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Cognitive processes in EFL learners' reading comprehension: A comparative analysis of WhatsApp and traditional group-driven reading

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ABSTRACT
WhatsApp (WA) has become increasingly popular in second language (L2) instructional practices, primarily for assessing L2 learners' outcomes. Despite this popularity, there remains a significant gap in the literature regarding well-documented inquiries into the cognitive processes and reading comprehension of L2 learners. This study aimed to explain L2 learners' reading comprehension abilities and explore the cognitive processes of L2 learners who were taught using WA reading groups and those taught using the traditional group-driven reading approach. A mixed quantitative approach using an experimental design with 32 learners (12 males and 20 females) and a qualitative design were applied to address the two research purposes. The study results illustrated that learners' cognitive process in the WA reading group was effective, and their reading comprehension scores were higher than the traditional reading group. The effective cognitive strategies were visualized from learners' WA chat histories. The WA reading group's cognitive process involved content discussion, self-reflection, and interpretation during online reading activities. They did not discuss from word to passage, but they tended to discuss the text's content and logical flow without finding the same difficult word for all group members. Conversely, the traditional reading group cognitive processes were less effective since the group member roles were not identified, such as all learners starting to find similar unfamiliar words and then discussing them again before interpreting the content of the texts. The study's limitations and pedagogical implications are adequately discussed.

Keywords: Cognitive process; Individual learning; Reading comprehension; Small group; WA-driven learning

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INTRODUCTION

Reading is one of the most vital and challenging skills in second language (L2) learning (Geva et al., 2019; Verhoeven et al., 2019). It is a vital skill because reading contributes to learners' critical thinking skills, vocabulary development, grammar, writing skills, and other L2 elements (Ng et al., 2019; Verhoeven et al., 2019). On the other hand, it is considered a challenging skill because reading involves a complex process of meaning interpretation, analysis, and readers' background knowledge, information processing, and orthographic and phonological awareness (Rosnaeni et al., 2020; Saksiriphol & Kunchune, 2023; Sungatullina et al., 2016; Zahraa et al., 2016). Due to the complex process of reading comprehension, numerous researchers worldwide report learners' low reading skills. The US Department of Education National Assessment of Educational Progress (Lutsic & Zhang, 2023; OECD, 2022; Solem &

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Stoltman, 2020; White et al., 2021), for example, reported that most elementary and adult learners in the United States had poor reading performance (Beauregard et al., 2018; Rist, 2017; Vargas et al., 2021). Other prominent countries such as the UK and Australia also report the same conditions (Gasque & Dos Santos, 2022; Hassan et al., 2021; Vargas et al., 2021). Similarly, the Korean National Assessment of Education Achievement (NAEA) results reported that approximately 8.6% of elementary and secondary students did not achieve well in reading (Kim et al., 2020). In the Indonesian L2 context, the PISA reading test results rank 64 out of 65 countries (Fenanlampir, 2021). This extreme portrayal represents the low ability of Indonesian learners' reading skills and is further reflected in the low quality of teaching reading (Ardhian et al., 2020; Belfali, 2019; Muhassin et al., 2021; Nugrahanto & Zuchdi, 2019; Riadil, 2020).

Due to its challenges, the prominent roles of reading skills in promoting L2 learners' performance and the massive use of mobile technologies in L2 pedagogy invite scholars worldwide to scrutinize their effectiveness in teaching reading comprehension. A plethora of research applies WhatsApp as a medium for teaching reading. Some reasons are the popularity of WhatsApp, which has reached 1.5 billion users compared to other mobile applications, and its effectiveness in L2 pedagogy (Arifani, 2019.; Arifin et al., 2022; Haque & Wok, 2020; Ramzan et al., 2019; Rosenfeld et al., 2018). To elevate the quality of teaching reading using WhatsApp, many L2 scholars scrutinized various aspects of reading. They involved reading comprehension (Chan et al., 2020; Minhas, 2016; Olofinlua, 2022; Soyturk, 2022), skimming and scanning strategies (Agarwal & Alrowaili, 2020; Basri et al., 2022; Sharma & Kumar, 2021), reading and autonomy (Hazaea & Alzubi, 2018; Hui et al., 2023; Kartal, 2022; Khubyari & Haddad Narafshan, 2016), reading interest and motivation (Ahmed, 2019; Hartati et al., 2023; Kanchana, 2016; Palupi et al., 2023), and reading performance (Chuks Danie, 2017; Mtega, 2021; Rahman et al., 2023; Warman, 2018; Zano, 2020). WhatsApp has also been used in the Indonesian context to teach reading comprehension from the elementary to university level (Ahmed, 2019; Hartati et al., 2023; Kanchana, 2016; Palupi et al., 2023) and to extensive reading programs (Anandari & Iswandari, 2019).

