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Self-directed extensive reading with social support: effect on reading and learning performance of high and low English proficiency students

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Abstract

To promote the development of students' reading literacy and learning skills in the k-12 setting, this study introduced an online extensive reading (ER) environment with self-directed learning (planning, monitoring, reflection) and social (discussion forum participation) support. This study aimed to examine whether planning behavior and discussion forum participation were associated with English learning performance over one school year in the online ER environment. Mediation analysis indicated that the ER engagement (i.e., e-book reading amount) partially mediated the effect of planning behavior on English performance, and the ER engagement fully mediated the effect of discussion forum participation on English performance. To follow up, the study investigated high and low English proficiency students and the effect of their ER engagement on English reading speed and learning performance. A within-group comparison revealed that high English proficiency students with high ER engagement gained reading speed significantly faster than those with low ER engagement; however, the difference in their English performance was not significant. For the low English proficiency students, there was no significant difference in their reading speed between high and low ER engagement groups, but high ER engagement students achieved significantly higher English performance than those with low ER engagement. These findings contribute to the understanding of the role of self-directed learning behavior and social behavior on reading engagement and how it affects English learning performance for high and low English proficiency students over a long-term duration.

Keywords: Extensive reading, Learning behavior, Learning analytics, Self-directed learning, Discussion forum

Introduction

Reading skills are an important aspect of academic and life success for school-age youth, and are associated with academic performance and the development of life-long learning skills (Carroll et al., 2011; Kim et al., 2012). Young learners require a great amount of reading exposure to develop their reading skills in EFL (English as a Foreign Language) settings. Extensive reading (ER), reading with exposing learners to large quantities of material within their linguistic competency, has been evidenced as one of the most effective methods for developing reading skills and language competency (Day & Bamford, 2002; Grabe, 2010; Grabe & Stoller, 2011). Unlike intensive reading or close reading, which focus on analyzing short, complex texts, ER provides students a more pleasure experience with large amount of comprehensible, enjoyable books, leading to improvements in vocabulary acquisition (Aka, 2019; Suk, 2021), reading fluency (Al-Homoud & Schmitt, 2009; McLean & Rouault, 2017), reading strategies (Huang, 2013; Urquhart & Weir, 2014), and general foreign language proficiency (Milliner, 2017; Sun et al., 2016).

The effects of ER were primarily examined from print-based book reading in previous studies (Beglar & Hunt, 2014; Day & Bamford, 2002; Tanaka, 2017). However, little is known about the effects of ER using technology in online learning environments, even less among adolescent EFL learners in the long-term duration (Cote & Milliner, 2015; Jeon & Day, 2016). Compared with traditional print-based ER, online ER provides learners easy access to a wealth of reading resources and allows them to read at their own time and pace. However, young learners have trouble managing the ER resources and learning process by themselves because of self-management in various reading resources, content understanding, and self-evaluation in language gains (Day & Bamford, 2002; Lake & Holster, 2014). They also lack the opportunity for communication with peers as well as instructors online without digital communication tools support than face-to-face classes, leading to dropout problems and failure in learning (Davies & Graff, 2005; Goggins & Xing, 2016). To tackle these significant challenges of online ER, this study adopted a self-directed extensive reading (SDER) environment with social discussion support. Students can read a vast amount of e-books using an interactive e-book system, manage their learning process by a self-directed learning (SDL) support system, and share their reading experience with peers in a discussion forum.

Previous studies have shown that reading engagement plays a crucial role in academic achievements in the online learning environment (Chen et al., 2022; Rashid & Asghar, 2016). Reading engagement can be referred to the interaction with text in ways that are both strategic and motivated (Guthrie et al., 2012). When students are heavily engaged in their reading, they will have more opportunities to acquire better reading performance and boost their learning performance. Although several empirical studies have confirmed the positive impact of reading engagement on English performance in online reading

environments, the specific effects across different student proficiency levels have not been well explored. Previous research has shown that individual differences in pre proficiency could affect students' reading and English learning performance (Aka, 2019; Jeon & Yamashita, 2014). By examining potential differences in how reading engagement impacts students at varying proficiency levels, we can gain maximal benefits from increased reading engagement and provide more targeted interventions to students.

The purposes of this study are therefore twofold. First, this study examines the association of planning behavior of self-directed learning and discussion forum participation of social interaction with English learning performance in the online support environment. This could contribute to a better understanding of the role of technology support in reading engagement and learning performance in online learning. Second, this study investigates the effect of online ER engagement on reading performance in terms of reading speed and English learning performance for the high and low English proficiency groups. Understanding the effect of ER engagement for students at different levels of English proficiency will help instructors and school administrators to prepare appropriate support in different groups. This study will address the following research questions:

1. How does ER engagement mediate effects of planning behavior and discussion forum participation on English learning performance?
2. What are the effects of ER engagement on reading performance and English learning performance in high and low English proficiency groups?

