challenging to determine what is true and what is false. When students can think critically, they can question information and sources, evaluate evidence, and form their own conclusions (Lai, 2011). This ability is invaluable in today's world, where anyone can publish anything online.

Sabri et al. (2015) indicated that the learning culture of their classrooms influenced student critical thinking. Moreover, critical thinking was related to their grades and the quality of feedback they receive from their teachers (Khoiri et al., 2021). Peer assessment can also promote critical

thinking (Amels et al., 2020). By having students assess peer work, they can identify strengths and weaknesses in the work, allowing them to see different perspectives and provide constructive feedback (Landry et al., 2015). Together, peer assessment can be a practical and effective approach to teaching and improving critical thinking.

For effective implementation of peer assessment at a primary level, Lai and Hwang (2014) suggested that developing peer-assessment criteria collaboratively with students led to more in-dept thinking and better critical thinking outcomes compared to conventional methods. Furthermore, training students in assessment techniques was crucial, as it significantly enhances reliability and validity (Li et al., 2020; van Zundert et al., 2010). Moreover, teachers' role was vital; their intervention and guidance can amplify the benefit of peer assessment (van Zundert et al., 2010). Finally, regular and frequent peer assessment activities led to better learning achievement and higher student motivation (Joh, 2021). These strategies collectively created a robust framework for integrating peer assessment into primary education, promoting active learning and critical thinking among young students.

Peer Assessment on Critical Thinking

Apart from the positive effects on writing, peer assessment can significantly improve critical thinking (Kumar et al., 2023). Peer assessment promotes active engagement, analysis and reflection, by involving students in the evaluation and feedback (Wang et al., 2023). Peer assessment actively involves students in learning, making them active rather than passive feedback recipients (Double et al., 2018). When students are responsible for evaluating peer work, they become more engaged and invested in the task (Wang et al., 2023). This active engagement fosters critical thinking as students analyze and evaluate the strengths and weaknesses of peer work (Wang et al., 2023).

Moreover, peer assessment requires students to analyze and evaluate peer work based on specific criteria or rubrics (Su, 2022). This encourages students to think critically about the quality, coherence and effectiveness of the assessed work (Wang et al., 2023). By carefully examining the work and providing constructive feedback, students develop the ability to identify strengths, weaknesses, and areas for improvement (Su, 2022). Peer assessment also prompts students to reflect on their own work as they evaluate peer work (Wang et al., 2023). This reflection encourages them to compare their work to their peers, identify areas for improvement, and consider alternative approaches (Kumar et al., 2023).

Despite its potential, several studies have highlighted challenges of implementing peer assessment within educational settings. Haddadi et al. (2018) and Gamage et al. (2021) reported that peer assessment often suffered from a lack of credibility and validity, which could undermine the accuracy of the grades assigned by peers. Moreover, interpersonal dynamics, such as concerns about anonymity and the impact of peer relationships, reduced the effectiveness of peer assessment (Rotsaert et al., 2018; Tornwall, 2018). Importantly, the absence of clear assessment criteria led to variability in peer assessments (Jones & Alcock, 2014).

Similarly, a traditional respect for teacher authority and the priority of teacher assessments over peer assessments posed significant challenges and was reported in many countries in this region (Yang et al., 2021). In a Thai context, students often viewed teacher evaluations as more credible and final, making it difficult to integrate peer assessment effectively (Tepsuriwong & Bunsom, 2013). Tawanwongsri and Phenwan (2019) investigated the effect of peer feedback by medical students on patient history-taking skills and found that only 22% of participants could effectively state what their peers did well, and only 15% suggested improvements. This indicated a potential struggle between maintaining objectivity and providing constructive feedback, which is crucial for fair peer assessment (Tawanwongsri & Phenwan, 2019).

In Thai primary education, there are few studies on peer assessment though the approach was claimed as suitable at all levels (Double et al., 2020). Narathakoon et al. (2020), surveying 97 primary teachers in Thailand, reported that teachers believed in the moderate use of peer assessment, but it was rarely used in the classroom. This suggested that although teachers may conceptually understand the value of peer assessment, there were barriers to its implementation (Narathakoon et al., 2020).

Varasunun (2015) reviewed peer feedback using Thai students; they indicated that students often demonstrated a lack of confidence in the accuracy of feedback from their peers. Moreover, studies frequently reported student hesitation toward participating in peer assessment (Sa-nguansat, 2011). Sa-nguansat (2011) used peer assessment with secondary science students and found that students who were subject to evaluation often experienced anxiety and harbored negative attitudes towards being assessed.

While the literature provides valuable insights into the individual benefits of cloud-based learning, gamification and peer assessment, there remains a gap in understanding whether these approaches can be effectively integrated into a comprehensive instructional model for primary students. The existing research predominantly focuses on isolated application of these approaches, often in higher education settings or with older learners. This study aimed to bridge this gap by investigating the effect of our Cloud-based

Gamified Instruction (CGI) model on English writing and critical thinking of younger learners.

In this study, we used our CGI model integrating peer assessment to enhance the student English writing and critical thinking. The CGI model is grounded by a careful synthesized pedagogical approaches and a deep awareness of the specific needs of young learners (Eang, 2024). Through the integration of technology, gamification, and peer assessment, the model encourages active engagement, collaborative learning, and the development of essential 21st-century skills (Eang, 2024). Furthermore, all stages of the CGI model used a dynamic cloud-based environment, fostering interaction and collaboration between students and teachers (Eang, 2024).

Research Methodology

Research Design

A pre- and post-test with a delayed pos-test research design was used to investigate the effects of the cloud-based gamified instruction integrating peer assessment on primary student writing and critical thinking. Writing and critical thinking tests were administered three times: at pre-, post- and delayed post-tests. Our intervention was applied after the pre-test and students were tested twice after it, initially in the post-test and after two weeks later in the delayed post-test.

Figure 2

Pre- and Post-Test with a Delayed Post-Test Research Design
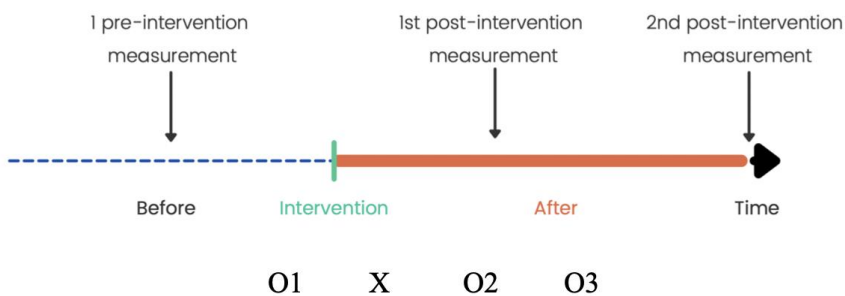
X is the cloud-based gamified instruction model integrating peer assessment.
O1, O2, and O3 are the English writing tests and critical thinking tests.