However, the effectiveness of teaching reading using mobile technology is still uncertain since many previous studies primarily focus on learners' reading comprehension assessed by their ability to answer comprehension questions. Analyzing learners' reading comprehension skills solely as product-based outcomes is inadequate, as these skills are profoundly influenced by their cognitive processes in reading comprehension (Al Aghar et al., 2023; Albashtawi & Mahfoodh, 2023; Ateek, 2021; Arifin et al., 2022; Maruf & Anjely, 2020) Underlining the crucial roles of learners' cognitive process in reading comprehension, this study attempts to fill this gap by examining both reading comprehension as an outcome-based reading and cognitive process under a single study.

Reading comprehension and cognitive process

How do learners' cognitive processes from the two groups differ in the reading comprehension process? Reading comprehension is the learners' mental representation of textual information in their minds after reading the passage. Learners' mental representation refers to their ability to extract specific information, find an event or facts, and infer meaning from the passage (Arifin et al., 2022; Chen, 2023; Maruf & Anjely, 2020; Zuhri et al., 2021). Meanwhile, the cognitive processes are interrelated because the cognitive process in reading significantly influences comprehension itself. One of the most well-known cognitive theories in reading comprehension is Planning, Attention, Simultaneous and Successive (PASS), initiated by Jagannath Prasad Das et al. (1994). Planning is defined as learners' behavior to organize, construct, and monitor learners' reading performance. Attention is interpreted as learners' responsibility for maintaining alertness and ensuring specific reading focus. Simultaneous processing integrates pieces of information into whole units of information that the learners read from the passage. Meanwhile, successive refers to a specific aspect of cognitive processing related to sequential information and how individuals handle and process this information. It involves the sequential arrangement of information and the ability to understand and process it in a step-by-step manner. It pertains to the linear processing of elements in a sequence, where individuals comprehend information by recognizing and interpreting one item after another in a specific order.

On the other hand, the subsequent processing only involves learners' ability to link sequential information from the passage. Apart from the above cognitive theory, Naglieri & Das (2005) and Naglieri et al. (1990)) proposed a more concise cognitive assessment, namely the Cognitive Assessment System (CAS) that addresses the component of the previous cognitive theory. In this study, the CAS theory is applied because, in the previous PASS, simultaneous processing is more relevant to assessing learners' reading comprehension. Meanwhile, the subsequent processing is more relevant to assess learners' decoding word reading as one of the precursors of low subsequent processing (Elwan et al., 2019; Keat & Khaidzir, 2011; Keith et al., 2001; Kranzler et al., 2000; Naglieri et al., 2003; Nishanimut & Padakannaya, 2014).

Previous Research on L2 Reading Comprehension Using WhatsApp

In a comprehensive review of reading comprehension using mobile technology, Gutiérrez-colón et al. (2020) presented an overview of mobile device utilization to enhance L2 learners' reading comprehension. Using electronic search, they extracted 44 relevant articles published on the Web of Science during 2012-2017. Of the 44 relevant papers, 17 of them mention the significant improvement of learners' L2 reading using mobile devices. Most of the studies implemented experimental or quasi-experimental with pretest and posttest designs, and some also assessed learners' attitudes and opinions. It seemed that teaching reading comprehension using mobile devices was better than the traditional instructions. Learners also like to read from mobile devices because of their ubiquity and flexibility merit. Ahmed (2019) investigated WhatsApp's effectiveness in enhancing learners' reading and writing at Radfan College, Yemen. The results indicated that WhatsApp was influential in developing L2 learners' reading and writing skills. It provided unlimited space for them to practice written communication naturally outside the influential room. It also motivated them to learn collaboratively.

In Ecuador, Laje & Dave (2020) conducted a similar study using the WhatsApp group as a medium to enhance learners' specific reading strategies, namely, skimming and scanning. The results of an action research study revealed that the collaborative learning facilitated by WhatsApp could enhance learners' reading ability. Collaborative activities via WhatsApp group also fostered their skimming, scanning, and online participation and reduced anxiety. It appeared that the WhatsApp texting facility took a more significant part of learners' confidence than its voice and video menus. Meanwhile, WhatsApp's collaborative reading activities provide opportunities for them to discuss and learn transfer from peers.

Some scholars investigated WhatsApp's impacts on learners' reading comprehension from elementary to college levels using different research designs in the Indonesian education context. Two studies applying the action research approach at elementary and senior high school levels reported positive impacts of WhatsApp on learners' reading comprehension and inference abilities (Anandari & Iswandari, 2019; Delfi & Yamat, 2017; Milal et al., 2021). WhatsApp to teaching reading comprehension to elementary learners, but one study applying an experimental design reported no significant differences in comprehension scores between the college learners who were taught using WhatsApp and traditional approaches (Susanti, 2020).

