

Changes and Sub-skill Outcomes of Modeling Heuristic Reading Comprehension Instructional Practice in Mobile-Mediated EFL Specialist Teacher Training

Gashaw Woldetsadik

gashawwtsadik@gmail.com

Arba Minch University

Research Article

Keywords: Mobile-mediated reading comprehension, heuristic/experimental model, EFL reading, teacher education/training, changes and sub-skill outcomes

Posted Date: October 12th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10654102/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Changes and Sub-skill Outcomes of Modeling Heuristic Reading Comprehension Instructional Practice in Mobile-Mediated EFL Specialist Teacher Training

Gashaw Tefera Woldetsadik

English Language and Literature Department

Arba Minch University

Arba Minch City, Ethiopia,

Email: gashawwtsadik@gmail.com

Abstract

Mobile phones have increasingly been adopted in EFL contexts, often emphasizing teaching and learning language structure, vocabulary, and pronunciation. Yet their potential for delivering skill-oriented reading instruction appears underexplored in formal teacher education, leaving educators and researchers uncertain about both its value and the challenges of implementation. Accordingly, the study examined the effects of mobile-mediated heuristic reading comprehension model on prospective English specialist teacher trainees at Arba Minch College of Teacher Education. It assessed changes in overall reading performance and determined which reading sub-skills showed the greatest and least impact on general reading comprehension. Employing an Alternative Time Series Design, the study administered four parallel reading comprehension tests. For analysis, Friedman's nonparametric inferential technique was used. In addition, Sequential Analysis provided graphical representations of learners' gradual performance changes, clarifying the level of improvements attributable to the mobile-mediated heuristic reading lessons. Lastly, findings demonstrated the successive mobile-mediated heuristic reading comprehension instructions produced significant positive gains in trainees' general reading comprehension performance. Further, the study indicated that these lessons are most beneficial for skimming and scanning activities, while other sub-skills showed comparatively weaker effects. EFL teacher educators are therefore encouraged to integrate mobile phones into reading instruction in a balanced manner, with particular emphasis on scanning and skimming skill activities

Key words: Mobile-mediated reading comprehension, heuristic/experimental model, EFL reading, teacher education/training, changes and sub-skill outcomes

Introduction

Mobile phones carried by most upper-class students have become alternative digital learning tools in contexts where expensive and more sophisticated digital technologies are unavailable or constrained in English as a Foreign Language (EFL) classrooms or digital labs in high schools, colleges and universities. Research indicates that students show strong interest in using mobile phones, and therefore EFL teachers are recommended to apply this technology to teach reading skills (Shofi & Jannah, 2022). Consequently, some teacher educators and schoolteachers have increasingly shifted toward using mobile phones to support evolving trends in English as a Second/English as a Foreign Language (ESL/EFL) teaching, treating mobile phones as emerging learning technologies. Accordingly, Mobile Assisted Language Learning (MALL) - which combines the use of built-in features, salient applications, and educational software/platforms - may satisfy learners' communicative needs in English, for example (Cicili et al., 2022, cited in Diaz-Ramirez et al., 2023).

Reading is widely recognized as one of the most serious challenges for students learning English in both native and non-native language settings. Therefore, after diagnosing learners' language-learning needs, and grounding the approach in sound pedagogical theories, teachers, educators, and/or researchers should consider likely effects before applying mobile-based instruction more broadly. In this study, the work is aligned with cognitivist theory because listening and reading comprehension processes are commonly viewed as cognitive processes.

Cognitive theory emerged in the late 1950s as a widely influential theoretical perspective, largely shaping educational thinking at the time by explaining comprehension as a mental process (Brown, 2007). However, it also emerged in reaction to behaviorism, which emphasized recitation. As a new and popular educational paradigm, cognitivism attempted to explain the complex nature of knowledge formation as a process involving "learning, memory, attention, language, reading, writing, reasoning, problem-solving, among others" (Knapp & Seidlhofer, 2009, p. 440; Aljohani, 2017). Similarly, reading researchers describe reading as an activity in which readers apply multiple cognitive capabilities, including "word recognition skills, vocabulary knowledge, text structure knowledge, background knowledge resources, and working memory skills," contributing to reading comprehension in both L1 and foreign language contexts (Knapp & Seidlhofer, 2009, p. 440).

Reading is a personal and interactive engagement with both text and author in attempts to fully understand information. However, this definition alone does not sufficiently explain how information is transmitted, processed, comprehended, and ultimately stored in the brain. Piaget is often credited with providing a scientifically elegant explanation of cognitive operations, which is also considered a basis for the $i+1$ hypothesis (Krashen & Terrell, 1983), contrasting the behaviorist idea of "tabula rasa" (a "white slate"). From a cognitivist perspective, reading comprehension can be explained through schema theory. Schema theories describe reading comprehension as the process of updating a reader's knowledge schemas by integrating information encountered in the text with information already stored in memory. When new information confirms what is stored, comprehension becomes easier. When new information conflicts with existing memory, the reader must evaluate it for correctness (or at least credibility) and decide whether to update the schema. If the new information agrees with existing knowledge, perhaps extending it, learning occurs relatively easily through schema updating (Murnane et al., 2012, p. 7).

In reading instruction, learners approach reading tasks with particular capabilities, knowledge, and experiences shaped by their schemas. Thus, reading activities are linked to actions that influence reading purpose, process, and outcome (Compton & Pearson, 2016). In reading comprehension instructional contexts, the heuristic model hypothesizes reading achievement results from a successful interaction among the reader, the text (e-text/e-reader), and the embedded activity within a school sociocultural context (Compton & Pearson, 2016). In technology blended learning environments, such interactions can also be supported through mobile phone as a tool for delivering reading comprehension lessons in these settings, which are viewed as sociocultural spaces. When implementation carefully accounts for the three reading instruction variables circumscribed by and embedded in sociocultural school context, a well-designed mobile-mediated instruction may enhance learners' reading achievements (Lin et al., 2019).