Literature review

Self-directed extensive reading in online learning environments

Reading is an essential skill for successful academic performance (Kim et al., 2012). Proficient readers tend to read more than novice readers, further improving their reading ability, increasing their knowledge and vocabulary, and reinforcing language learning skills (Cunningham & Stanovich, 1997). To become a skilled reader, learners require considerable amounts of repeated input and develop habitual processing of that input. Extensive reading (ER) has been proposed as one of the most effective methods for developing reading skills and language competency in the EFL research area (Day & Bamford, 2002; Grabe, 2010). ER can expose learners to ample amounts of meaningful input, motivate learners to read, and lead to the development of fundamental components in reading, including decoding and reading comprehension (Grabe & Stoller, 2011).

Compared with traditional print-based ER, online ER provides learners easy access to a wealth of reading resources and allows them to read at their own time and pace, thus making it more suitable for reading in an autonomous way (Coiro & Dobler, 2007; Milliner, 2017). However, there are specific challenges faced by young students in the online ER

environment. One of the key challenges is how to maintain online reading regularly by the students themselves (Day & Bamford, 2002; Lake & Holster, 2014). The lower constraints of online reading necessitate self-directed learning by students. Self-directed learners are required to take responsibility for initiating, planning, monitoring, and reflecting on their learning. Previous studies indicated that students' self-direction failures led to poor academic achievement (Michinov et al., 2011; Rashid & Asghar, 2016). To address this significant challenge, researchers have suggested to adopt different self-directed learning strategies in the online learning environment (Arnold, 2009; Lai et al., 2022; Lake & Holster, 2014). During self-directed reading, learners can set their reading goals and then monitor and reflect their cognition, motivation, and behavior for achieving their reading goals. Goal-setting and planning play a leading role on self-direction and self-regulation in online reading (Cleary & Zimmerman, 2004, Klimas, 2017). Several studies (e.g., McLean & Rouault, 2017; Suk, 2017) have implied that setting a reading goal facilitated more reading. Helping students create their own goals transfers responsibility for the success or failure of the activity from the instructors to the students. The cycle through the effective use of goal-setting assisted in continuously enhancing students' perceived achievement, intrinsic motivation, and self-efficacy. Because of the lack of research on students' goal-setting behaviors in self-directed reading from trace data, more exploration is needed. It would be helpful to promote efficient self-directed reading if we gain more understanding of the goal-setting strategy from a behavioral perspective.

Extensive reading and social support in online learning environments

Social Cognitive Theory (Bandura, 1986) shows that cognitive factors, environmental factors and human behavioral factors interact with and influence each other. Social interaction as an environmental factor can potentially influence the cognitive and behavioral engagement during ER (Kew & Tasir, 2021). Unlike face-to-face learning, there is less opportunity for communication between learners without high-quality communication tools and also less time pressure on them in online learning environments. The lack of online interaction leads to dropout problems, students' feelings of isolation, low learning satisfaction, and failure in learning performance (Davies & Graff, 2005; Yuan & Kim, 2014).

Research has found that the social factor played an important role in learners' engagement and performance in online learning contexts (Alzahrani, 2017; Huang et al., 2019). The online discussion forum was commonly used in online learning since it had benefits for learners and instructors (Goggins & Xing, 2016). Online participation could not only facilitate knowledge acquisition and construction but also enhance social presence on a social connection (Kent et al., 2016). Both knowledge construction and social interaction in online discussions contributed to the learning outcomes (Kent et al., 2016;

Naranjo et al., 2012). Learners' behavior could be influenced by the structure of discussion forum and the instruction of the discussion prompts when they post and respond to asynchronous online discussions (Burke et al., 2024). Research highlights the socio-emotional interactions play an important role on richer and deeper online discussions (Li & Yu, 2020).

Extensive reading engagement, reading performance, and learning performance

Guthrie et al. (2012) defined reading engagement as interacting with text in ways that are both strategic and motivated. Reading engagement is involved in behavioral, cognitive, emotional, and social engagement from the text (Lee et al., 2021). Previous studies mostly focused on observations and interviews but few studies utilized the trace data to measure students' reading engagement (Lee et al., 2021). Furthermore, the relationship between reading engagement and learning performance was mostly studied in the offline setting but there is relatively little research on the relationship in the online setting (Cote & Milliner, 2015; Jeon & Day, 2016). In this study, reading engagement was measured by the trace data from an e-book reader in terms of the amount students read e-books. The investigation on the relation between reading engagement and learning performance was conducted in online self-directed learning settings.