Previous studies in the realm of teaching reading via mobile technologies, including WhatsApp and similar platforms, have predominantly focused on enhancing comprehension skills, neglecting the cognitive processes involved in L2 learners' reading comprehension. Consequently, the present inquiry aims to address this gap by delving into both the improvement of L2 learners' reading comprehension and cognitive processes through the use of the WhatsApp application. This study endeavors to answer two crucial research questions: firstly, to investigate potential variations in reading scores between learners instructed through WhatsApp reading groups and those participating in the traditional group-driven reading approach, and secondly, to explore differences in the cognitive processes of learners during the reading comprehension process across these two instructional methods.

METHOD

Design and procedures

This study can be classified as a mixed design combining experimental and quantitative approaches. Firstly, a quasi-experimental design with a non-equivalent control group and pretest/post-test design was implemented to find any significant difference in reading comprehension scores between EFL learners taught using a Small WhatsApp Group-driven Reading (SWAGR) and Small Traditional Group-driven Reading (STGR). Subsequently, two replicas of experimental groups similar in English proficiency and classroom atmosphere were applied.

Second, a qualitative thematic analysis was consecutively performed to draw learners' cognitive reading processes. Furthermore, both experimental and control groups were administered a pretest followed by six weeks of treatment and a posttest using reading test part 7, which contains 48 multiple-choice questions taken from the TOEIC test. After the pretest session, eight sets of PISA reading passages and their questions were employed during the study (Araújo et al., 2021).

There were two types of experimental groups in this study. First, the small WhatsApp group-driven reading (SWAGR) received a set of PISA reading passages and their questions every week via the WhatsApp group. This SWAGR should discuss the process of comprehending the texts and answering the questions collaboratively using their WA groups. Then, reporting the discussion process and answers to their teachers' WA. This group was only permitted to look for unfamiliar words from their mobile dictionary. To monitor the learners' WA group's online discussion process, the teacher joined each WA group.

Second, the small traditional group-driven Reading (STGR) received a set of printed PISA reading passages and their questions every week. Then, they discussed the process of comprehending the passage and answering the question using traditional face-to-face discussion and submitted the written reports to their teacher. This group was only allowed to look for unfamiliar words using a printed dictionary. To monitor the face-to-face discussion processes, the teacher joined each learner group at every meeting. The summary of the instructional design is shown in Table 1 below.

Table 1
The Summary of Instructional WA-driven Reading Design

Stage	**Small WhatsApp Group-driven Reading (SWAGR)**	**Small Traditional Group-driven Reading (STGR)**
Stage 1 Introduction (Week 1)	The students were introduced to the study designs, rules, teaching, and learning practices using small WA and traditional-driven reading.	
	The teacher created five WA groups. Each WA group consisted of four to five learners and the teacher.	The teacher created traditional groups. Each group consisted of three learners.
(Week 2)	Pretest	
Stage 2 Implementation (Week 3 to 8)		
(Week 3)	• PISA reading one entitled *The professor's log* file with 7 item questions were sent to each learner's WA group. • Cognitive process: Access and retrieve information within a text • Simple multiple-choice format • PISA reading two entitled *The professor's blog* file document and its question was sent to each learner's WA group.	• PISA reading 1, entitled. *The professor's blog* with 7 item questions was printed and administered to the learner's group. • Cognitive process: Access and retrieve information within a text • Simple multiple-choice format • PISA reading two entitled *The professor's blog* and its question was printed and administered to the learner's group.
(Week 4)	• Cognitive process: Represent literal meaning • Open response format • PISA reading 3 entitled *Review collapse* file document and its question was sent to each learner's WA group.	• Cognitive process: Represent literal meaning • Open response format • PISA reading three entitled *Review collapse* and its question was printed and administered to learner's group.
(Week 5)	• Reflect on content and form • Complex Multiple Choice • PISA reading four entitled *Science News* file document and its question was sent to each learner's WA group.	• Reflect on content and form • Complex Multiple Choice • PISA reading four entitled *Science News* and its question was printed and administered to learner's group.
(Week 6)	Access and retrieve information within a text. • Simple multiple-choice format	• Access and retrieve information within a text. • Simple multiple-choice format
(Week 7)	• PISA reading five entitled *The professor's blog* file document and its question was sent to each learner's WA group. • Integrate and generate inferences across multiple sources • Complex Multiple Choice	• PISA reading five entitled *"The professor's* blog" and its question was printed and administered to the learner's group. • Integrate and generate inferences across multiple sources • Complex Multiple Choice
(Week 8)	• PISA reading six entitled *The professor's blog* file document and its question was sent to each learner's WA group. • Detect and handle conflict • Open Response format	• PISA reading six entitled *The professor's* and its question was printed and administered to learner's group. • Detect and handle conflict • Open Response format
Stage 3 Assessment (Week 9)	Post-test Focus group interview	