Seemingly m-learning has attracted academic attention since the late 1990s, leading to many studies examining the impact of MALL (Marzouki et al., 2017). Over time, it has increasingly been treated as a distinct educational area (Amer, 2014), although some scholars still consider its development to be in its early stages. Despite the global underuse of mobile phone integration in formal English language instruction, limited attention is given by ELT practitioners and learners at all levels. However, research on mobile phone use in language education - often grounded in constructivist-learning theories - has generated new and valuable insights for English language teaching. For instance, studies on Jordanian EFL students' attitudes toward mobile-based learning show increased awareness of its value and recognize the importance of implementing mobile phones in ELT without significant effects from gender or academic major differences (Ababneh, 2017). Similar research confirms that mobile phones used as mediational artifacts can lead to positive attitude changes toward learning English (Mottear, 2013; Amer,

2014; Hariry, 2015; Ababneh, 2017; Blasco, 2016; Nalliveettil & Alenazi, 2016). In addition, Faria et al. (2019) recommend more careful consideration of using mobile technology to improve English language learners' language skills, identifying reading as one of the priority areas for investigation in ELT. Therefore, this study examines the effect of mobile-mediated heuristic reading comprehension instructional model on EFL teacher trainees' general reading comprehension performance and identifies which reading sub-skills (sub-construct variables) are the most and least significant predictors of change.

Research Questions

The following are the specific questions that the current study gives answers:

1. What is the effect of mobile-mediated heuristic reading comprehension instruction on the English specialist teacher trainees' general reading performance?
2. Which sub-skill is the reading sub-construct variable that is the highest predictor of the change in the teacher trainees' general reading comprehension performance?
3. What is the reading sub-construct variable least predicted the trainees' general reading comprehension performance change?

Theoretical and Conceptual Frameworks

Constructivism and its learning foundations

Theoretically, constructivism is rooted in behaviorist and cognitivist perspectives. Like cognitive theory, constructivism treats learning as knowledge construction through a building-block process. Learners use prior information and construct new meanings by assimilating previous knowledge with new input. However, constructivism is multi-dimensional, and adopting it as a whole may provide stronger theoretical grounding for this study. A cognitive-constructivist perspective emphasizes comprehension as the learner's active involvement in using prior knowledge to make sense of subject matter. A social-constructivist perspective highlights the importance of social interaction among learners, teachers, peers, and caregivers. A radical-constructivist view emphasizes that meaningful learning occurs through a learner's interaction with a machine or learning technology. For example, within this study, learners engage in hands-on learning using mobile phones in both classroom and beyond-class contexts.

In addition, when categorized by different types of mobile-based learning activities, behaviorist activities (focused on changes in observable learner behaviors) and constructivist activities (focused on learners constructing new knowledge from their schemas) can guide mobile-mediated instructional practices. These two types are treated as equally important foundations for implementing mobile-mediated instruction (Futurelab Overview, 2004, in Guide to Mobile Learning, 2015). Consequently, the preceding constructivist assumptions are given equal weight to effectively realize mobile-mediated reading comprehension lessons in heuristic instructional contexts. Constructivism also emphasizes learning as a social phenomenon. Therefore, designing constructivist activities supports the need to plan learning experiences and tasks from the perspective of their suitability for acquiring new information through interactive learning within a mobile-embedded social learning environment.

RAND heuristic reading comprehension model

In this study, the RAND study-group heuristic reading comprehension design is used to develop reading lessons and corresponding comprehension activities/tasks. Learning experiences are mediated through mobile phones so that changes in teacher trainees' current reading performance can be observed through successive reading comprehension tests. The lessons are organized as tasks and/or activities that learners engage with in three stages: pre-reading, while-reading, and post-reading.

The RAND model ensures that comprehension is evidenced through a wide range of observable task outcomes, such as answering questions, paraphrasing text segments, summarizing sections and passages, integrating information across segments, interpreting text and implied meanings, and critiquing both text features and author strategies (Compton & Pearson, 2016, p. 224). Thus, reading tasks are implemented heuristically and account for the interconnectedness of the three core elements: the reader, the text, and the activity. These elements are essential for reading comprehension practice, and their interaction can support effective use of mobile phones for teaching reading.

Within the RAND model, the sociocultural element that frames the interaction among the reader, text, and activity depends on the mobile application used. The selection of appropriate texts and the design of feasible activities also encourage exposure to e-readers in experimental conditions (RRSG & Snow, 2002, cited in Compton & Pearson, 2016). In this sense, the mobile phone functions as the central medium through which reading moves forward in comprehension practices (see Figure 1). Overall, the heuristic analysis proposes that reading comprehension is an output of the combined interaction among reader, text, and activity, bounded within a broader sociocultural context within the experiential reading process (Compton & Pearson, 2016).

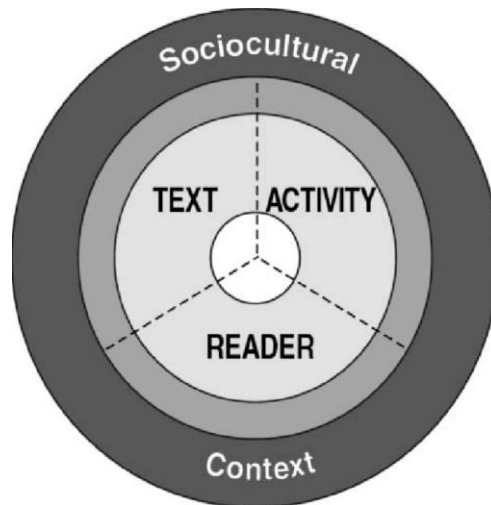


Fig. 1. RAND study group heuristic for thinking about reading comprehension (Adopted from Compton & Pearson, 2016)

Complex interaction of heuristic reading components in the process of attaining comprehension in school practice to reading that is bounded with the broader sociocultural learning context (Adopted from Compton & Pearson, 2016)

In the context of the present study, the college environment serves as the sociocultural setting in which students complete various academic and non-academic reading tasks using mobile phones. Because reading occurs during academic engagement (as the trainees' major focus), it is also important to consider learners' involvement in popular culture and to value the learning resources provided by learners' background experiences (Beck & Kosnik, 2006). For instance, teacher trainees' experience with mobile phone use during their college years is emphasized as a background factor that may be used to heuristically analyze effects on reading comprehension performance. Blending technology into sociocultural theoretical views is therefore an important theoretical lens for framing this study, allowing the cognitive, social, and radical constructivist dimensions to be considered together. Each dimension contributes to the way mobile phones function as an emerging learning technology when integrated into the sociocultural context of schools to support the delivery of reading lessons.