A number of studies have suggested that ER is one of the most effective ways of promoting reading speed as reading performance (Al-Homoud & Schmitt, 2009; Day & Bamford, 2002; McLean & Rouault, 2017). During ER, learners have more opportunities to rapidly decode the words and phrases that they have seen before, and increase their comprehension processes. Previous researchers have also reported that the development of reading speed was influenced by the level of reading skills of child and adolescent students (Klauda & Guthrie, 2015; Landerl & Wimmer, 2008). Therefore, there is a need to examine how ER affects young learners' reading speed at different levels of English proficiency in the online learning environment.

Learners can also gain a general understanding of content knowledge and acquire different aspects of language ability through ER, and thus ER has a great potential to improve their general English learning performance (Milliner, 2017; Sun et al., 2016). However, evidence has demonstrated that individual differences in pre-English proficiency could affect EFL learners' post-test performance (Aka, 2019; Jeon & Yamashita, 2014). Since the specific effects of ER on learning performance across different student proficiency levels have not been well examined, it will contribute to the understanding of students' general language development by investigating the effects of ER on English learning performance at different levels of English proficiency.

Method

Study design

Figure 1 shows the design of this study. In the beginning, the students were introduced to four key principles for self-directed ER: read easy materials without dictionaries, self-select what they want to read, read as much as possible, and take responsibility to set their own goals. They were then given instructions on how to select appropriate e-books, read e-books interactively, and manage their reading plans regularly. From the first to the tenth month, the students selected and read e-books by themselves in an e-book reader called BookRoll using their tablet computers. Especially, they were asked to read e-books at the beginner level of A1 in CEFR (Common European Framework of Reference for Languages) in the first and final months in order to compare reading speed at approximately the same CEFR level. They were encouraged to set their weekly or monthly plans for ER activity at their own pace in an SDL support system called GOAL. They were also reminded to share stories and favorite sentences and discuss their feelings about the stories with their classmates in the LMS discussion forum each month. Both students' planning and discussion form interactions were optional. All the instructions were designed by researchers and they were conducted by their English teacher. All the reading activities were automatically recorded by the BookRoll e-book reader and the SDL interactions between the students and the GOAL system were also automatically tracked during the experimental duration.

At the beginning of the experiment, the students took a test to measure their level of English proficiency, which was prepared and evaluated by their English teacher. The English proficiency test consisted of listening, vocabulary, grammar, and reading

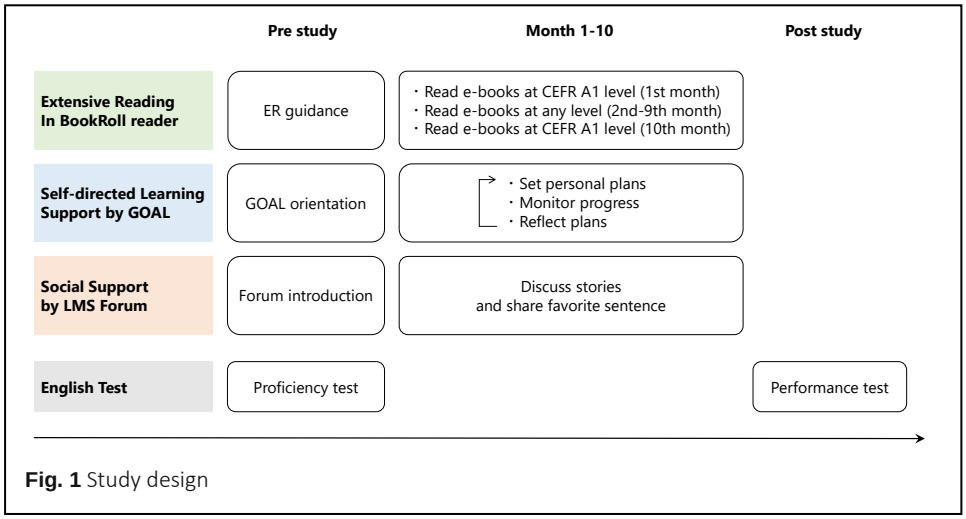

Fig. 1 Study design

comprehension domains and the test items were evaluated by the school each year. At the end of the experiment, students' English performance was assessed through their final standardized English exam administered by the school. The final standardized English exam was in a 100-point scale and consisted of five different sections: listening comprehension, vocabulary, grammar, reading comprehension, and writing with 36, 13, 12, 13, and 26 points, respectively.

Participants and contexts

A total of 115 seventh graders (46 boys and 69 girls) aged around 13 years old in a public junior high school in Japan participated in this study. They were from 3 classes and instructed by the same experienced English teacher, who had more than ten years of teaching in EFL.