A total of 42 L2 learners (19 males and 23 females, ages 20 to 22) who attended an Intensive Reading Course (IRC) in the first semester at the English Language Education Department (ELED) from a well-established private university in Gresik participated in this study. This study was applied to the first-semester students since they did not receive-semester students since they had not received any reading classes before. As part of the university curriculum, the reading course was distributed into four different semesters. From the first to the third semester, the learners were taught intensive reading, extensive reading, and academic reading. Meanwhile, in the fourth semester, they took a teaching reading course. The study participants were classified into two equal classes using university entrance and placement tests. Based on the previous research project, the learners who obtained test scores ranging from 6.5 to 7.5 were selected as the study participants. The participants were then randomly assigned to two different groups. The first 21 learners were plotted as Small WhatsApp Group-driven Reading (SWAGR). The second group consisted of 21 learners who were labeled as Small Traditional-driven Reading (STGR).

Data Analysis

The L2 learners' answers to the reading comprehension tests were coded based on their correct options in the multiple-choice format for every question from the TOEIC test, consisting of 48-multiple-choice questions, seven single passages, and four pairs of doubled passages (Wang & Wang, 2016). The reliability score was calculated using Cronbach's alpha, and the value was reported to be 0.846.

Descriptive statistics tests were initially utilized to examine data distribution and average scores in the study. Subsequently, the one-sample t-test was employed to assess the reading comprehension scores within each group from the pre-test to the post-test phase. Furthermore, an independent sample t-test was utilized to compare the reading comprehension scores between the experimental group (SWAGR) and the control group (STGR). Concurrently, the qualitative analysis of learners' cognitive processes during reading comprehension tests was conducted through focus group interviews. This qualitative research method involved structured discussions with small groups of individuals sharing relevant characteristics or experiences. The focus group interviews specifically addressed aspects such as retelling, application of textual information to reading questions, and the answering process, facilitating a thematic understanding of learners' cognitive approaches (Vanbecelaere et al., 2012).

FINDINGS

The first objective of this research was to measure whether there was a significant effect found among the L2 learners who were taught reading using the small WhatsApp (WA) group and those who were taught the exact reading comprehension using the small traditional group on their reading comprehension abilities. A set of reading tests was administered to respond to this first study's aim, followed by normality, homogeneity, and t-tests to interpret the data. The normality test results from the two different reading instructional designs, namely small WA group-driven reading and small traditional reading groups, were statistically calculated in the following table.

Table 2

Normality test

	Small WhatsApp Group-driven Reading (SWAGR)		**Small Traditional Group-driven Reading (STGR)**	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
N	21	21	21	21
Sign. (2-tailed)	.248	.512	.312	4.17

*significant at p < .05.

Table 2 describes the result of the normality test calculation, both from SWAGR and STGR cohorts. The index scores (sig 2-tailed) from the SWAGR in the pre-test and post-test with N=21 were .248 and .512. Meanwhile, the index scores (sig 2-tailed) from the STGR within the same number of the sample were .312 and 4.17. Since the normality test results from the two groups were more extensive than the Alpha coefficient of 5%, the two groups' data were categorized into a normal distribution. It could be said that the research samples of both cohorts were generally distributed in terms of English scores.

Table 3

Normality test

Levene's statistics	df1	df2	Sig.
2.168	1	.67	.146

*significant at p < .05.

Table 3 illustrates the result of a homogeneity test from the two cohorts. Levene's statistical calculation indicated 2.168, and the p-value (sig) was higher than the Alpha coefficient levels (5%). Therefore, the homogeneity of the data was confirmed.

To address the differences in L2 learners' reading comprehension scores between the two different groups of reading instructions, an independent t-test was applied. The t-test results from the two different reading instructional designs, namely small WA group-driven reading and small traditional reading groups, were statistically illustrated in the following table.

Table 4

Independent t-test results

		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
									Lower	Upper
Mean Score	Equal variances assumed	0.33	.857	6.147	48	.000	.92000	.14967	.61908	1.22092
	Equal variances not assumed			6.147	47.455	.000	.92000	.14967	.61899	1.22101

Table 4 depicts the results of the independent sample t-test. The table illustrates that the significant value level (sig. 2-tailed) was .000 below the Alpha coefficient (5%). As a result, it was verified that there was a significant difference between L2 learners' reading comprehension scores who were taught using small WA group-driven reading and those taught using small traditional-driven reading activities.