Fox (1987) also clarified that computers play a supportive role in enabling interaction between learners and text when reading from e-printouts. Similarly, the effect of using mobile phones to mediate reading skills and facilitate related comprehension activities becomes meaningful once selected trainees complete scanning, skimming, intensive, and extensive reading activities on their mobile phones. Through these activities, learners may apply both bottom-up and top-down reading approaches (reading strategies) in a timed manner to read for comprehension and communicate with the author through the texts they access on their mobile phones (Carrell, Devine, & Eskey, 1988, cited in Knapp & Seidlhofer, 2009).

Text genres, vocabulary, and instructional design

Different genres of reading texts and their related comprehension activities are designed according to Compton and Pearson's (2016) categories for mobile-mediated reading comprehension. Texts are arranged in ascending order of difficulty based on their closeness to or remoteness from learners' experiences and on the topicality of the content. The RAND model also accounts for invisible activities that help learners construct meaning representations while reading e-texts.

In addition, research indicates that both the depth and breadth of vocabulary knowledge significantly contribute to reading comprehension achievement, even though they are positively correlated. Some evidence also suggests that these vocabulary factors are more important than demographic variables such as gender (Mehrpour et al., 2011). Consistently, language knowledge, world knowledge, and language use are described as shared factors that strengthen interactions among reader, text, and activity (Hu & Nation, 2000, cited in Mehrpour et al., 2011; Compton & Pearson, 2016). When these interactions occur successfully, competence is reflected in general comprehension performance, mediated by mobile phone technology.

Educational practitioners should consider how reading texts are graded to match a heterogeneous group of readers with different reading levels. Therefore, differences in text difficulty and comprehension-checking tasks are used in a balanced approach to organize and present heuristic reading comprehension lessons. In this way, the lessons can address learner differences and be used effectively in mixed-ability classroom settings by categorizing tasks/activities for beginner readers (e.g., phoneme segmentation, word guessing), intermediate readers (e.g., annotating), and advanced readers (e.g., inferring) (Lin et al., 2019). Strategies are applied flexibly according to the suitability of each reading session labeled as pre-reading, while-reading, or post-reading. Strategic recommendations generally encourage selecting reading strategies that match learners' needs and proficiency levels, including skimming, phoneme segmentation, decoding, identifying main ideas, interpreting, and inferring through evaluation and critical examination.

Mobile-mediated heuristic instruction as experimental treatments

Overall, mobile-mediated reading comprehension activities/tasks are organized based on theoretical assumptions and practical variability so that the heuristic reading comprehension lessons can function as experimental instructional treatments. Therefore, teacher trainees are exposed to different reading tasks/activities designed to support scanning, skimming, intensive, and extensive reading during three treatment phases. In this respect, the RAND heuristic reading comprehension instructional model serves as the instructional guide for the experimental reading context, integrating the mobile phone as a learning technology for English reading instruction. Ultimately, the study determines the effect of mobile-mediated heuristic reading comprehension interventions on teacher trainees' general reading comprehension performance and identifies the highest and lowest performance indicators among the reading sub-construct variables.

Methods and Materials

To identify the effects of mobile-mediated heuristic reading comprehension instructional interventions, an *Equivalent Time Series* design was used in this study. This design controls threats to internal validity by

administering successive tests (Creswell, 2012). In addition, time series designs support internal validity and offer higher reliability (Cohen et al., 2007, p. 284). For the diagram of the study design, see Figure 2.

$$O1 \rightarrow X a \rightarrow O2 \rightarrow X b \rightarrow O3 \rightarrow X c \rightarrow O4$$

Keys

O = Observation One (Reading Comprehension Test/T1, T2, T3, T4)

X = Treatments (or heuristic reading lessons) Xa_aa, Xb_bb, Xc_cc

Fig. 2. Equivalent Time Series Design applied in the mobile-mediated heuristic reading study.

Samples and Sampling

The college was purposefully selected because it was the nearest option and fell within the catchment area of the researcher's home university. Then, 27 English Language Specialist teacher trainees were selected as representative samples using a comprehensive sampling method for the experimental investigation at the Arba Minch Teacher Education College.

Procedures

At the onset of the study, the researcher communicated with officials at the Arba Minch Teachers' Education College, including the head of the Department of English Language and other staff members, to obtain permission. This enabled the researcher to work more autonomously and move freely across the campus during times when research participants carried out reading practice on their mobile phones, including locations such as the ELIC (English Language Improvement Center), near trees, the teachers' lounge, and classrooms. In their free time, participants also conducted additional reading activities on their mobile phones at their homes. Movement and activity scheduling depended on the availability of Wi-Fi connections within the campus. Participants also used mobile internet data to communicate with the researcher in order to solve problems encountered while learning, explore similar texts, independently practice EFL reading, prepare reports, give speeches, and reflect on their exploratory reading activities related to topics/issues in the syllabus adapted for implementation of the current study.

During the experimental interventions, teacher trainees were advised to use the salient features (built-in apps) of their mobile phones to facilitate the heuristic reading lessons. They completed scanning, skimming, intensive, and extensive reading practice activities both online and offline. In addition, PDF reader apps, e-dictionaries, spelling checkers, internet browsers, SC Scanner, Screen Shooter, and similar tools were used to support reading and mediate reading practices on mobile phones.