Students engaged in extensive reading inside and outside of the school using BookRoll. The e-books were from more than 500 graded readers, which predominantly from the Magic Adventures series, the Vera the Alien Hunters series, the School Adventures series, and the Classic Readers series published by e-future. The levels of e-books were from level pre-A1 for beginners to level B2 for upper intermediates in CEFR.

Online extensive reading support environment

Figure 2 shows the environment of self-directed extensive reading with social support. It consists of a learning management system like Moodle, a linked e-book reader named BookRoll, and a linked SDL support system named GOAL. The BookRoll is used to execute ER activities by students, the Moodle is offered to engage students to discuss ER activities, and the GOAL system is provided to support their SDL for ER, such as planning for ER.

The BookRoll e-book reader is designed to access e-books or lecture slides inside or outside of the classroom. The user interface supports a variety of operations, such as: moving to the next or previous page, jumping to a specific page, adding an electronic bookmark, making markers in yellow or red, creating memos at the page level, or searching keywords in the e-book. All operations of the readers are recorded in the learning record store (LRS). With the help of BookRoll, students' reading behaviors are collected, including the reading pages, words, and time.

The GOAL system (Li et al., 2021) is a platform to support students' development of SDL ability. It can be launched through the Learning Tool Interoperability (LTI) (IMS Global Learning Consortium, 2019) in a typical LMS such as Moodle. It synchronizes automatically learning activity data from the LRS, which stores the learning logs of the BookRoll e-book reader. The contextual information is aggregated from learning activity data as various contextual indicators with hourly, daily, and weekly scales, such as daily

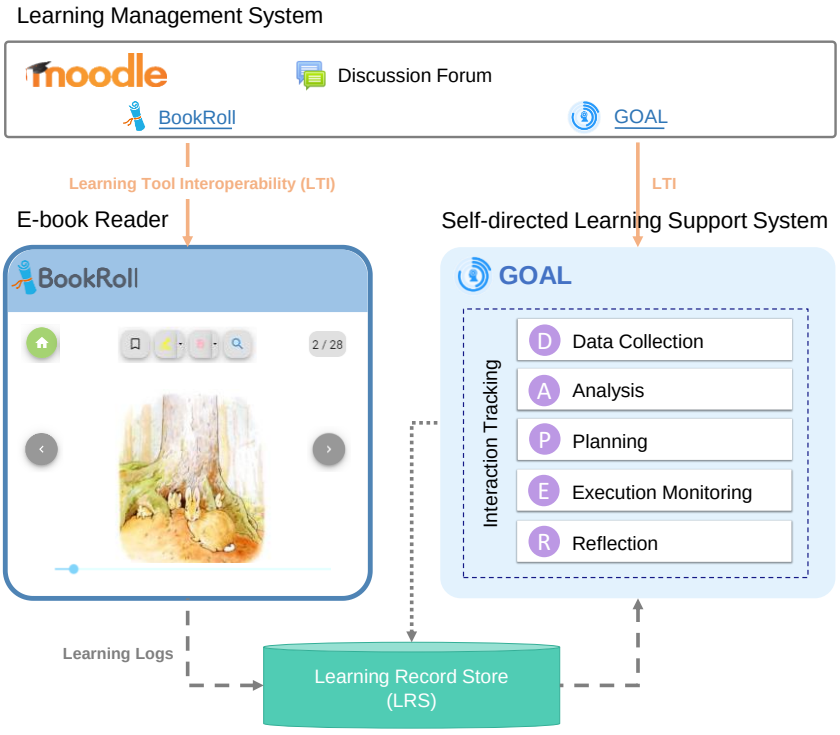

Fig. 2 Self-directed extensive reading with social support

reading time spent in ER. Then SDL scaffoldings are implemented and provided to students using the DAPER (Data collection - Analysis - Planning - Execution monitoring - Reflection) model. The implementations systematically assist learners in taking initiatives to identify their status in contextual activities, set smart goals, monitor their progress, and reflect their strategies. Thus, GOAL system not only provides critical indicators in a learning activity context such as ER for engaging learners in SDL but also provides computer-based scaffolds that aim to improve learners' SDL abilities in each phase. Learners can create, edit, review, and delete personal plans for extensive reading in the planning support page in GOAL system and the interactions with the GOAL system are automatically tracked as learning logs in the LRS.

Measures

The measures and their descriptions in this study are shown in Table 1. Three measures were from the reading behaviors in BookRoll: reading time, reading word, and reading amount. The reading word was extracted from the word count of the e-book by pages. The reading amount was used as an indicator of reading engagement. The plan count measure was obtained from the planning interactions with the GOAL system and adopted as an indicator of planning behavior. The forum post measure was collected from the Moodle system and used as an indicator of discussion forum participation.