Table 5

Mean score comparison between the two groups

	N	**A Reading Group**		**Change**	**Traditional Reading Group**		**Change**
		Pre-test	**Post-test**		**Pre-test**	**Post-test**	
Represent literal meaning	21	56.16	74.74	18.58	55.42	61.02	05.06
Integrate and generate inferences	21	55.31	73.44	18.13	54.02	60.17	06.15
Total scores	21	55.73	74.09	18.35	54.72	60.79	05.65

Table 5 represents the differences in the mean scores obtained from both SWAGR's and STGR's pre-test and post-test. The above table confirms that the learners who were taught using small group WA group-driven reading(SWAGR) activities performed better in the reading comprehension test than the learners who were taught using small traditional-driven reading (STGR) since the obtained scores from the pretests (41.97 and 38.78) to post-tests (68.19 and 54.72) were significantly different.

To address the second research question on L2 learners' cognitive process from the two groups, L2 learners' cognitive process in reading was analyzed using Van Den Broek & Espin (2012) cognitive interview protocol, which contained four primary categories: interpretation probe, paraphrasing, available probes, and clarification. The interview was conducted with all groups from the two different reading interventions (WA and traditional reading groups) while discussing the passage with their group. The questions derived from the above categories, such as "can you repeat the questions using your own words?", "How did you arrive at that answer?" and "I noticed that you hesitated; tell me what you were thinking?" were translated into Bahasa to make it easy to get the natural learners' understanding and cognitive processes.

The first cognitive process aimed at matching the paraphrase and representing literal meaning from the passage of "Ivana_88's initial question to the options in the item" (Is it okay to give aspirin to my hen?). The WA group's answer to this literal reading question was mainly true, but only one learner whose answer was incorrect. Those two different answers are shown in the following figure.

Figure 1

Cognitive Processes in Comprehending Literal Meaning - WA Reading Group

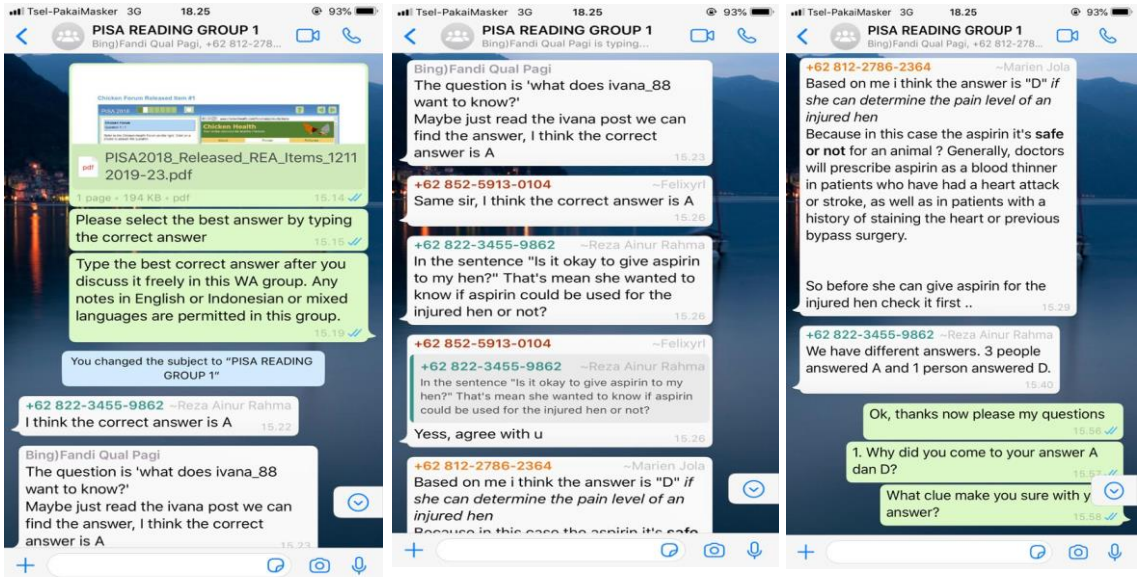

Figure 1 represents learners' cognitive process in understanding the literal meaning of the passage entitled "Chicken Health." The students who answered correctly preferred to choose A as their best option. This group could understand the contents of the blog's conversations very well by paraphrasing using their own words to represent the intention of Ivana_88's question. They also looked at other bloggers' responses in the conversation to come up with their correct decision. Therefore, connecting the Ivana_88 blog's question and other bloggers' messages became an essential step for this group to answer the question correctly. Conversely, one student whose answer was not correct, as shown in the WA chat history could not understand the message from the bloggers' members. This student's cognitive process only relied much on the veterinarian/doctor blog's message. As a result, he/she matched the perceived information from the blogs to the question and came up with the incorrect answer (option D).