Using the consultation reading skills course syllabi obtained from the college, and through careful selection of graded passages for regular exposure on mobile phones, reading comprehension texts and accompanying activities were adopted from Sharma and Upadhyay (2007), *How to Practice for the Verbal Ability and Reading Comprehension for the CAT*. Accordingly, the passages and comprehension tasks were carefully selected based on their feasibility for delivery via mobile phones. Passages were sampled to suit trainees at absolute beginner, beginner, intermediate, and advanced reading levels (Lin et al., 2019). Consequently, greater attention was given to (1) skimming and scanning practice in the first phase of the intervention, (2) annotation practice alongside intensive reading activities in the second phase, and (3) inferential, creative, and critical thinking skills during extensive reading practice in the third phase.

To implement these activities, Moodle 3.0 was used to post each passage and the accompanying reading comprehension tasks. Links for extensive reading practice sourced online were also provided and added alongside lessons uploaded on the university server, enabling trainees to access them through the LMS once they were given user names and passwords to access them.

Overall, mobile-mediated treatments were organized vertically in ascending order of difficulty, while the simplicity of tasks increased sequentially as the instructional intervention progressed from phase one to phase three. This structure was implemented within each treatment phase through lesson section activities, and within each session through reading comprehension lesson activity types. In line with Krashen's *i+1* theory, the researcher prepared instructional materials (reading comprehension passages compiled as a module) with variations in genre (type), size (length), and difficulty level. Sub-skills were organized to help trainees progress from near to remote, from simple to complex (difficult), and from known to unknown. Instruction also accounted for linguistic variants (dominantly used in the passages), topicality, and relevance to teacher trainees' needs and experiences.

Data Collection

Four paper-and-pencil parallel reading comprehension tests were administered to collect data on teacher trainees' reading comprehension performance before, during, and after the intervention training at different intervals. These tests were objective in nature and included question items based on vocabulary, comprehension, prediction, and verbal reasoning. The items were presented in multiple-choice formats (e.g., true/false, matching, reordering, completion, prediction, and others), adapted from Sharma and Upadhyay (2007). A test-retest measure was used to check reliability by determining the consistency of results of the parallel reading comprehension tests administered to English linear-group teacher trainees in the same college during the pilot study and one year before the main study. The results showed a correlation coefficient of 0.892, which was above the accepted level for a good test to produce consistent results upon subsequent administration.

Data Analysis

The study mainly used Friedman's nonparametric inferential analysis technique. Therefore, pairwise comparisons were conducted to examine changes in reading comprehension performance across reading sub-variables (sub-construct skills) and to identify changes in overtime and the trainees' overall reading comprehension achievement as well as to identify that were least and most affected by the intervention. In addition, a sequential analysis approach was used to graphically display gradual changes in teacher trainees' performance over time. For these analyses, SPSS version 20 was used. Consequently, the results were reported quantitatively. At the end, ChatGPT was used to partially edit the language of the manuscript's sections to improve readability, except for the results section.

Results

This section reveals a stepwise analysis of data based on performance scores in the four reading comprehension tests administered as pre-, mid-, and post-tests to determine the effects of the treatments on the general and specific reading comprehension sub-skills.

The effect on the teacher trainees' general reading comprehension performance

H₀₁: After heuristic reading comprehension instructional trainings, English specialist teacher trainees have not shown significant change in their general reading comprehension performance.

Table 1. Median of the four reading comprehension test scores

	N	Percentiles		
		25	50 th (Median)	75 th
Reading Comp. Skill Pre-test (T1)	27	6.5000	7.5000	9.0000
Reading Comp. Skill Mid-test 1 (T2)...	27	8.0000	9.0000	10.0000
Reading Comp. Skill Mid-test 2 (T3)	27	8.0000	9.0000	10.5000
Reading Comp. Skill Post-test (T4)	27	9.0000	10.0000	11.5000

First, as can be seen from the above table, Friedman's Related Samples analysis descriptively revealed that performance differences were observed on four different test occasions. As a result, the median of the reading comprehension pre-test (T1), the first reading comprehension mid-test (T2), the second reading comprehension mid-

test (T3), and the reading comprehension post-test (T4) revealed differences in the performances at T1, T2, T3, and T4 occasions having median values $Md = 7.5000$, $Md = 9.0000$, $Md = 9.0000$, and $Md = 10.0000$, respectively.

Along with the above analysis, as also revealed in Figure 3, Related Samples Kendall's Coefficient of Concordance Analysis displayed the results of T1 (Reading comprehension pretest), T2 (Reading comprehension mid-test 1), T3 (Reading comprehension mid-test 2) and T4 (Reading comprehension post-test) that disproved the above null hypothesis. Therefore, after mobile-based heuristic reading training, the teacher trainees significantly changed their general reading comprehension performance, $p = .000$.

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distributions of ReadingT1, ReadingT2, ReadingT3 and ReadingT4 are the same.	Related-Samples Kendall's Coefficient of Concordance	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05

Fig. 3. Hypothesis test summary of the trainees' general comprehension performance

Based on the four successive heuristic reading comprehension test-results, Related-samples Kendal's Coefficient of Concordance analysis rejected the first null hypothesis.

Thus, the Freidman test along with Kendall's related-samples coefficient of concordance analysis was used again to graphically compare the magnitude of the effect of the heuristic treatment on the teacher trainees' reading comprehension performance based on the mean ranks using the default bar graph analysis output revealing the four aural comprehension test results and magnitude of the effect.