Research Questions

The following research questions all relate to students who learnt with the new CGI model integrating peer assessment.
1. Will these students have higher mean scores in English writing and will this effect persist after the intervention?
2. Will these students have higher mean scores in critical thinking and will this effect persist after the intervention?

Research Hypotheses

1. These students will have improved writing scores from the pre-test to the post-test and delayed post-test.
2. These students will have improved their critical thinking from the pre-test to the post-test and delayed post-test.

Population and Sample

The population of the study consisted of 132 students from six sixth-grade classes at a private school in Suphanburi Province, Thailand. This grade level was specifically chosen due to persistent challenges in English language acquisition among Thai students, as evidenced by consistently low scores on O-NET results for grades 6th to 12th (NIETS, 2019-2023). Research suggests that early intervention is key in language learning (Fricke et al., 2013).

Of the 132 students, 35 were randomly selected to test and investigate the effect of the intervention. A 35-student sample size was considered sufficient to provide a representative sample and a normal contribution. Researchers can be confident of the normal distribution when the sample size is at least 30 (Ross, 2017).

Research Instruments

The research instruments in the study included English writing tests and critical thinking tests. The English writing test was a simple writing instruction where the students chose a topic and wrote a short paragraph of at least five sentences. The topics were as follows:
1. My house
2. My beautiful mother
3. My lovely dog
4. The holiday I cannot forget
5. My comfortable bedroom.

To ensure a comprehensive assessment of writing skills and to prevent any practice effect or memorization, students were instructed to choose a different topic for each subsequent test (post-test and delayed post-test).

The student writing was evaluated using a rubric with the following criteria:

1. content and ideas,
2. organization,
3. sentence structure and language use, and
4. grammar.

Table 1

Rubric for English Writing Assessment

Criteria	Excellent (25)	Proficient (20)	Basic (15)	Limited (10)
Content and Ideas	Demonstrates a clear, focused, and compelling main idea with excellent development.	Presents a clear main idea with solid development and relevant supporting details.	Introduces a main idea, but clarity and depth may be lacking.	Main idea is unclear or insufficiently developed. Supporting details are lacking or irrelevant.
Organization	Exhibits a logical structure with a well-crafted introduction, body, and conclusion.	Demonstrates logical organization with a clear introduction, well-developed body, and conclusion.	Presents an adequately organized piece with some flaws in the introduction, body, or conclusion.	Lacks a clear organizational structure, making it challenging for the reader to follow the narrative.
Sentence Structure and Language Use	Displays a high level of proficiency with varied and well-constructed sentences.	Employs correct sentence structure with a good level of variety. Language is generally clear and engaging.	Shows some sentence variety, but there may be occasional issues with structure or language precision.	Limited sentence variety, and basic structure impedes the flow of the writing. Vocabulary and expression are limited and unclear.
Mechanics and Conventions	Virtually error-free in grammar,	Minor errors in grammar, punctuation, and spelling	Contains noticeable errors in grammar,	Numerous errors in grammar, punctuation, and spelling

Criteria	Excellent (25)	Proficient (20)	Basic (15)	Limited (10)
	punctuation, and spelling.	that do not significantly detract from overall quality.	punctuation, and spelling that mildly impact readability.	significantly impair understanding and communication.

To ensure the content validity of the rubric, it was validated by three experts who completed the evaluation form. The experts' responses were calculated using Item-Objective Congruence Index (IOC). The acceptable value of IOC for each item should not be lower than 0.5, otherwise the item needs to be revised. Based on Table 2, the average IOC value was 0.92, with the IOC values of each item was higher than 0.5; therefore, the rubric was suitable for evaluating student writing.

Table 2

Experts' Opinions on the Rubric for Writing Evaluation

Item	IOC	Interpretation
Content and Idea	1.00	Use
Organization	0.67	Use
Sentence Structure and Language Use	1.00	Use
Mechanics and Convention	1.00	Use
Average	**0.92**	**Use**

The inter-rater reliability of the rubric was assessed using Cohen's Kappa for the two raters who independently scored 15 student writings using the rubric. The result of Cohen's Kappa = 0.82, indicating excellent agreement among the raters

Table 3

Inter-Rater Reliability of Writing Assessment Rubric

Statistic	Value	Interpretation
Cohen's Kappa (k)	0.82	Excellent Agreement
95% Confidence Interval (CI)	0.71 – 0.93	

The critical thinking test was designed to cover all the components of the critical thinking skills of primary students, as suggested by Ennis (2011). The components include:

1. credibility of source and observation,
2. deduction,
3. induction, and
4. assumption and identification.

There were five test items for each component, accumulating 20 items. The critical thinking test was evaluated by three experts for Item Objective Congruence (IOC) based on scores +1, 0, and -1. the average IOC value was 0.85, with the IOC values of each item were higher than 0.5; therefore, the test was suitable to use for assessing student critical thinking.

To ensure the test reliability, Kuder-Richardson 20 (R-20) was determined. The KR-20 was 0.79, which was generally considered acceptable, indicating that the scale had decent internal consistency. Details were set out in Eang (2024).

Implementation Procedure

Figure 3

Cloud-based Gamified Instructional Model Integrating Peer Assessment (Eang, 2024)
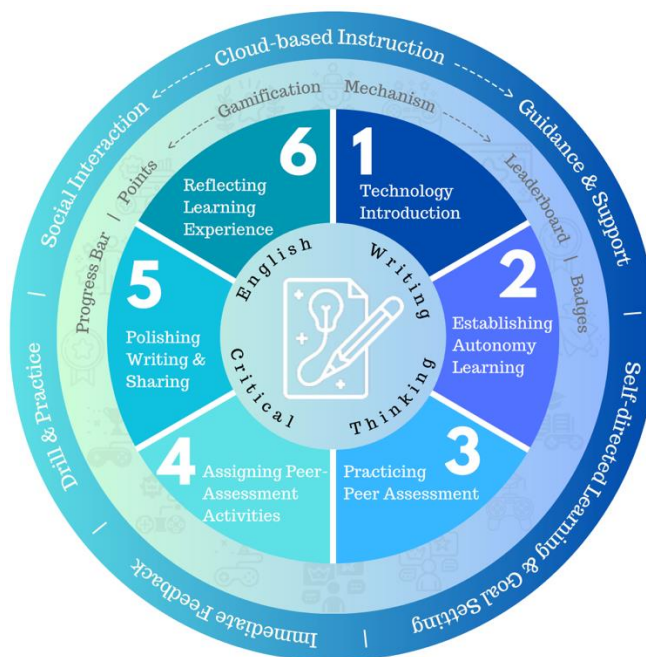
The cloud-based gamified instruction integrating peer assessment was implemented through six steps developed from the cloud-based gamified instructional (CGI) model integrating peer assessment (Figure 3). A comprehensive exposition of the CGI model is available in (Eang, 2024).

In the first session, we administered the writing and critical thinking tests. In the second session, students were prepared to use the cloud-based learning management system and other digital tools and platforms used. In the third session, the students independently studied the course content in the learning management system (LMS) (Figure 4).