The following figure illustrates the same purposes of L2 learners' cognitive processes to represent literal meaning from the traditional reading group.

Figure 2.

Cognitive Processes in Comprehending Literal Meaning - Traditional Reading Group

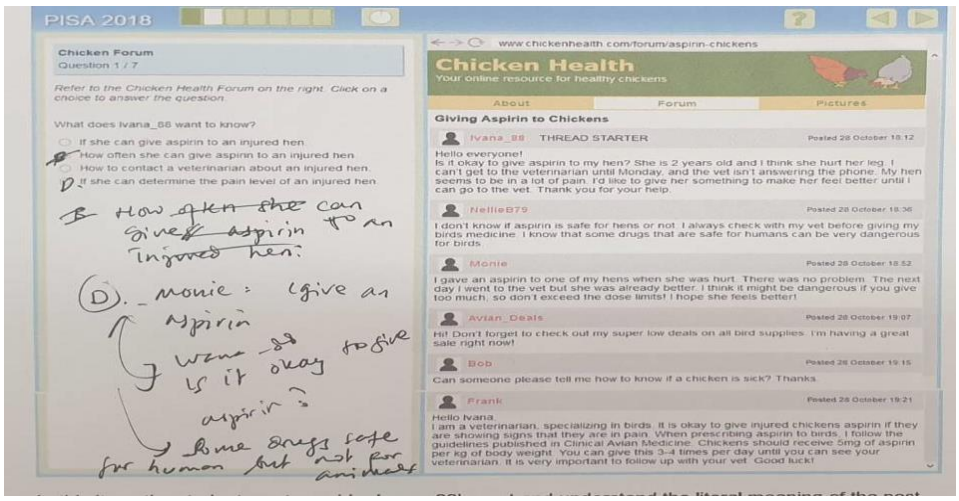

Figure 2 describes the cognitive process from the traditional reading group responding to the same comprehension question or representing literal meaning from the exact text. The answer of this group, as seen from the printed notes, indicated the incorrect answer. This group also felt doubtful in selecting their best answer, either the C or D option. They came up with this answer from Monie's

message blog telling that she had ever given aspirin to her injured chicken. Consequently, they interpreted it to determine the level of an injured hen. Similarly, through Ivana's and the veterinarian's blogs, it seemed that they were talking about the use of aspirin for recurring injured animals. During the observation process, most of them also discussed similar difficult words from this passage. The second cognitive process aimed to introduce learners' cognitive processes in integrating and generating inferences from another reading passage entitled "The Galapagos' Island – A Natural Treasure." This passage's question required them to find critical differences in the researcher's approaches in the conservation programs. The following figure represents the cognitive process from the learners' WA and traditional reading groups.

Figure 3

Cognitive Processes in Integrating and Generating Inferences - WA Reading Group

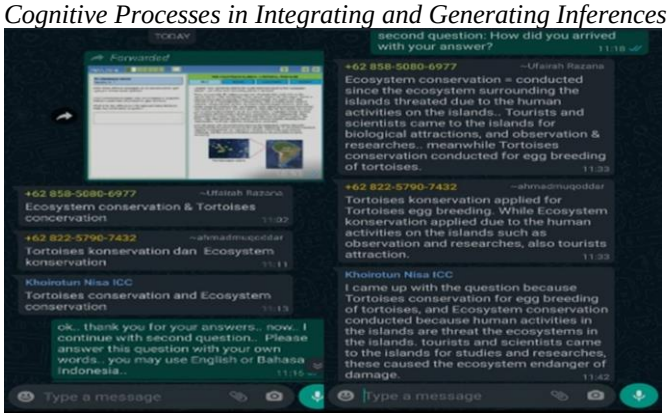

Figure 3 depicts learners' cognitive process from the WA reading group in addressing an open-ended comprehension question. The question required them to answer two different approaches in the conservation program. The WA group's chat histories indicated that their answers were correct since they mentioned that the two different approaches were tortoise conservation programs (breeding) and ecosystems. This group arrived at this correct answer by reading the passage's details and understanding the plot of the passage from the chat histories. They also asserted that the implied questions needed a logical story interpretation. They interpreted the different approaches from the tortoise breeding success story and ecosystem conservation stated at the end of the paragraph. They connected their interpretation, plot, and critical analysis for the interpretive question types. This group seemed to discuss the passage's content from the chat histories before they came up with a final answer. Therefore, they preferred to use their logical and chat messages as supporting indicators for comprehension. No word-by-word translation was performed since the meaning of the problematic words had been written in the chats.