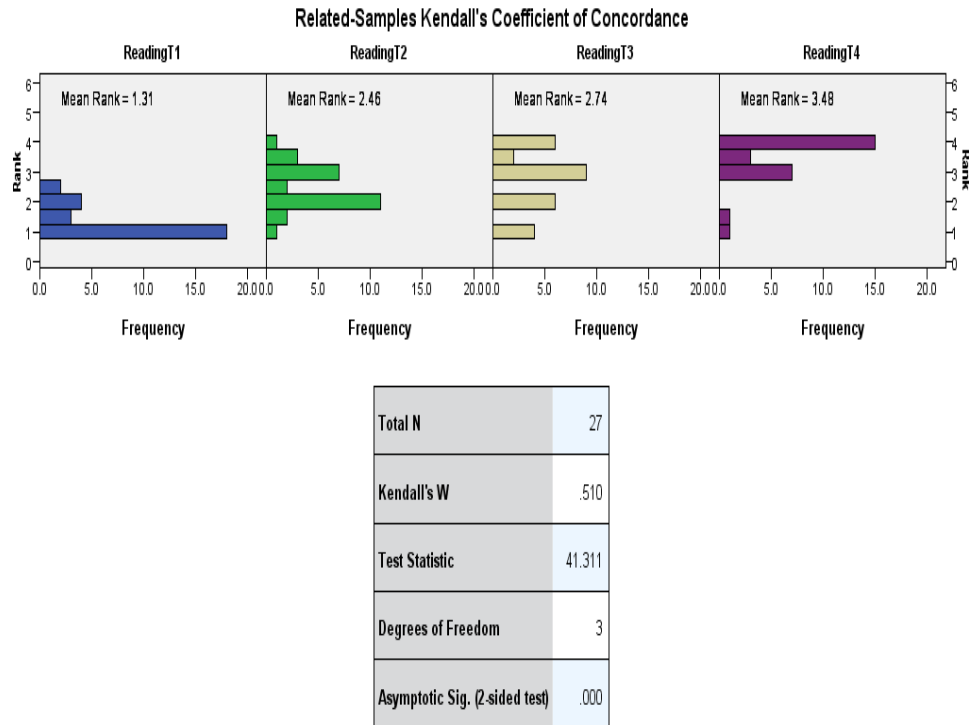


Fig. 4. Analysis of the effect size of the heuristic reading treatment using Kendall's W

As shown in Figure 4 above, the mobile-mediated heuristic reading instructional approach significantly affected teacher trainees' general reading comprehension performance $X^2(3) = 41.311$, $p = .000$, $W = .510$. According to Chritian (n.d.), Kendall's W, the size of the effect of the mobile-based heuristic reading comprehension intervention was large. In addition to this, Wilcoxon's effect size estimate revealed the same result that the size of the effect of the heuristic reading treatment was large, $z = -4.562$, $p = .000$, $r = -0.57617$. Conventionally, if r is less than 0.5, the effect understood as it is large. Therefore, the effect size of the treatment was large when the results were analyzed in the preceding two ways and when the outputs of analyses were compared against each other. Finally, the study rejected the first null hypothesis.

The highest and the least significant reading comprehension sub-construct skill(s)

Ho 2. After receiving the heuristic reading comprehension instructional treatments, the teacher trainees do not demonstrate equal performances in all the reading skill sub-constructs.

Pairwise comparisons of mean rank values were interpreted descriptively based on median of the four reading comprehension test results. The relationships between sub-variables were also compared to determine significance the most and the least contributions of the reading sub-skill that could be a highest and the lowest predictors of the teacher trainees' general reading comprehension performance change. See table 1 first to compare medians of the four reading comprehension test results obtained from the trainees performance scours in the pre-test (T1), the couple of mid-interval tests (T2 and T3) and the post-intervention test (T4) administered at four different points of time during the implementation of the four separate phases of heuristic reading intervention with mobile phones.

Table 2. Mean rank scores and differences in the reading comprehension test performances

Reading Tests	Mean Rank	Test being Compared	Mean Rank Difference/Change
ReadingT1	1.31	-	-
ReadingT2	2.46	T2 & T1	1.15
ReadingT3	2.74	T3 & T2	0.28
ReadingT4	3.48	T4 & T3	0.74

The sequential analysis of the four heuristic reading comprehension test results also revealed that the change brought by the teacher trainees that was vividly evident from the line graph in Figure 4 below and the bar graph in Figure 5.

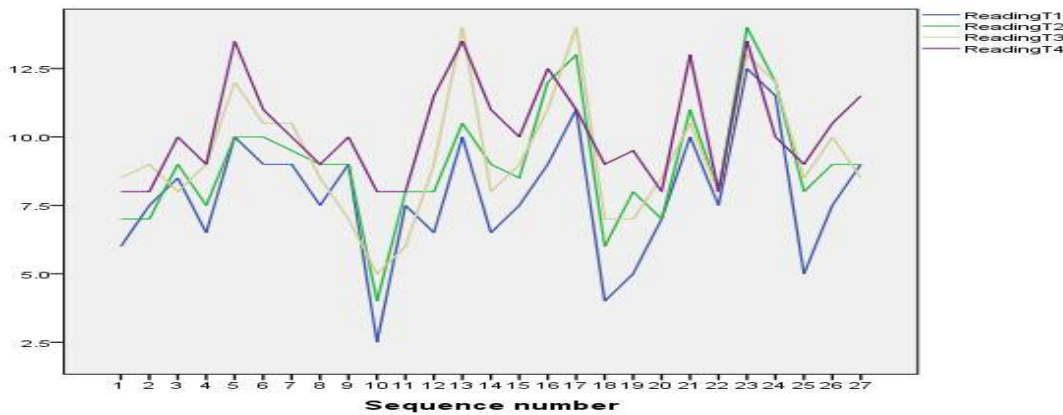


Fig. 5. Sequential analysis of reading comprehension performance

Figure 5 presents line graphs of the four time-interval test results, showing the gradual changes in teacher trainees' reading comprehension performance at the end of each successive heuristic reading comprehension session. Accordingly, Friedman's pairwise comparison of the mean ranks from the four tests was used to determine when, during the delivery of the mobile-mediated instructional treatments, the effects were greatest and least statistically significant.