Figure 4

Student Self-Learning Page
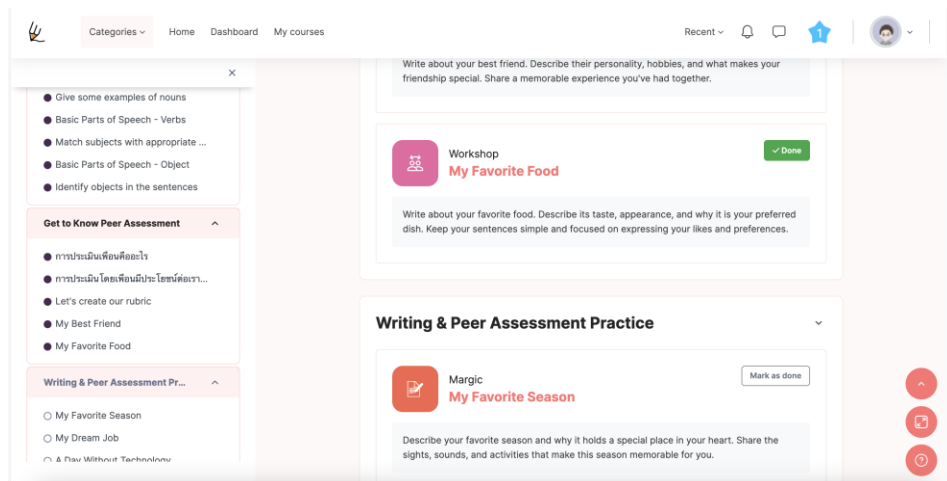

In the fourth session, we provided an example of a peer assessment scenario, and introduced a built-in rubric for peer assessment, and explained how to use it in the LMS. After that, the students worked in pairs to practice the peer assessment tool in the LMS by evaluating provided writing samples. The students were rewarded with points and badges when they finished the activity (Figure 5).

Figure 5

Gamification Dashboard
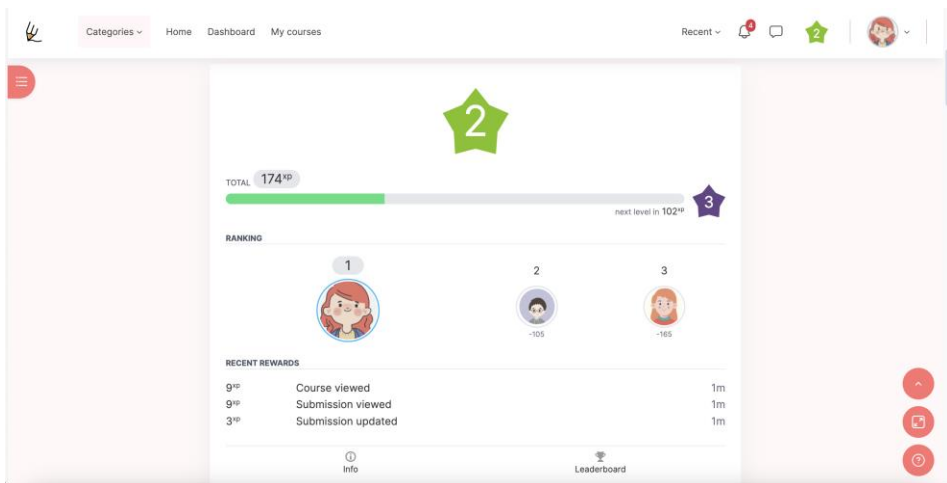
In the fifth session, students were instructed to write a short paragraph on the topic "My Best Friend" in the LMS. Upon completion, they were randomly assigned to assess two pieces of their peers' work. The students who completed the writing assignment and assessment activities were rewarded with points and badges on the profile page.

Figure 6

Peer Assessment Activity
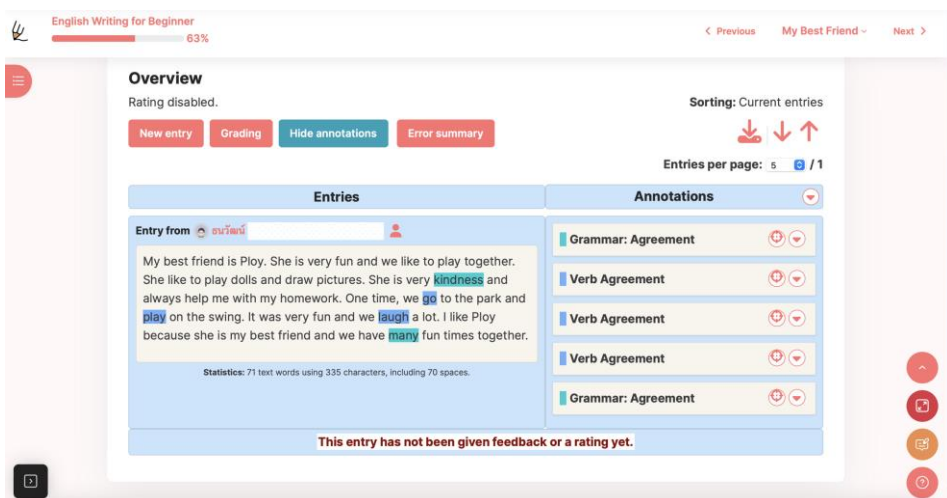
In the sixth session, the students independently studied the content in the LMS: there was a discussion forum, where the teacher shared common writing mistakes with the students. In the seventh session, the students wrote a short paragraph about a topic of their choice and submit it to the LMS assignment page. Then, two peer pieces were assigned to them to evaluate using a simplified version of rubric for English writing assessment for teachers.

Table 4

Rubric for English Writing Assessment for Students

Criterial	Great Job (3)	Good Effort (2)	Keep Trying (1)
Main Idea & Details	I understand the main idea, and there are lots of interesting details!	I get the main idea, and there are some good details.	It's a bit hard to figure out the main idea, and there aren't many details.
Organization	The writing is like a smooth ride, with a clear start, middle, and end.	It's mostly smooth, but there could be a clearer beginning, middle, or end.	It's a bit bumpy. I'm not sure where it starts and ends.
Sentences & Words	Writer used different sentence lengths, and their words make the writing fun to read.	Writer used some different sentences, and their words are okay.	Writer needs to work on using different sentences, and their words are simple.
Grammar & Spelling	No mistakes! Writer's grammar and spelling are perfect.	A few little mistakes, but most of it is correct.	There are quite a few mistakes. Writer needs to check their grammar and spelling.

In the last session, the students wrote their reflections in their native language, Thai, using the provided self-reflection section in the LMS. The teacher posted a discussion board and shared feedback and suggestions for improvement in future writing with the students. At the end of the session, the teacher administered the post-test of the critical thinking test. The writing assignment in the eighth session was used as the English writing post-test. Please note that the reflection activities served primary as a cognitive tool for

the students, rather than a formal writing exercise, and thus were not expected to directly impact the primary intervention outcomes.

After the two-week interval, the teacher administered the delayed post-test of both English writing and critical thinking to confirm the student retention.