Figure 4

Cognitive Processes in Integrating and Generating Inferences - Traditional Reading Group

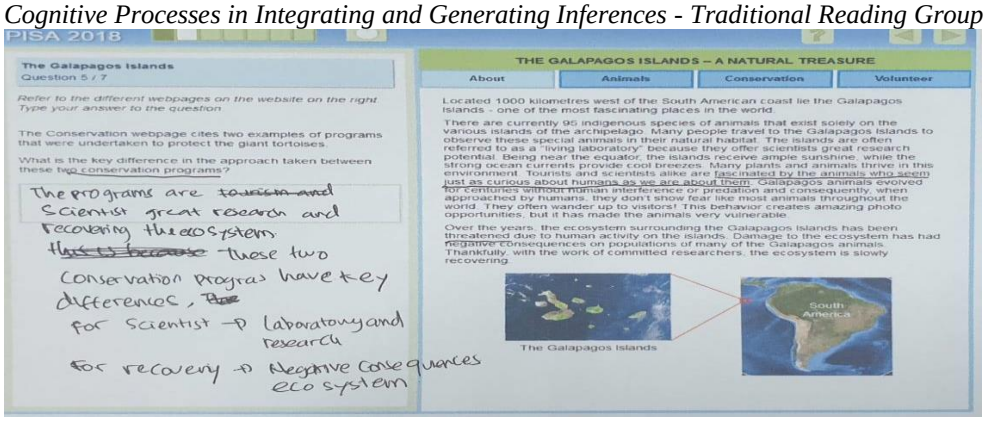

Figure 4 illustrates learners' cognitive processes from the traditional reading group in understanding, integrating, and generating inferences. The questions asked about two types of conservation programs from the passage. The relevant answers required a conservation program for Tortoises and a conservation program for the ecosystem, but the above figure shows that learners

could not derive correct inferences from the passage since they only took some crucial keywords from the passage. Their opinions answers were "The programs are scientists' great research and recovering the ecosystem." Their first program was incorrect since they read the passage and found a researcher who researched Tortoises without understanding the details. Therefore, they came up with the incorrect answer. Differently, the second program was nearly correct since it involved ecosystem recovery. This answer was implicitly stated at the end of the passage. The above-underlined words also did not indicate and lead to the correct answers. From the observation, most of the reading group learners tended to find the exact unfamiliar words. Afterward, they discussed the passage and sometimes looked at the problematic translated word again for content interpretations. It seemed every individual had the power to self-comprehend the passage and discuss the answer at the end of the activities.

DISCUSSION

This study aimed to explain L2 learners' reading comprehension abilities and explore their cognitive processes between L2 learners who were taught using WA reading groups and those taught using traditional reading groups. The study results asserted L2 learners' reading scores in the WA reading group were higher than in the traditional reading group in terms of literal and interpretive comprehension. Similarly, the WA reading group's literal comprehension score gain was also higher than their interpretive comprehension. In terms of L2 learners' cognitive processes, the findings echoed different cognitive processes in comprehending literal and critical reading comprehension. The cognition processes of L2 learners in the WA group were shown more comprehensively when they were reading in their WA group, involving finding the main idea, interpreting the passage and question using their own words, and addressing the question. Conversely, the cognitive processes of the traditional reading group tended to be less comprehensive when they were collaboratively reading the printed texts in their group involving This involved reading the questions, translating words, reading the passage, partially interpreting the passage, attempting to predict or guess possible answers, and rechecking their answers within the passage.

The first discussion dealt with the difference in reading comprehension scores between the two different reading group strategies. Reading activities via the WA group offered many benefits, such as group ubiquity, flexibility, and chat history merits. Learners in the WA reading group are free to discuss and read the passage anytime and anywhere. Although the merits of WA in L2 instructional practices have been acknowledged by previous researchers, such as providing its ubiquity and practicality, and but relatively few studies took advantage of the WA chat histories to monitor and (Arifin et al., 2022; Barianty et al., 2022; Maruf & Anjely, 2020) assess learners' cognitive learning during reading collaboration processes. These points are the novelty of this study since they were not discovered in the aforementioned previous studies. As shown during the WA collaboration process, learners made use of their WA chat histories to comprehend the passage's contents during the online discussion process. Leaners in the WA group used their group's chats as a medium of crosschecking and self-assessing their ideas whether their ideas were acceptable or not. Meanwhile, the traditional group could not take advantage of these benefits. The discussion process from the traditional reading discussion relied on the group's verbal chats, which usually were not written, only listened, and sometimes were neither listened nor understood well. Regarding these notions, Schwering & MacDonald (2020) and Özer & Göksun (2020) asserted that comprehending verbal information could be more difficult than the written forms since the verbal provides short-term processing compared to the written ones. Only those who took notes and gave serious attention to their members could discuss, crosscheck, and reflect on their ideas. These activities did not appear in the traditional reading group discussion. Their cognitive processes tended to be individually ego-centric (these findings did not appear from previous studies) rather than discussing the ideas from the traditional reading group members. Individual capacity in comprehending the different ideas with no written notes made it hard to respond to all ideas that emerged from the group during the reading collaborative process (Judy Shih & Huang, 2020; Soto et al., 2020). The studies conducted by two different researchers, Soto et al. (2020) and Judy Shih & Huang (2020), proved that learners performed better in comprehending cognitive activities involved in logical interpretation during collaborative reading activities. This discussion strengthened the importance of written notes, which provided a more intensive cognitive process since all learners in the WA group could read, re-read, discuss, and self-check to compromise the correct answer from the passage.