The mean rank of the pre-test (T1) was 1.31, which was substantially lower than the mean rank of Mid-intervention test 1 (T2), recorded as 2.46. This indicates an increase of 1.15 mean-rank points from T1 to T2. This difference was considered notable because it coincided with the scanning and skimming skill-focused heuristic reading comprehension activities implemented between the pre-test (T1) and the first test after phase one (T2). Friedman's analysis further showed that this improvement was statistically significant ($p = .007$). The median also supported this pattern, with $Md = 1.5000$ for T2 compared to median values of $Md = 7.5000$ for T1 and $Md = 9.0000$ for T2 (see the consistency of the results across the analyses presented in Figure 6, Tables 1, and 2).

However, the mean rank difference between reading comprehension test three (T3) - administered after completing the intensive reading lessons—and test two (T2) was small, at 0.28. The change from 2.46 (T2 mean rank) to 2.74 (T3 mean rank) was not statistically significant ($p = 1.00$). This was confirmed by the descriptive statistics (Table 1), which showed no change between the median performance scores for T3 ($Md = 9.0000$) and T2 ($Md = 9.0000$), indicating that phase two of the mobile-mediated heuristic reading comprehension instructional treatment was not significant ($p = 1.000$).

Similarly, phase three - which focused on extensive reading practices and critical thinking skills -was also not statistically significant ($p = .210$). When post-test (T4) performance was compared with T3, Friedman's inferential

results indicated a mean rank difference of 0.74 between T3 and T4. Descriptive analysis also indicated that the median changes between T3 and T4 were limited, with Md = 10.0000 for T4 and Md = 9.0000 for T3. Overall, these results suggest that improvements during the third phase were minimal and not statistically significant (see Figure 6 and Table 1).

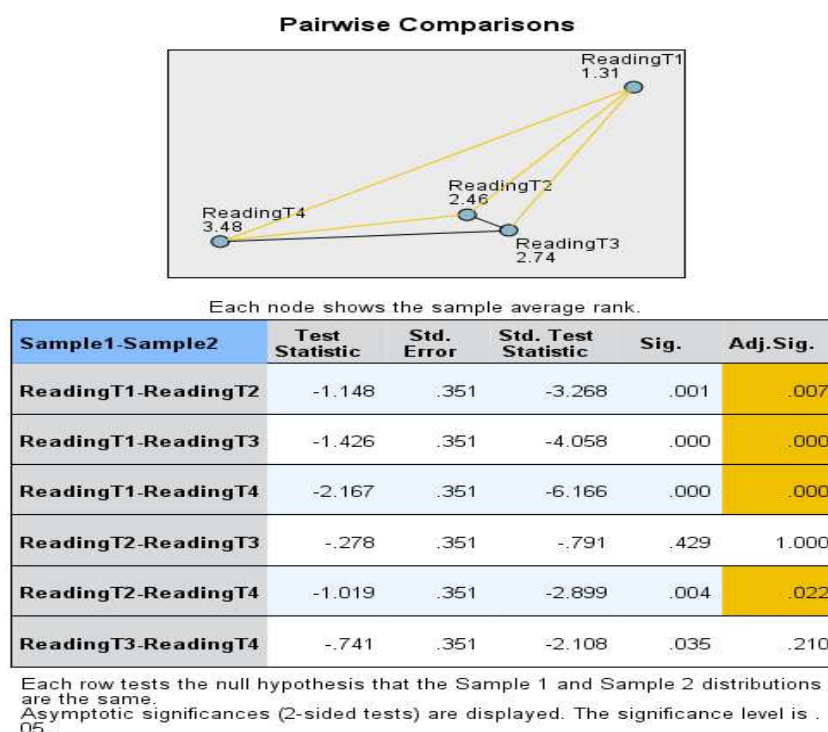


Fig. 6. The relationships and magnitude of the effect of the treatment on the reading comprehension performance.

The four heuristic reading comprehension test results being-compared pair-wise to recon whether the null hypothesis is confirmed being distributions of sample 1 and 2 are the same in rows. When the total effect of the training was taken into account, the change in the trainees' heuristic reading comprehension performance, the difference of the mean scores of T4 and T1 performances was significant when compared with the mean rank differences between performances in T2 and T1, T3 and T2, T3 and T1, T4 and T3, and T4 and T2. This was revealed in a successively decreasing mean rank order observed between the changes in 3.48 and 1.31, 2.46 and 1.31, 2.74 and 2.64, 2.74 and 1.31, 3.48 and 2.74, 3.48 and 2.46 mean rank scores, respectively (See Figure 6).

Generally, by the mobile mediated heuristic reading comprehension instructional treatments, the teacher trainees brought significant changes that varying in degree of performance range that decreased from 1.15, to 0.28, and promoted to 074 mean rank values as the experiment unfolds itself from phase one to phase two and phase three, respectively (Refer back to Table 2.).

Discussion

The analyses showed that the mobile-mediated heuristic reading comprehension instruction produced a statistically significant improvement in the performance of English specialist teacher trainees at ____ Teacher Education College. This result is consistent with Khubyari and Narafshan (2016), who reported that EFL learners who use mobile phones tend to favor reading comprehension because of the convenience associated with portability and accessibility.

However, the trainees' improvement differed across four reading sub-skills: scanning (related to vocabulary), skimming (identifying the gist), intensive reading (making inferences and contextualizing meaning beyond the text), and extensive reading (evaluating a text and critiquing the writer). Hazaeal and Alzubil (2016) found that mobile-based reading practices positively affect vocabulary development, pronunciation, grammatical knowledge, and correct punctuation use. Their findings align with the present study, particularly during the first mid-intervention and/or at Mid-test 1 (T2), when teacher trainees' scores increased by 2.74 in mean rank values, reflecting a 1.15 mean rank score difference.

In a meta-analysis of empirical studies grounded in social constructivism, Marzouki et al. (2017) also reported positive effects of mobile-based learning on learners' knowledge acquisition. In the current study, the first phase of mobile-mediated heuristic reading comprehension training emphasized foundational reading skills—especially scanning (locating answers in the text), skimming (identifying the gist and guessing new words using inference strategies and word games), and studying key grammar elements.