Ethical Consideration

We obtained student and parent consent before applying our intervention. Parents and students were informed of the purpose of the study, the procedures involved, potential risks and benefits, and their rights. The study was approved by the Research Ethics Committee of King Mongkut's Institute of Technology Ladkrabang (No: 041 EC-KMITL_66_041).

Data Analysis

The primary data were English writing tests and critical thinking tests, each administered at three different time points: pre-intervention, post-intervention, and a two-week retention interval.

The English writing test, with a maximum score of 100, evaluated the student ability to write a short paragraph on a given topic, assessed based on (1) content and ideas, (2) organization, (3) sentence structure and language use and (4) mechanics and conventions. The critical thinking test, with a maximum score of 20, had 20 multiple-choice questions, designed to assess various critical thinking skills, including (1) credibility of source and observation, (2) deduction, (3) induction, and (4) assumption identification.

The data collected from the tests were analyzed using repeated measures ANOVA to measure the changes in student performance over time. The analysis focused on determining whether there were significant differences between the pre-test, post-test, and delayed post-test scores for both English writing and critical thinking.

Results

The Results of the Effectiveness of the Intervention on the Students' English Writing

Before performing the repeated measures ANOVA test, we confirmed the data normality. In Table 5, the Z-test results of the pre-test score were used to confirm data normality, with the Z-scores for sample kurtosis (Z_{SK}) and kurtosis under the null hypothesis (Z_{KU}) were 1.10 and -1.30, respectively. The two Z scores are defined as:

$$Z_{KU} = \frac{KU}{SE} \text{ and } Z_{SK} = \frac{SK}{SE}$$

SE is the standard error of the kurtosis estimates. The SE quantifies the variability or uncertainty in the estimate of the statistic.

The Z_{KU} value at -1.30, was below 2, suggesting the assumption of normality even though the pre-test scores showed considerable variability with SD = 5.29. The Z-test results for the post-test score supported the normal distribution of the data with a notably lower SD = 2.64, as reflected in Z_{SK} = -0.35 and Z_{KU} = 0.89, which were below 2. While the delayed post-test scores showed a slight increase in SD = 5.01, the Z-test confirmed the normality of the dataset, with Z_{SK} = 0.15 and Z_{KU} = 0.50, both below 2, affirming the appropriateness of parametric statistical analyses applied to the examined variables.

Table 5

Skewness and Kurtosis Analysis of the Pre-test, Post-test, and Delayed Post-test Score

	N	Min	Max	Mean	SD	Skewness		Kurtosis	
						SK	SE	KU	SE
Pre-test	35	40	55	46.85	5.29	0.43	0.39	-1.00	0.77
Post-test	35	80	90	84.42	2.64	-0.14	0.39	0.69	0.77
Delayed post-test	35	75	95	86.14	5.01	0.06	0.39	-0.39	0.77

After confirming data normality, we checked the assumption of sphericity, i.e. tested whether the variances of the differences between all possible pairs of related groups were equal.

Table 6 shows that the significance level from Mauchly's Test of Sphericity over all three tests was 0.209 > 0.05, so we accepted the null hypothesis that the variances of the differences between all possible pairs of related tests were equal.

Table

Mauchly's Test of Sphericity

Within Subjects Effect	Mauchly's W	χ^2	df	Sig.
Over the three tests	0.909	3.134	2	0.209

After the data normality and sphericity were confirmed, the repeated measures ANOVA test determined the significant differences between the pre-test, post-test, and delayed post-test scores. Based on Table 7, the one-way repeated measures ANOVA revealed a significant effect over time on student performance, $F(2, 68) = 853.76$, $p < 0.001$, $\eta^2 = 0.96$. The large F-value indicated that the variance between the means of pre-test, post-test, and delayed post-test scores was significantly greater than the variance within each time point. $p < 0.001$ confirmed that these differences occurring are not by random chance.

Furthermore, the effect size, as measured by $\eta^2 = 0.96$, was remarkably high; it indicated that 96% of the difference in student performance in writing can be attributed to time. This substantial effect size indicated the practical significance of the findings, implying that the observed changes in the student performance across the three time points were statistically significant.

Table 7

Repeated Measures ANOVA

Source of Variance	SS	df	MS	F	p	Partial Eta-Squared
Times	34509.05	2	17254.53	853.76	0.001*	0.96
Error	1374.29	68	20.21			
Total	35883.34					

Table 8 shows pairwise comparisons of the writing scores at the three-time point, revealing statistically significant differences, $p \leq 0.001$. A subsequent examination of mean scores indicated a significant improvement in writing between the pre-test and the post-test and the pre-test and the delayed post-test. However, it is noteworthy that no significant difference was observed between the post-test and delayed post-test scores. This confirmed the effectiveness of the cloud-based gamified instruction model in enhancing writing skill. Further details are provided in Table 8.

Table 8

English Writing Test: Means

Means		Numbers of Tests		
		Pre-test (M = 46.85)	Post-test (M = 85.42)	Delayed post-test (M = 86.14)
English Writing	Pre-test (M = 46.85)	-	-37.57*	-39.28*
	Post-test (M = 85.42)	37.57*	-	-1.71
	Delayed post-test (M = 86.14)	39.28*	1.71	-

Effectiveness of the Intervention on Critical Thinking

As with English skills, basic checks on data normality were made before the repeated measures ANOVA test on the critical thinking scores of the three tests. Z-test computations showed all values (Z_{SK} and Z_{KU}) were less than 2, confirming that the distributions were normal – see Table 5. This was confirmed by sphericity tests – see Table 9.

Table 9

Skewness and Kurtosis Analysis of the Pre-test, Post-test, and Delayed Post-test Test Score

	N	Min	Max	Mean	SD	Skewness		Kurtosis	
						SK	SE	KU	SE
Pre-test	35	5	10	7.31	1.27	-0.27	0.39	-0.43	0.77
Post-test	35	14	19	16.05	1.32	0.21	0.39	-0.21	0.77
Delayed post-test	35	14	20	16.25	1.48	0.65	0.39	0.14	0.77

Further, Mauchly's Test of Sphericity returned 0.718 < 0.05, so we accepted the null hypothesis (variances of the differences between all possible pairs of related groups were essentially equal). The next step is to check the assumption of sphericity, which hypothesized that the variances of the differences between all possible pairs of related groups are equal.

From the results in Table 10, the significant level of Mauchly's Test of Sphericity is 0.718, which is higher than 0.05, meaning it accepts the null

hypothesis that the variances of the differences between all possible pairs of related groups are equal.

Table 10

Mauchly's Test of Sphericity

Within Subjects Effect	Mauchly's W	χ^2	df	Sig.
Times	0.980	0.664	2	0.718

The one-way repeated measures ANOVA test (Table 11) demonstrated a statistically significant effect of time on student critical thinking (F (2, 68) = 632.89, p < 0.001, η^2 = 0.95). The F-value confirmed that the student improvement between the means of pre-test, post-test and delayed post-test scores was significantly greater than the improvement within each time point at the p ≤ 0.001.