Table 1 Measures and descriptions in this study

Category	Measure	Description
Reading behavior	Reading time (minutes)	Sum of total time during the e-book reading.
	Reading word	Sum of total words during the e-book reading.
	Reading amount	Count of completed books during the e-book reading.
Self-directed behavior	Plan count	Number of reading plans created by the student in GOAL system.
Social behavior	Forum post	Count of messages posted by the student in LMS forum.
Performance	Pre reading speed	Average words per minute (WPM) when the student read e-books in the first month.
	Post reading speed	Average WPM when the student read e-books in the final month.
	English performance	Total scores achieved by the student in the final standardized English exam administered by the school.

The pre and post reading speeds were measured as reading performance by the average number of words per minute (WPM) when the student read e-books in the first and final months, respectively. The reading speeds were calculated by dividing the reading words of e-books by the reading time in minutes. Total scores of the final standardized English exam at the end of the experiment were measured as students' English learning performance.

Analysis

Descriptive statistics were computed for behavioral measures, reading performance, and English learning performance, including reading behavior, planning behavior, discussion forum participation, reading speed, and English learning performance (see Table 2).

Table 2 Descriptive statistics of the behavioral variables, reading performance, and English performance (N = 115)

Measure	Mean	SD	Range
Reading time (minutes)	349	382	7 - 1,930
Reading word	32,072	37,421	418 - 282,617
Reading amount	38	39	1 - 193
Plan count	12	4	0 - 24
Forum post	41	64	1 - 331
Pre reading speed	99	36	40 - 228
Post reading speed	132	47	36 - 288
English performance	53	15	17 - 92

To quantify the mediation effect of ER engagement on the relationship between planning behavior, discussion forum participation, and English learning performance, we executed a causal mediation analysis (Imai et al., 2010). The method computes the total effect, average causal mediation effect (ACME), reflecting indirect/mediated effects, and proportion mediated, reflecting the percentage of the total effect on the outcome explained by the indirect/mediation path. Confidence Interval (CI) and test statistics for these measures were estimated by non-parametric bootstrapping with 5,000 simulations.

Furthermore, the students were divided into the high and low English proficiency groups based on their scores of English proficiency test (details in study design section). The students who achieved higher than the median score were labeled as having high English proficiency (n = 57), while those who achieved lower than the median score were considered as having low English proficiency (n = 58). To evaluate the effects of ER engagement on students' reading performance and English learning performance in the two groups, one-way ANCOVA analyses were carried out. First, a one-way ANCOVA analysis was performed to assess the effect of ER engagement on reading speed as reading performance. The independent variable was the ER engagement with students grouped as high ER (n = 58) and low ER (n = 57) group by the median count of total reading amount. The dependent variables and covariates were their post reading speed and pre reading speed, respectively. Second, another one-way ANCOVA analysis was performed to assess the effect of ER engagement on English learning performance. The independent variable was also the ER engagement with students grouped as high ER (n = 58) and low ER (n = 57) group by the median count of total reading amount. The dependent variables and covariates were their scores of English performance test and English proficiency test, respectively.

Results

RQ1: Mediation effects of ER engagement

The mediation effect of ER engagement in the relationship between planning behavior and English performance and the direct effect of planning behavior on English performance are shown in Figure 3. The mediation effect of ER engagement on the effects of planning behavior association on English performance was significant (mediated effect = 0.69; 95% CI, 0.13 to 1.40; $p < .05$). The direct effect of planning behavior on English performance was also significant (direct effect = 1.41, $p < .001$). The mediation path explained 49.27% ($p < .05$) of the association between planning behavior and English performance. Consequently, the results showed that ER engagement can be considered a partial mediator of the relationship between planning behavior and English learning performance.

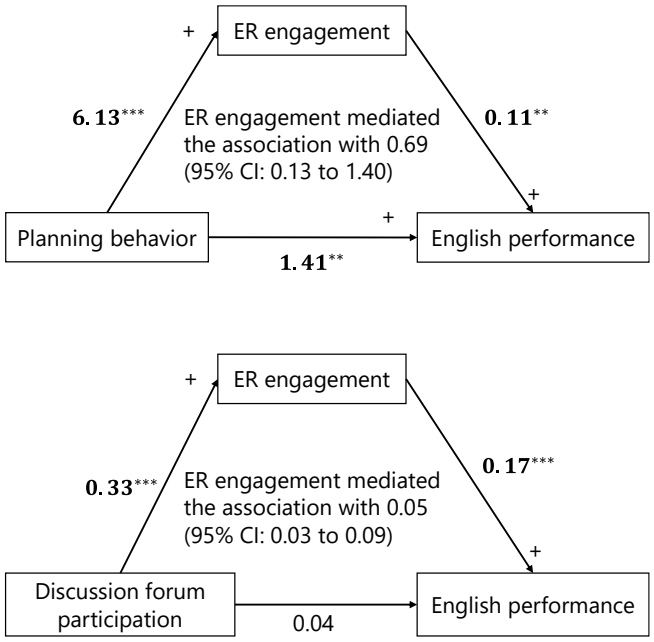

Fig. 3 Mediation effects of ER engagement in the relationship between planning behavior, discussion forum participation, and English performance