Strength of the intervention across sub-skills

Regarding the role of computers and technology in teaching reading, Fox (1987) noted that technology allows learners to select tasks that match their interests. In this study, the heuristic intervention involved repeated assessment across a range of reading activities, including pre-reading questions, scanning with specific-question prompts, gist identification using multiple-choice items, guessing new words through inference strategies and word games, and noticing grammatical and discourse relationships (e.g., deixis). Consistent with Compton and Pearson (2016), the study assessed trainees' general reading comprehension outcomes in relation to reading sub-construct variables considered potentially important for reading comprehension performance—namely cognitive processes, linguistic processes, and responses to instruction (Compton & Pearson, 2016, p. 225).

Effects of phases two and three

The second phase focused on intensive reading and required learners to make inferences. Although this phase aimed to strengthen inference-based comprehension, trainees did not show better performance; rather, their mean rank scores were lower at Mid-test 3 (T3). The difference was not statistically significant ($p = 1.000$). Therefore, the second phase alone did not produce meaningful improvement in trainees' reading comprehension development (with a change of 2.74 mean rank and only a 0.28 mean rank difference).

Between T3 and the post-test (T4), the third phase introduced extensive reading practice. The tasks in this phase followed the RAND heuristic model and included: answering questions, paraphrasing text segments, summarizing sections/passages, integrating information and insights across segments, interpreting text and implied meanings, and critiquing both text features and authorial strategies. Learners completed these tasks through navigation on online platforms to access closely related graded reading texts. However, the results remained statistically not significant ($p = 2.10$).

This finding is supported by research indicating that online mobile-based extensive reading practices using graded readers and LMS platforms may still result in limited effects on extensive reading engagement, even when students' reflections are positive (Milliner & Cote, 2015). In that study, lack of effectiveness was attributed not to technological inability, but to factors such as insufficient training in using the LMS, misconceptions about extensive reading, and ineffective exploitation of intrinsic and extrinsic motivators. Similarly, the limited effect in the present study suggests that the failure to enhance reading performance substantially was likely due to issues beyond the technology itself—possibly related to trainees' engagement, preparation, or task implementation.

Cumulative effect across treatment phases

When comparing overall changes, the results showed that the treatment contributions differed across phases. Although the second and third phases individually were not statistically significant, the combined (cumulative) effect between T2 and T4 was statistically significant ($p = 0.022$). Descriptive results also indicated that the second and third phases produced little to no positive effect on trainees' performance (T2: Md = 9.00, and T3: Md = 9.00).

At this point, it is reasonable to infer that some latent changes may have been present but not visible through isolated phase comparisons. The pattern of outcomes suggests that, while individual phase effects were mixed, sequential implementation produced a combined improvement. This also supports the idea that trainees' reading comprehension performance declined as task difficulty increased in the ascending order of the sub-skills. As the mobile-mediated heuristic instructional program progressed from phase one to phase two and three, trainees' performance scores decreased. Differences across time points (e.g., T2 vs. T1, T3 vs. T2, and T4 vs. T3) showed mean rank differences of 1.15, 0.28, and 0.74, respectively, with phase comparisons showing an unpredictable pattern of significance ($p = .007$, $p = 1.000$, and $p = .210$) (see Table 2 and Figure 6).

Overall interpretation of findings

In general, mobile-mediated heuristic reading comprehension instructional model had a statistically significant positive impact on the English specialist teacher trainees' overall reading comprehension growth. Specifically:

- Phase one (lower-level reading comprehension sub-skills) focusing on scanning and skimming lesson activities - including identifying new/special vocabulary, predicting grammar at word/sentence/text levels - produced the strongest predictor of change in general reading comprehension performance.
- Phase two (intensive reading/inference training) contributed the least to comprehension growth, even though phase three also showed a limited independent effect.
- The cumulative effect of phases two and three together contributed positively ($p = .022$) when performance changes from T2 to T4 were analyzed.

Overall, the study supports the notion that as the complexity and difficulty of reading sub-skills training increased, the magnitude of the instructional effects tended to decrease. Learners performed best on tasks involving basic language-element comprehension practices, such as scanning, skimming, and grammar-related comprehension (e.g., structures and tenses embedded in texts). Thus, mobile-mediated heuristic lessons appear to be especially suitable for strengthening scanning and skimming activities.

Implications for inference, evaluation, and critical thinking

The intervention showed limited effects for tasks requiring inferential skills such as evaluation, and critical thinking. Extensive reading activities delivered through mobile-based practices were only moderately insignificant when used alone. Inferential reading tasks were the least significant individually, although they still produced positive effects when combined with other elements. In sum, mobile-mediated reading comprehension improved general reading comprehension ability, but the degree of significance declined as comprehension demands increased in terms of text type/size and sub-skill difficulty level.

Recommendations

Accordingly, in mobile-mediated EFL instructional contexts, EFL teachers and teacher educators are advised to:

1. Use mobile phones primarily to strengthen initial reading capabilities, especially scanning and skimming, and therefore focus on beginner-level, low-complexity sub-skills.
2. Provide reading lessons through mobile technology while placing comparatively less emphasis on annotation practices at intermediate levels, at least until learners develop sufficient readiness for such tasks.
3. Treat extensive reading practice carefully: although it may contribute positively as a combined effect, it should not receive excessive instructional prominence, and learners need guided support to sustain meaningful engagement.
4. Ensure students gradually progress toward more demanding tasks (intensive reading with inference, and evaluative/critical reading), but with strong scaffolding.

Finally, this study highlights that reader characteristics should be considered a key area for future mobile-mediated reading research. Policy-makers, curriculum designers, teacher educators, and education administrators should also

give due attention to the importance of mobile phone integration for reading instruction, since early reading proficiency remains a major global educational challenge.