Moreover, the effect size, as indicated by partial eta-squared (η^2 = 0.95), was remarkably high, implying a substantial impact of time on student improvement in critical thinking, with a high effect size of 95%. The effect size highlights the practical significance of the study, suggesting that the observed improvement in critical thinking over the three-time points is statistically significant.

Table 11

Repeated Measures ANOVA

Source of Variance	SS	df	MS	F	p	Partial Eta-Squared
Times	1825.28	2	912.64	632.89	0.001*	0.95
Error	98.06	68	1.44			
Total	1923.34					

As depicted in Table 12, the pairwise comparisons of students' critical thinking scores across three-time points showed statistically significant differences at p ≤ 0.001. Subsequent analysis of mean scores revealed an improvement in critical thinking from pre-test to post-test and pre-test to delayed post-test (p ≤ 0.001). Importantly, no statistically significant difference was found between post-test and delayed post-test scores. These outcomes indicate the effectiveness of the cloud-based gamified instructional model in enhancing critical thinking.

Table 12

Critical Thinking Test: Means

		Numbers of Tests		
Means		Pre-test (M = 7.31)	Post-test (M=16.05)	Delayed post-test (M = 16.25)
Critical Thinking	Pre-test (M = 7.32)	-	-8.74*	-8.94*
	Post-test (M = 16.05)	8.72*	-	-0.20
	Delayed post-test (M = 16.25)	9.94*	0.20	-

Discussion and Conclusion

ANOVA analysis of the writing test showed that post-test and delayed post-test test scores were significantly higher than their pre-test scores ($p \leq 0.01$). The significant improvement in writing skills was attributed to several factors within the cloud-based gamified instruction model. Firstly, the model provided students with access to interactive multimedia resources, which allowed them to link to the learning materials in a dynamic and engaging manner. This multimedia approach was confirmed to enhance comprehension and retention of information, leading to improved writing skills. This was consistent with Zahro (2019), who developed Moodle e-learning media to teach descriptive text writing; his study suggested that Moodle e-learning media effectively taught descriptive text writing, with 96% of students agreeing it was very helpful and 79% of experts validating its implementation in an English learning exercise.

Furthermore, the integration of peer assessment activities within the model played a crucial role in enhancing writing skills. Peer assessment allowed students to receive feedback from their peers, which encouraged them to critically evaluate their own work and make improvements. Chang et al. (2020) showed that peer assessment promoted metacognitive skills and self-reflection, leading to enhanced writing abilities. Similarly, Double et al. (2018) analyzed the impact peer assessment on student performance; they found that peer assessment improved academic performance compared to no assessment, teacher assessment and self-assessment, and was effective in several disciplines.

The gamification elements incorporated into the model also contributed to the improvement in writing skills. The use of rewards, badges,

and progress tracking motivated students to actively participate in writing activities and strive for improvement. Gamification was found to increase student engagement, motivation and persistence - all essential factors in developing strong writing skills (Pingmuang & Koraneekij, 2022).

In addition to the improvement in writing skills, the study also revealed significant improvement in critical thinking from pre-test to post-test (p ≤ 0.01). Importantly, this improvement was maintained in the delayed post-test, also showing a significant improvement compared to the pre-test (p ≤ 0.01). Whereas lack of a significant difference, between the post-test and delayed post-test, indicated that the gains in critical thinking achieved through the cloud-based gamified instruction were sustained over time. The CGI model provided opportunities for students to engage in problem-solving, reflection and analysis. These activities fostered the development of higher-order thinking skills, such as evaluating evidence, making logical connections, and generating innovative ideas. This result aligns with Lynch et al. (2012), who promoted deep learning in a teacher education program through self- and peer-assessment and feedback. The results showed that cloud-based peer feedback resulted in higher quality learning outcomes and enhanced critical thinking in primary school students (Lynch et al., 2012).

However, implementing the CGI model was not without its challenges. The students required additional training on the technology used in the cloud-based platform. Xie et al. (2020) also suggested that for cloud-based learning to be successful, students needed basic digital skills, such as navigating the internet and creating new documents. Moreover, we observed that the students needed more peer assessment exercises to provide constructive feedback. Joh (2021) reported the same problem and suggested regular and frequent peer assessment activities, especially for young students. These challenges highlighted the importance of providing adequate support and training when implementing innovative instructional models like the CGI.

Despite the challenges, we found evidence supporting the effectiveness of the CGI model in enhancing writing and critical thinking among primary EFL students. The integration of cloud-based learning, peer assessment, and gamification in the instructional model offers a promising approach to enhance writing and critical thinking skills. By leveraging technology and incorporating collaborative and interactive elements, teachers can create engaging and effective learning environments that promote active student participation and skill development. The sustained improvement in both writing and critical thinking, even after the intervention, suggested that the CGI model fostered the development of enduring skills that persisted beyond the immediate learning context. The delayed post-test results

provided evidence for the effectiveness of the CGI model in promoting not only immediate but also long-term skills development.

In conclusion, the implementation of the cloud-based gamified instruction model resulted in significant improvements in writing and critical thinking skills. The integration of cloud-based learning, peer assessment, and gamification provided students with engaging and interactive learning experiences, fostering the development of essential skills. These findings underscore the importance of innovative instructional approaches that leverage technology and promote active student engagement in enhancing educational outcomes.

Contributions

Narathakoon et al. (2020) noted earlier that there was a unsatisfied need for studies of peer assessment in primary classes, so our work provided some needed confirmation of its effectiveness. Narathakoon et al. (2020) also reported a barrier to practical implementation: here, we confirmed that the new CGI model to guide implementation (Eang, 2024) was effective. Gamification, as used in this study, removed some of the hesitation reported by Varasunun (2015) and Sa-nguansat (2011) engaging in peer assessment by encouraging active participation. Both the games and the technology were new pedagogical ideas. The study's focus on primary school students showed that early intervention in developing English writing and critical thinking was possible and effective. We also showed that it was possible to integrate technology, specifically cloud-based platforms, in instructional practice at the primary level. Overall, the combination of cloud-based gamified instruction integrating peer assessment has not been used previously. This study confirmed that the combination of all three (cloud, games, and peer assessment) was effective in enhancing primary student writing and critical thinking for students studying a foreign language.

Limitations

The study was limited to a specific discipline and group of students. Thus, in future studies, researchers should confirm the generalizability of the findings by conducting similar studies in different educational contexts, grade levels, subject areas etc.

Moreover, the study employed a one-group pre- and post-test with a delayed pos-test design. Thus, future studies can conduct a two-group design to compare the effectiveness of the cloud-based gamified instruction model with other instructional approaches.

Future studies should consider using qualitative data collection methods such as semi-structured interview or focus group discussions, to complement the quantitative data. This would provide richer insights into participant subjective experiences and perceptions of gamification, capturing nuances that might not be fully reflected in numeric data.

Acknowledgments

About the Authors

Norphealey Eang: A PhD student in Technology-Enhanced Learning and Innovation, King Mongkut's Institute of Technology Ladkrabang. His research focus is on cloud-based instruction for language learning.