The mediation effect of ER engagement in the relationship between discussion forum participation and English performance and the direct effect of discussion forum participation on English performance are also shown in Figure 3. The mediation effect of ER engagement on the effects of discussion forum participation association on English performance was significant (mediated effect = 0.05; 95% CI, 0.03 to 0.09; $p < .001$). However, the direct effect of discussion forum participation on English performance was not significant (direct effect = 0.04, $p > .05$). Therefore, the ER engagement has a role of full mediator in the relationship between discussion forum participation and English learning performance.

RQ2: Effects of ER engagement on reading performance and English performance

Table 3 shows the difference in ER engagement on post reading speed for high and low English proficiency students. The assumption of homogeneity of regression coefficients for the post reading speed in high English proficiency group ($F = 0.43$, $p = .51 > .05$) and in low English proficiency group ($F = 0.95$, $p = .33 > .05$) were confirmed.

For the high English proficiency students, the adjusted means of the post reading speed in the high and low ER engagement groups were 147.38 and 124.31, respectively. Moreover, the post reading speed between the high and low ER engagement groups reached

Table 3 Differences in ER engagement on post reading speed for different levels of English proficiency students

Post reading speed	Group	n	Mean	SD	Adjusted mean	F	η^2
High English proficiency students	High ER	36	150.50	45.76	147.38	4.34*	0.07
	Low ER	21	118.95	56.05	124.31		
Low English proficiency students	High ER	22	138.55	36.07	133.63	1.64	0.03
	Low ER	36	118.47	40.53	121.48		

*$p < .05$

a significant level with F = 4.34 ($p < .05$) with $\eta^2 = 0.07$, while controlling for the pre reading speed, showing a moderate effect size (Cohen, 1988). For the low English proficiency students, the adjusted means of the post reading speed in the high and low ER engagement groups were 133.63 and 121.48, respectively. However, the post reading speed between the high and low ER engagement groups didn't reach a significant level with F = 1.64 ($p = .21$) with $\eta^2 = 0.03$ after controlling for the pre reading speed.

Table 4 shows the difference in ER engagement on English learning performance for high and low English proficiency students. The assumption of homogeneity of regression coefficients for the English learning performance in high English proficiency group (F = 0.20, $p = .66 > .05$) and in low English proficiency group (F = 0.20, $p = .65 > .05$) were confirmed.

For the high English proficiency students, the adjusted means of English performance in the high and low ER engagement groups were 59.80 and 63.70, respectively. However, the English performance between the high and low ER engagement groups didn't reach a significant level with F = 0.97 ($p = .33$) with $\eta^2 = 0.02$ after controlling for the test score of English proficiency. For the low English proficiency students, the adjusted means of English performance in the high and low ER engagement groups were 48.50 and 41.30, respectively. Moreover, the English performance between the high and low ER engagement groups reached a significant level with F = 5.32 ($p < .05$) with $\eta^2 = 0.09$, while controlling for the test score of English proficiency, showing a moderate effect size (Cohen, 1988).

Table 4 Differences in ER engagement on English performance for different levels of English proficiency students

English performance	Group	n	Mean	SD	Adjusted mean	F	η^2
High English proficiency students	High ER	36	61.00	12.30	59.80	0.97	0.02
	Low ER	21	61.60	15.00	63.70		
Low English proficiency students	High ER	22	49.60	11.20	48.50	5.32*	0.09
	Low ER	36	40.60	12.10	41.30		

*$p < .05$

Discussion

Students have more opportunities to read English books extensively in the online context due to the advances in technology and more abundant learning resources. However, it becomes more important to motivating students by integrating individual and social support in the online learning environment, especially for young EFL learners in k-12 settings. In this study, we explored the mediation effect of ER engagement on the association of individual and social support with English learning performance and further examined the impacts of students' ER engagement on their reading performance and English learning performance in English proficiency groups.

Mediation effect of ER engagement

Mediation analysis on planning behavior found that the effect of planning behavior on English performance was partially mediated by the ER engagement. Researchers showed that planning (goal-setting) intervention was closely associated with the improvement of task engagement in reading for middle school students (Stevenson, 2016). Self-report planning activities (goal-setting) have also been found to support higher student performance in the MOOC environment (Handoko et al., 2019). The present study provides evidence that planning behaviors, which extracted from the trace data, can affect student learning performance directly and indirectly through reading behaviors.