References

- Ababneh (2017). Using mobile phones in learning English: The case of Jordan Sana'. *Journal of Education and Human Development*, 6(4), 120-128. DOI: 10.15640/jehd.v6n4a14 <https://doi.org/10.15640/jehd.v6n4a14>
- Aljohani, M. (2017). Principles of "Constructivism" in Foreign Language Teaching. *Journal of Literature and Art Studies*, 7(1) 97-107. <http://www.davidpublisher.com/Public/uploads/Contribute/583d2297ba95a.pdf>. doi: 10.17265/2159-5836/2017.01.013
- Beck, C., & Kosnik, C. (2006). *Innovations in teacher education: A social constructivist approach. Innovations in Teacher Education: A Social Constructivist Approach*. 1–157. Mendeley. State University of New York Press.
- Blasco, D. (2016). Student's attitudes toward integrating mobile technology into translation activities. *International Journal on Integrating Technology in Education*, 5(5). DOI :10.5121/ijite.2016.5101
- Brown, H. D. (2007). *Teaching by Principles: An interactive approach to language pedagogy* (3rd ed.). Pearson Edu, Inc.
- Chritian, P. (n.d.) Freidman test in SPSS. <https://www.youtube.com/watch?v=2X1oGVnTTkI>
- Compton, D. L., & Pearson, P. D. (2016). Identifying robust variations associated with reading comprehension skill: The search for pressure points. *Journal of Research on Educational Effectiveness*, 9(2), 223-231, DOI: 10.1080/19345747.2016.1149007
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. Routledge Taylor & Francis. <https://doi.org/10.4324/9781315456539> <https://www.taylorfrancis.com/books/edit/10.4324/9781315456539/>
- Cresswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. (4th ed). Pearson Education, Inc.
- Faria, A., et al. (2019). Using technology to support English language learners in higher education: A study of Voxy's effect on English language proficiency. *American Institute for Research*, 1–22. <http://files.eric.ed.gov/fulltext/ED596252.pdf>
- Fox (1987). Some advantages and disadvantages of developing reading comprehension with computers. *Reading in a Foreign Language*, 4(1), 59 - 67.
- Guo, H. (n.d.). Analysing and evaluating current mobile applications for learning English speaking. *British Council ELT Master's Dissertation Awards: Commendation*; Birkbeck, University of London.
- Hariry, N. A. (2015). Mobile phones as language learning tools. *European Scientific Journal*, 11(16), 298- 317. <https://ejournal.org/index.php/esj/article/view/5870/5593>
- Hazaea1, A. N. & Alzubi1, A.A. (2016). The effectiveness of using mobile on EFL learners' reading practices in Najran University. *English Language Teaching*, 9(5): 8-21.

Khubyari, L. & Narafshan, M. H. (2016). A study on the impact of MALL (Mobile Assisted Language Learning) on EFL learners' reading comprehension. *International Journal of English Language Teaching*. 4(2), 58-69. <https://www.researchgate.net/profile/Mehry-Haddad-Narafshan/publication/353234573>

Knapp, K. & Seidlhofer, B. (2009) (Eds). *Handbook of foreign language communication and learning*. Hubert & Co: Germany, Göttingen.

Krashen, S. and Terrel, T. (1983). *The natural approach: Language acquisition in the classroom*. Prentice Hall ELT.

Lin, C., et al. (2019): Mobile-assisted reading development: A review from the activity theory perspective. *Computer Assisted Language Learning*, DOI: 10.1080/09588221.2019.1594919; <https://doi.org/10.1080/09588221.2019.1594919>

Marzouki, O.F., et al. (2017). Effects of social constructivist mobile learning environments on knowledge acquisition: A meta-analysis. *IJIM*, 11(1), 18-39. <https://doi.org/10.3991/ijim.v11i1.5982>

Mehrpour, S., et al. (2011). The relationship between depth and breadth of vocabulary knowledge and reading comprehension among Iranian EFL learners. *Journal of English Language Teaching and Learning*, 22(53), 98-127. https://elt.tabrizu.ac.ir/article_635_fab1c9e8728137f413c8c18a4db48906.pdf

Milliner, B. & Cote, T. (2015). Mobile-based extensive reading: An investigation into reluctant readers. *International Journal of Computer Assisted Language Learning and Teaching*, 5(4), 1-15. https://www.academia.edu/108143865/Mobile_based_Extensive_Reading

Murnane, R., et al. (2012) (Eds.). Literacy challenges for the twenty-first century. *FALL*, 22(2), 3- 15. doi:10.1353/foc.2012.0013 <http://nrs.harvard.edu/urn-3:HUL.InstRepos:34785395> https://dash.harvard.edu/bitstream/handle/1/34785395/Literacy_Challenges_for_the_Twenty-First_Century_I.pdf?sequence=1

Nalliveettil, G. M. & Alenazi, T. H. (2016). The impact of mobile phones on English language learning: Perceptions of EFL undergraduates. *Journal of Language Teaching and Research*, 7(2), 264-272. DOI: <http://dx.doi.org/10.17507/jltr.0702.04>; <http://www.academypublication.com/issues2/jltr/vol07/02/04.pdf>

Ottenbreit-Leftwich, T., et al. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education: journal homepage*, 55, 1321-1335. <http://dx.doi.org/10.1016/j.compedu.2010.06.002>

Sharma, A. & Upadhyay, M. (2007). *How to Practice for the Verbal Ability and Reading Comprehension for the CAT*. The McGraw-Hill Publishing Company Limited: New Delhi.

Shofi, A.T. & Jannah, W. (2022). Developing mobile learning application as instructional media for reading comprehension. *Jurnal Bahasa*, 7(2), 198-224. <https://journal.iaingorontalo.ac.id/index.php/al>

Ethics Approval

This study was approved by the Institutional Ethics Committee of SSH College and DELL of Arba Minch University, Arba Minch, Ethiopia, and was conducted in accordance with the Declaration of Helsinki and Arba Minch University's ethical research practice guidelines.

Data Availability Statement

All data supporting the findings of this study are available within the paper.

Consent to Participate

Informed consent was obtained from all participants on a voluntary basis prior to their involvement in the study.

Consent to Publish

Not applicable. No identifiable images or other identifying materials were used in the study, and no consent for publication of such materials was required.

Funding

No funding was received to assist with the preparation of this manuscript.