Sirirat Petsangsri: The director of the International Office, King Mongkut's Institute of Technology Ladkrabang. She has an Ed.D. in instructional design and technology, School of Education, University of Pittsburgh. Her research focuses on technology-enhanced learning, motivation in e-learning and cognitive overload.

John Morris: A graduate of The University of Sydney with a PhD in Physical Chemistry. He now also teaches research methods, technical writing and image processing in King Mongkut's Institute of Technology Ladkrabang.

References

Abe, M. (2020). Interactional practices for online collaborative writing. *Journal of Second Language Writing*, *49*, 100752. https://doi.org/10.1016/j.jslw.2020.100752

Ahmed, S. A. M. (2021). A gamification program to enhance writing skills of EFL secondary stage students and their motivation towards learning these skills. *Mansoura College of Education Journal*, *116*(3), 65-88. https://doi.org/10.21608/maed.2021.235826

Aljraiwi, S. (2019). Effectiveness of gamification of web-based learning in improving academic achievement and creative thinking among primary school students. *International Journal of Education and Practice*, *7*(3), 242-257. https://doi.org/10.18488/journal.61.2019.73.242.257

Amels, J., Krüger, M. L., Suhre, C. J. M., & van Veen, K. (2020). The effects of distributed leadership and inquiry-based work on primary

teachers' capacity to change: Testing a model. *School Effectiveness and School Improvement, 31*(3), 468-485. https://doi.org/10.1080/09243453.2020.1746363

Ammar, A., & Spada, N. (2006). One size fits all? Recasts, prompts, and L2 learning. *Studies in Second Language Acquisition, 28*(4), 543-574. https://doi.org/10.1017/S0272263106060268

Anggrawan, A., & Jihadil, Q. S. (2018, 17-18 Oct. 2018). Comparative analysis of online E-learning and face to face learning: An experimental study. *2018 Third International Conference on Informatics and Computing (ICIC)*, 1-4. https://doi.org/10.1109/IAC.2018.8780495

Asriati, S., & Maharida, M. (2013). Improving the students' writing skill by using process writing approach at the second grade students of SMK Grafika Gowa Makassar. *Exposure: Jurnal Pendidikan Bahasa dan Sastra Inggris, 2*(2), 2240244. https://doi.org/10.26618/ejpbi.v2i2.788

Azmi, S., Iahad, N. A., & Ahmad, N. (2016, 10-12 Oct. 2016). Attracting students' engagement in programming courses with gamification. *2016 IEEE Conference on e-Learning, e-Management and e-Services (IC3e)*, 112-115. http://doi.org/10.1109/IC3e.2016.8009050.

Bae, J., & Lee, Y.-S. (2012). Evaluating the development of children's writing ability in an EFL context. *Language Assessment Quarterly, 9*(4), 348-374. https://doi.org/10.1080/15434303.2012.721424

Cameron, L., & Larsen-Freeman, D. (2007). Complex systems and applied linguistics. *International Journal of Applied Linguistics, 17*(2), 226-240. https://doi.org/10.1111/j.1473-4192.2007.00148.x

Carlgren, T. (2013). Communication, critical thinking, problem solving: A suggested course for all high school students in the 21st century. *Interchange, 44*(1), 63-81. https://doi.org/10.1007/s10780-013-9197-8

Chang, S.-C., Hsu, T.-C., & Jong, M. S.-Y. (2020). Integration of the peer assessment approach with a virtual reality design system for learning earth science. *Computers & Education, 146*, 103758. https://doi.org/10.1016/j.compedu.2019.103758

Chans, G. M., & Castro, M. (2021). Gamification as a strategy to increase motivation and engagement in higher education chemistry students. *Computers, 10*(10), 132. https://doi.org/10.3390/computers10100132

Cheung, A. (2021). Integrating e-learning into process writing: The case of a primary school in Hong Kong. *Innovative approaches in teaching English writing to Chinese speakers*, 19-42. https://doi.org/10.1515/9781501512643-002

Chicho, K. Z. H. (2022). An analysis of factors influencing EFL learners' writing skills. *Canadian Journal of Language and Literature Studies*, *2*(2), 28-38. https://doi.org/10.53103/cjlls.v2i2.38

Christina, F. (2021). Correlating vocabulary and sentence structure mastery to students' writing skill in descriptive text. *Journal of English Language Teaching and Cultural Studies*, *4*(1), 47-56. http://dx.doi.org/10.48181/jelts.v4i1.10080

Daffern, T., Mackenzie, N. M., & Hemmings, B. (2017). Predictors of writing success: How important are spelling, grammar and punctuation? *Australian Journal of Education*, *61*(1), 75-87. https://doi.org/10.1177/0004944116685319

Double, K. S., McGrane, J. A., & Hopfenbeck, T. N. (2020). The impact of peer assessment on academic performance: A meta-analysis of control group studies. *Educational Psychology Review*, *32*(2), 481-509. https://doi.org/10.1007/s10648-019-09510-3

Duron, R., Limbach, B., & Waugh, W. (2006). Critical thinking framework for any discipline. *International Journal of Teaching and Learning in Higher Education*, *17*(2), 160-166.

Eang, N. (2024). *Development of a cloud-based gamified instruction model integrating peer assessment to enhance primary school students' English writing and critical thinking* [Unpublished doctoral dissertation]. King Mongkut's Institute of Technology Ladkrabang.

Elimelech, A., & Aram, D. (2020). Using a digital spelling game for promoting alphabetic knowledge of preschoolers: The contribution of auditory and visual supports. *Reading Research Quarterly*, *55*(2), 235-250. https://doi.org/10.1002/rrq.264

Ennis, R. (2011). Critical thinking. *Inquiry: Critical Thinking Across the Disciplines*, *26*(2), 5-19. https://doi.org/10.5840/inquiryctnews201126215

Ennis, R. H., Millman, J., & Tomko, T. N. (2005). *Cornell Critical Thinking Tests Levels X & Level Z Manual*. Critical Thinking Company.