Goal-setting and planning are key components in a variety of established behavioral and academic interventions (Cauley & McMillan, 2010; Cleary & Zimmerman, 2004). Students in goal setting and planning promote self-efficacy, enhance motivation, and develop self-regulated learning skills (Mikami, 2020). Furthermore, students set their own goals and plans instead of being assigned in this study, which could lead to greater self-regulation and confidence in goal attainment (Cleary & Zimmerman, 2004).

Mediation analysis on discussion forum participation found that the effect of discussion forum participation on English performance was fully mediated by the ER engagement for adolescent students. This finding is consistent with previous research showing that no correlation between the number of posts and students' learning performance in terms of final course grades and grade point averages (Alzahrani, 2017; Davies & Graff, 2005; Song & McNary, 2011). However, some other studies found the number of posts students write is significantly correlated with students' course outcomes in higher education (Goggins & Xing, 2016; Palmer et al., 2008).

Instructional design, students' motivation, and discussion structuring were found to moderate the relations between discussion forum participation and learners' performance (Huang et al., 2019; Song & McNary, 2011). The discussion forum participation played an important role in the understanding of the course content and the evaluation of the final

course grades in previous studies (Goggins & Xing, 2016; Palmer et al., 2008). However, the discussion forum in this study was used voluntarily by students, mainly engaged in story sharing, and not related to the course evaluation. An example of students' posts in the discussion form is "I read the Fox and the Stork book and recommend it to you. I learned that sometimes if you don't know a person well, the person may not like you even though you act nice". The instructional design and discussion structure are likely to contribute more to social and emotional support but less to the improvement of learning performance.

Reading speed growth at different levels of English proficiency

The present study revealed that high ER engagement students achieved significantly higher reading speed than those with low ER engagement in the high English proficiency group, and the difference was also found but it was not significant in the low English proficiency group. The finding of that more ER engagement contributed to the improvement of reading speed for all readers online is consistent with previous evidence that there is a positive correlation between the amount of reading and reading fluency in print book based ER programs (Huffman, 2014; McLean & Rouault, 2017). However, the present study also revealed a larger effect of reading amount on reading speed for high English proficiency students than those with low English proficiency. Scholars have indicated that the students who had limited language proficiency need to overcome many challenges on cognition, attitude, and engagement during ER in formal school settings (Klauda & Guthrie, 2015; Landerl & Wimmer, 2008). Further, studies on the development of reading ability have identified the importance of specific learning skills (e.g., prior knowledge sourcing, self-regulated reading) in the online environment for struggling readers (Coiro & Dobler, 2007; Kanniainen et al., 2019). The low proficiency students need to put more cognitive attention on decoding and comprehending tasks since the difficulties they faced in the more complex online cognitive process, and thus gained less fluency improvement through ER.

Learning performance varied at different levels of English proficiency

Results of the English learning performance indicated that ER engagement played a significant role in the difference in English learning performance among students with low English proficiency, but not among those with high English proficiency. It seems that the low English proficiency students activated their previous lexical knowledge and developed their general English knowledge from extensive reading in context. A previous study has highlighted that ER had a more positive effect on reading ability development of lower and middle proficiency students than higher proficiency peers in the offline setting (Aka, 2019). Empirical research on online ER reported that university students achieved a significant increase in their reading section and overall TOEIC (Test of English for International Communication) scores after a year-long ER on smartphones; however, their gains in the

TOEIC scores were not significantly correlated with ER engagement (Milliner, 2017). Findings from the current study extend the previous result to infer that ER engagement has stronger influences on the development of general language competency for adolescent learners with low English proficiency in both offline and online learning environments.

Theoretical contribution and implications for technology support for self-directed ER

It's critical for researchers and educators to further understand how young EFL learners develop their reading and other language ability, and how to support the development more effectively and efficiently in the information era.

Two theoretical implications for the development of young EFL learners' language ability can be suggested based on the results of this work. First, this study suggests that long-term online ER is an effective means to improve adolescent learners' language ability in the early stages of EFL learning. Long-term online ER can help learners acquire their sight vocabulary in context and increase their reading fluency, leading to the development of general English ability. This study adds evidence to the literature that adolescent learners in high and low proficiency groups receive different benefits from the long-term online ER during the early stages of EFL learning. High-proficiency adolescent learners can improve their reading fluency significantly than low-proficiency ones from long-term ER. On the other hand, low-proficiency adolescent learners can receive more significant benefits of general language ability improvement than high-proficiency ones from long-term ER. Second, ER support could contribute to promoting learner reading engagement and learning performance together in the online language learning environment. Particularly, goal-setting and planning strategies have direct and indirect effects on English learning performance, which suggests they are key strategies for success in long-term online language learning. Considering the across-context power of the goal-setting and planning strategies, the findings could be generalizable to other learning subjects such as mathematics learning and other educational mode such as hybrid teaching.