The second discussion dealt with the cognition process between the two different WA and traditional reading activities. The findings also revealed that the WA group's cognitive processes involved finding the main idea, interpreting the passage and question using their own words, and answering the question. These activities occurred because each member of the WA reading group could commonly discuss the problematic words in the WA group with their meaning and then share their interpretations of the passage content via WA

chats. Therefore, some learners just used their cognitive functions to interpret the passage's contents using the clues/ideas from the chat messages histories, and they did not feel it necessary to read all the content verbatim because they had 'interpretation clues' in their WA chats. Therefore, most of the WA reading group members performed better in their reading comprehension, and their cognitive process involved shorter stages than the traditional reading group as they did not need to read word by word. In this case, the cognitive functions' role relied much on the group's chat messages or written messages and logical interpretations from them. This evidence was another merit of applying the WA reading group to interpret the L2 cognitive process in reading using group chat history.

Moreover, the traditional reading group's cognitive process in reading comprehension was longer than the opponent group's. "It involved reading the question and passage several times to find the possible answer through direct guessing, if possible, interpret the passage partially by translating the unfamiliar words where each member also tried to find words translation and rechecking their answer from the passage for their final decision. Less compelling evidence was shown from the traditional reading group discussion process while translating the unfamiliar words from the passage done by every member of a traditional reading group member. The possible question was why everyone should find the same difficult word during the discussion process if every difficult word could be shared at once by the group member who had already found the meaning so that the rest of the learners did not do the same things. This evidence also showed that the traditional reading group performed less effective strategies in the discussion process. Again, this evidence also re-strengthened that the WA chat messages/histories played an essential role in the practical reading discussion and cognitive process in reading.

One of the potential limitations of the study rested on the learners' background knowledge, such as vocabulary mastery and heterogeneity of the groups' distribution, which may be unequal and influence the intervention results of the cognitive and comprehension process as research showed that vocabulary mastery and groups selection and distribution significantly influence learners' reading comprehension and collaborative learning (Chung & Bidelman, 2021; Crosson et al., 2021).

CONCLUSION

The outcomes of this study underscored the heightened efficacy of learners' cognitive processes when engaged in reading through the WA group, outperforming those in the traditional reading group. Notably, the superior reading comprehension scores achieved by the WA reading group were intrinsically tied to the distinct cognitive approach cultivated during online collaborative reading. The visualization of cognitive process effectiveness within the WA group unveiled a strategic emphasis on logical interpretations derived from passages and questions. These findings hold substantial pedagogical implications, spotlighting the imperative need to prioritize learners' passage interpretation and cognitive capacities over mere textual comprehension and word-meaning assimilation in reading instruction.

The study's pedagogical implications advocate for a structured approach to teaching reading comprehension, emphasizing the optimization of learners' cognitive abilities in interpreting passages. A critical facet of this approach involves delineating specific roles for each group member during collaborative reading, facilitating a conducive environment for sharing unfamiliar words among students within the WA group. Central to the art of collaborative reading is the deliberate cultivation of a discussion space where learners transcend individual egos, each contributing their unique perspectives to decode passages and reflect logically on their interpretations collectively. Moreover, this study underscores the pivotal role played by cognitive processes in bolstering learners' reading comprehension abilities, emphasizing the necessity of integrating cognitive engagement during reading activities.

In essence, these findings emphasize the paramount importance of nurturing cognitive processes during reading, particularly within collaborative contexts facilitated by technological platforms like WA. They advocate for a pedagogical shift towards elevating learners' interpretative abilities and cooperative engagement over surface-level comprehension, reinforcing the pivotal role of cognitive processes in shaping proficient reading comprehension skills.

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