Facione, N. C., Facione, P. A., & Sanchez, C. A. (1994). Critical thinking disposition as a measure of competent clinical judgment: The development of the California critical thinking disposition inventory. *Journal of Nursing Education*, *33*(8), 345-350. https://doi.org/10.3928/0148-4834-19941001-05

Faradhibah, R. N., & Nur, N. A. (2017). Analyzing students' difficulties in maintaining their coherence and cohesion in writing process. *English, Teaching, Learning, and Research Journal*, *3*(2), 183-194. https://doi.org/10.24252/Eternal.V32.2017.A7

Flores, A., & Brittain, C. (2003). Research, reflection, practice: Writing to reflect in a Mathematics methods course. *Teaching Children Mathematics*, *10*(2), 112-118. https://doi.org/10.5951/tcm.10.2.0112

Fricke, S., Bowyer-Crane, C., Haley, A. J., Hulme, C., & Snowling, M. J. (2013). Efficacy of language intervention in the early years. *Journal of Child Psychology and Psychiatry*, *54*(3), 280-290. https://doi.org/10.1111/jcpp.12010

Gamage, D., Staubitz, T., & Whiting, M. (2021). Peer assessment in MOOCs: Systematic literature review. *Distance Education*, *42*(2), 268-289. https://doi.org/10.1080/01587919.2021.1911626

Haddadi, L., Bouarab-Dahmani, F., Guin, N., Berkane, T., & Lazib, S. (2018). Peer assessment and groups formation in massive open online courses. *Computer Applications in Engineering Education*, *26*(5), 1873-1887. https://doi.org/10.1002/cae.22005

Hubackova, S., Semradova, I., & Klimova, B. F. (2011). Blended learning in a foreign language teaching. *Procedia - Social and Behavioral Sciences*, *28*, 281-285. https://doi.org/10.1016/j.sbspro.2011.11.054

Ja'ashan, M. M. N. H. (2020). The challenges and prospects of using e-learning among EFL students in Bisha University. *Arab World English Journal*, 124-137. https://dx.doi.org/10.24093/awej/vol11no1.11

Jashari, L. T., & Fojkar, M. D. (2019). Teachers' perceptions of developing writing skills in the EFL classroom. *ELOPE: English Language Overseas Perspectives and Enquiries*, *16*(2), 77-90. https://doi.org/10.4312/elope.16.2.77-90

Jiang, D., & Kalyuga, S. (2022). Learning English as a foreign language writing skills in collaborative settings: A cognitive load perspective. *Frontiers in Psychology*, *13*, 1-11. https://doi.org/10.3389/fpsyg.2022.932291

Jiang, D., Kalyuga, S., & Sweller, J. (2021). Comparing face-to-face and computer-mediated collaboration when teaching EFL writing skills. *Educational Psychology*, *41*(1), 5-24. https://doi.org/10.1080/01443410.2020.1785399

Joh, J. (2021). Implementing peer assessment for optimal effects: Learners' voice. *Journal of AsiaTEFL*, *18*(1), 1-22. http://dx.doi.org/10.18823/asiatefl.2021.18.1.1.1

Jones, I., & Alcock, L. (2014). Peer assessment without assessment criteria. *Studies in Higher Education*, *39*(10), 1774-1787. https://doi.org/10.1080/03075079.2013.821974

Kemp, N., & Grieve, R. (2014). Face-to-face or face-to-screen? Undergraduates' opinions and test performance in classroom vs.

online learning. *Frontiers in Psychology*, *5*. 1-11. https://doi.org/10.3389/fpsyg.2014.01278

Khoiri, A., Evalina, Komariah, N., Utami, R. T., Paramarta, V., Siswandi, Janudin, & Sunarsi, D. (2021). 4Cs analysis of 21st century skills-based school areas. *Journal of Physics: Conference Series*, *1764*(1), 1-10. https://doi.org/10.1088/1742-6596/1764/1/012142

Krashen, S. (1982). *Principles and practice in second language acquisition*. University of Southern California.

Kumar, T., Soozandehfar, S. M. A., Hashemifardnia, A., & Mombeini, R. (2023). Self vs. peer assessment activities in EFL-speaking classes: impacts on students' self-regulated learning, critical thinking, and problem-solving skills. *Language Testing in Asia*, *13*(1), 1-22. https://doi.org/10.1186/s40468-023-00251-3

Lai, C. L., & Hwang, G. J. (2014). A peer-assessment criteria development approach to improving critical thinking of students. *2014 IIAI 3rd International Conference on Advanced Applied Informatics*, 355-360. https://doi.org/10.1109/IIAI-AAI.2014.80

Lai, E. R. (2011). Critical thinking: A literature review. *Pearson's Research Reports*, *6*(1), 40-41.

Lam, Y. W., Hew, K. F., & Chiu, K. F. (2018). Improving argumentative writing: Effects of a blended learning approach and gamification. *Language Learning & Technology*, *22*(1), 97-118. https://dx.doi.org/10125/44583

Landry, A., Jacobs, S., & Newton, G. (2015). Effective use of peer assessment in a graduate level writing assignment: A case study. *International Journal of Higher Education*, *4*(1), 38-51. https://doi.org/10.5430/ijhe.v4n1p38

Leenknecht, M. J. M., & Prins, F. J. (2018). Formative peer assessment in primary school: the effects of involving pupils in setting assessment criteria on their appraisal and feedback style. *European Journal of Psychology of Education*, *33*(1), 101-116. https://doi.org/10.1007/s10212-017-0340-2

Li, H., Xiong, Y., Hunter, C. V., Guo, X., & Tywoniw, R. (2020). Does peer assessment promote student learning? A meta-analysis. *Assessment & Evaluation in Higher Education*, *45*(2), 193-211. https://doi.org/10.1080/02602938.2019.1620679

Liu, Q. (2023). Gamification in primary school mathematics teaching. *Journal of Education, Humanities and Social Sciences*, *22*, 428-433. https://doi.org/10.54097/ehss.v22i.12493

Longcamp, M., Velay, J.-l., Berninger, V. W., & Richards, T. (2016). Neuroanatomy of handwriting and related reading and writing skills in adults and children with and without learning disabilities: French-

American connections. *Pratiques. Linguistique, littérature, didactique* , 171-172. https://doi.org/10.4000/pratiques.3175

Lynch, R., McNamara, P. M., & Seery, N. (2012). Promoting deep learning in a teacher education programme through self- and peer-assessment and feedback. *European Journal of Teacher Education*, *35*(2), 179-197. https://doi.org/10.1080/02619768.2011.643396

Magi, T. J., & Mardeusz, P. E. (2013). Why some students continue to value individual, face-to-face research consultations in a technology-rich world. *Coll. Res. Libr.*, *74*, 605-618. https://doi.org/10.5860/crl12-363

Maulidah, U. N., & Aziz, I. N. (2020). The effectiveness of online collaborative learning on students writing skills. *EDUCATIO: Journal of Education*, *5*(2), 141-149. https://doi.org/10.29138/educatio.v5i2.291

McCarthy, M. (2013). Corpora and the advanced level: Problems and prospects. *English Australia Journal*, *29*(1), 39-50. https://search.informit.org/doi/10.3316/informit.338459106539810

Mehta, S. R., & Al-Mahrooqi, R. (2015). Can thinking be taught? Linking critical thinking and writing in an EFL context. *RELC Journal*, *46*(1), 23-36. https://doi.org/10.1177/0033688214555356

Miller, D. M., Scott, C. E., & McTigue, E. M. (2018). Writing in the secondary-level disciplines: A systematic review of context, cognition, and content. *Educational Psychology Review*, *30*(1), 83-120. https://doi.org/10.1007/s10648-016-9393-z

Mohamed, M., Abdul Razak, N., & Wahi, W. (2023). Peer- and self-assessment in primary school English language classrooms. *2023*, *13*(7), 243-252. https://doi.org/10.5430/wjel.v13n7p243