Three important instructional implications can be suggested from this study for implementing a successful online extensive reading program. First, it's more suitable to conduct ER in a self-directed manner in the online learning environment. Both a wealth of reading resources and an instruction on SDL strategies are required to start the ER activity by students themselves (Milliner, 2017). Second, setting specific personal goals and plans would help students to read consistently and improve linguistic abilities effectively (Lee et al., 2015). If students can set their goals by themselves, they would have more opportunities to practice their goal-setting skills and put more effort to achieve their goals than assigned goals. Finally, providing an online discussion forum can potentially facilitate student-student interactions and extensive reading engagement (Kent et al., 2016; Naranjo et al.,

2012). As a metacognitive factor, online discussion in the forum could enhance students' content understanding, knowledge acquisition, and language output.

Limitations

One limitation of this study was that the participants were young EFL students and therefore the effects may differ for different levels of EFL learners such as skilled EFL students or adult learners. The second limitation was that the narrow sample may limit the generalizability of the findings and there is a need to strengthen this study's external validity by including a more diverse sample from different cultural and linguistic backgrounds. The third limitation was that apart from the frequency of self-directed learning activity and social interaction, the quality and dynamics of these behaviors may also be important influencing factors in reading performance and learning performance. The fourth limitation was that the measures of reading behaviors are based on the quantity of the interactions in the learning environment, which was not sophisticated measures combining the quality of the interactions such as the level of reading engagement. The fifth limitation was that other factors outside the designated learning environment can also impact on the observed outcomes since a lack of the controlled environment in this study.

Conclusion

In summary, this study created a self-directed ER environment with social support to tackle the challenges of ER in the online learning environment. 115 seventh graders in a Japanese junior high school engaged in the support environment for one school year. Each student read an average of 32,072 words or 38 digital graded readers during this period. This study examined the mediation effect of ER engagement on the relationship between planning behavior, discussion forum participation, and English learning performance to quantify the effect of technology support on learning performance. Furthermore, this study investigated the effect of online ER engagement on reading speed and English learning performance for the high and low English proficiency groups, in order to help teachers and school administrators to prepare effective instructions and specific interventions.

The finding of mediation analysis indicated that the ER engagement played a partially mediating role in the association between planning behavior and English learning performance and the mediation path explained almost half (49.27%) of the association between planning behavior and English learning performance. Moreover, the ER engagement was found to fully mediate the association between discussion forum participation and English learning performance.

The findings of within-group comparison revealed that high English proficiency students acquired significantly reading speed faster from high ER engagement than those with low ER engagement ($F = 4.34$, $p < .05$, $\eta^2 = 0.07$); however, a significant difference was not

found in their English learning performance. For the low English proficiency students, there was no significant difference in their reading speed gains between high and low ER engagement, but high ER engagement students achieved significantly higher English learning performance than those with low ER engagement ($F = 5.32$, $p < .05$, $\eta^2 = 0.09$).

These findings suggest that junior high school EFL students in high and low proficiency groups receive different benefits from the long-term online ER activity. Consistently reading more e-books, low-proficiency students can gain more improvement in general language competency than high-proficiency peers; however, high-proficiency students can increase faster reading fluency than low-proficiency ones. The method in this study can be utilized by automatically detecting low proficiency learners and creating personalized scaffolds to support their planning and monitoring behaviors, thus enhancing their language skills. It is critical to provide online support including interactive e-book reading, self-directed learning, and online discussion in the online ER environment. Along with these supports, it's possible to improve students' reading habits and learning performance consistently and enable teachers to provide individualized instruction. Both the effects of ER engagement and technology support in this study deserve further research to understand their theoretical and instructional implications in online language learning.

Abbreviations

ER: Extensive Reading; EFL: English as a Foreign Language; SDER: Self-Directed Extensive Reading; SDL: Self-Directed Learning; CEFR: Common European Framework of Reference for Languages; LRS: Learning Record Store; LTI: Learning Tool Interoperability; DAPER: Data collection, Analysis, Planning, Execution monitoring, Reflection; WPM: Words Per Minute; ACME: Average Causal Mediation Effect; CI: Confidence Interval; TOEIC: Test of English for International Communication.

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Authors' contributions

HL developed the system, designed the experiment, performed data analysis and drafted the initial manuscript. RM performed data analysis and edited the manuscript. HO contributed to the final manuscript and supervised the project. All authors read and approved the final manuscript.

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Declarations

Competing interests
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