Narathakoon, A., Sapsirin, S., & Subphadoongchone, P. (2020). Beliefs and classroom assessment practices of English teachers in primary schools in Thailand. *International Journal of Instruction*, *13*(3), 137-156. https://doi.org/10.29333/iji.2020.13310a

NIETS. (2019-2023). *O-NET result of Grade 6 from 2019 - 2023*. Retrieved from https://www.niets.or.th/th/catalog/view/2989

Park, S., & Kim, S. (2021). Is sustainable online learning possible with gamification?—The effect of gamified online learning on student learning. *Sustainability*, *13*(8), 4267. https://doi.org/10.3390/su13084267

Pingmuang, P., & Koraneekij, P. (2022). Mobile-assisted language learning using task-based approach and gamification for enhancing writing skills in EFL students. *Electronic Journal of e-Learning*, *20*(5), 623-638. https://doi.org/10.34190/ejel.20.5.2339

Plass, J. L., O'Keefe, P. A., Homer, B. D., Case, J., Hayward, E. O., Stein, M., & Perlin, K. (2013). The impact of individual, competitive, and collaborative mathematics game play on learning, performance, and motivation. *Journal of educational psychology*, *105*(4), 1050. https://doi.org/10.1037/a0032688

Ross, S. M. (2017). Chapter 7 - Distributions of Sampling Statistics. In S. M. Ross (Ed.), *Introductory Statistics (Fourth Edition)* (pp. 297-328). Academic Press. https://doi.org/10.1016/B978-0-12-804317-2.00007-2

Rotsaert, T., Panadero, E., & Schellens, T. (2018). Peer assessment use, its social nature challenges and perceived educational value: A teachers' survey study. *Studies in Educational Evaluation*, *59*, 124-132. https://doi.org/10.1016/j.stueduc.2018.07.001

Sa-nguansat, K. (2011). *Learning and sharing proceses in project-based science learning based on activity theory using different types of Avatar icons on blogs and peer assessment of gifted upper secondary school students in science and technolgy* Chulalongkorn University]. Chulalongkorn University. https://cuir.car.chula.ac.th/bitstream/123456789/21765/1/kajohnsak_sa.pdf

Sabri, P. S. U., Ilyas, M., & Amjad, Z. (2015). Organizational learning culture and its effects on critical thinking skills on female teachers of public sector HEI. *Bulletin of Education and Research*, *37*(2), 69-90.

Sanchez, C. E., Atkinson, K. M., Koenka, A. C., Moshontz, H., & Cooper, H. (2017). Self-grading and peer-grading for formative and summative assessments in 3rd through 12th grade classrooms: A meta-analysis. *Journal of educational psychology*, *109*(8), 1049-1066. https://doi.org/10.1037/edu0000190

Srimunta, P., Suphandee, T., Senarat, S., Sripai, S., & Ardwichai, S. (2020). Development of the English teaching evaluation model focusing on task-based learning to develop English writing ability and creative thinking in Language for sixth grade students in Thailand. *Educational Research and Reviews*, *15*(7), 377-384. https://doi.org/10.5897/ERR2020.3955

Su, W. (2022). Understanding rubric use in peer assessment of translation. *Perspectives*, *30*(1), 71-85. https://doi.org/10.1080/0907676X.2020.1862260

Susandia, A. D., Saâdijahb, C., Asâaric, A. R., & Susiswod. (2020). M6 Learning model: The framework to design a learning model that improves students' critical thinking skill. *Systematic Reviews in Pharmacy*, *11*(6), 1245-1254.

Tawanwongsri, W., & Phenwan, T. (2019). Reflective and feedback performances on Thai medical students' patient history-taking skills.

BMC Medical Education, *19*(1), 141. https://doi.org/10.1186/s12909-019-1585-z

Tepsuriwong, S., & Bunsom, T. (2013). Introducing peer assessment to a reading classroom: Expanding Thai University students' learning boundaries beyond alphabetical symbols. *Mediterranean Journal of Social Sciences*, *4*(14), 279-286. https://doi.org/10.5901/mjss.2013.v4n14p279

Todd, V., & Hudson, J. C. (2007). Using graded peer evaluation to improve students writing skills, critical thinking ability, and comprehension of material in a principles of public relations course. *Journal of College Teaching & Learning*, *4*(10). https://doi.org/10.19030/tlc.v4i10.1534

Tornwall, J. (2018). Peer assessment practices in nurse education: An integrative review. *Nurse Education Today*, *71*, 266-275. https://doi.org/10.1016/j.nedt.2018.09.017

Van Waes, L., van Weijen, D., & Leijten, M. (2014). Learning to write in an online writing center: The effect of learning styles on the writing process. *Computers & Education*, *73*, 60-71. https://doi.org/10.1016/j.compedu.2013.12.009

van Zundert, M., Sluijsmans, D., & van Merriënboer, J. (2010). Effective peer assessment processes: Research findings and future directions. *Learning and Instruction*, *20*(4), 270-279. https://doi.org/10.1016/j.learninstruc.2009.08.004

Varasunun, P. (2015). Developing learners by using peer feedback. *Humanities and Social Sciences*, *9*(1), 33-40.

Wang, A. Y. (2012). Exploring the relationship of creative thinking to reading and writing. *Thinking Skills and Creativity*, *7*(1), 38-47. https://doi.org/10.1016/j.tsc.2011.09.001

Wang, X.-M., Yu, X.-H., Hwang, G.-J., & Hu, Q.-N. (2023). An online progressive peer assessment approach to project-based learning: a constructivist perspective. *Educational Technology Research and Development*, *71*(5), 2073-2101. https://doi.org/10.1007/s11423-023-10257-6

Watson, G. (1980). *Watson-Glaser critical thinking appraisal.* Psychological Corporation San Antonio, TX.

Wen, X. (2023). The effect of gamification learning on primary school students' second language learning. *Journal of Education, Humanities and Social Sciences*, *22*, 492-501. https://doi.org/10.54097/ehss.v22i.12510

Wonglakorn, P., & Deerajviset, P. (2023). The effects of collaborative process writing approach on Thai EFL secondary school students' writing skills. *LEARN Journal: Language Education and Acquisition Research Network*, *16*(1), 495-522.

https://so04.tci-thaijo.org/index.php/LEARN/index

Xie, X., Siau, K., & Nah, F. F.-H. (2020). COVID-19 pandemic – online education in the new normal and the next normal. *Journal of Information Technology Case and Application Research*, *22*(3), 175-187. https://doi.org/10.1080/15228053.2020.1824884

Yang, X., Teng, Y., Gu, Z., & Zhang, D. (2021). Self and peer assessment in K–12 Chinese language classrooms: teachers' perceptions and implementation. *Research in Language and Education: An International Journal*, *1*(1), 69-84.

Zahro, L. F. (2019). *Developing Moodle e-learning media to teach descriptive text writing : a study at X grade of SMK NU Ma'arif 01 Semarang in the academic year of 2018/ 2019*. Undergraduate (S1) thesis, UIN Walisongo Semarang.