International Journal of Instruction *April 2024 ● Vol.17, No.2*
e-ISSN: 1308-1470 ● www.e-iji.net *p-ISSN: 1694-609X*
pp. 29-48

Article submission code: 20230304075806
Received: 04/03/2023 Revision: 18/08/2023
Accepted: 08/09/2023 OnlineFirst: 01/01/2024

The Effect of Text Display in Mobile Reading to Reading Comprehension, Attention, and Cognitive

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The aim of this study was to investigate the types of static, dynamic, and mixed text display on students' reading comprehension, attention, and cognitive. In addition, this study also considers sitting, standing, and walking positions and different types of text. Quasi-experiments were used in this study with random sample selection of students at the high school level who have mobile reading habits. The instruments used in this study were gadgets for mobile reading, reading comprehension tests, and cognitive level measurement scales. The results showed that the reading positions that made a significant positive contribution to sustained attention were sitting reading positions and mixed text types which made the lowest contribution to sustained attention. In addition, it was found that the type of text did not have a significant effect on students' reading comprehension skills. Moving text also does not contribute significantly to students' reading comprehension skills. Students' reading comprehension ability is significantly influenced by the type of text display and reading context. Students' cognitive abilities are significantly influenced by the type of text display, but not by the reading context. Of the three types of text display, the sequence of text types that make a significant contribution from the highest to the lowest is mixed text which makes the most significant contribution, then dynamic text, and static text. So, it can be concluded that the reading context and the type of text display have different impacts on students' reading comprehension skills, sustained attention and cognitive levels of students. This research has implications that teachers must modify students' mobile reading habits by displaying text, and reading contexts so that reading comprehension skills can increase optimally.

Keywords: reading comprehension, mobile reading, attention, cognitive level, text display, attention, cognitive

INTRODUCTION

The development of the digital world has had a major impact on the world of education, one of which is changing the habit of reading textbooks to reading texts from mobile. Of course, changing the reading method will more or less have an impact on students' reading skills at school (Y. Liu & Gu, 2020; Shadiev & Huang, 2020). Previous research findings (Chen et al., 2021; Johann et al., 2020) favor mobile reading providing better

Citation: Nurmahanani, I. (2024). The effect of text display in mobile reading to reading comprehension, attention, and cognitive. *International Journal of Instruction*, *17*(2), 29-48. https://doi.org/10.29333/iji.2024.1723a

performance compared to reading traditional books, but previous studies have not uncovered to the extent the role of digital reading on students' attention and cognitive abilities. In terms of quality, digital media has more practical qualities and characteristics. The activity of reading traditional books also has advantages, namely making it easier for readers to give reading marks. In mobile reading, aspects that must be considered to improve mobile reading results, one of which is the aspect of comfort when reading through layers is carried out, for example position, distance, or the type of static or dynamic layer display. Digital reading is less effective in providing contextual meaning for readers that supports the reader's ability to remember and find information. Some of the contextual signs possessed by textbooks are thickness estimates by the senses, estimated information locations, estimates that have been read and have not been read (Kuzmičová et al., 2020; Meguro, 2019). In mobile reading, there are several things that must be considered to improve the results of mobile reading, one of which is aspects of comfort when reading through layers is done, for example position, distance, or the type of static or dynamic layer display. In addition, other factors that affect the results of cellular reading are differences in information processing abilities, eye endurance, eye distance to the screen, and students' cognitive abilities. In the learning process, things that often affect the results of mobile reading are screen sizes and learning navigation (Brown et al., 2021; Bonifacci et al., 2022; Cheng, 2019).

This mobile reading has limitations when used in the learning process. A strategy is needed that can facilitate students to be able to process the material provided effectively. One way that can be done is to design a type of text display that must be able to meet the needs of students so that they can get optimal results. This text display design technique is generally divided into two types, namely static text display and dynamic text display that can be used by students when reading (Albus & Seufert, 2023; Malakul & Park, 2023). The main difference between the two types of static and dynamic displays is the movement of text either automatically or independently. One of the techniques that can be used on the display screen is the paging and scrolling technique (Bonifacci et al., 2022; Xu et al., 2020). Thus, this text display design technique is a very important aspect in mobile reading activities to support students' reading effectiveness. Previous studies have found that static and dynamic text displays can affect students' reading comprehension abilities, but there is no research that integrates both types of text display on reading comprehension at the same time. In addition, based on the results of research studies, no research has investigated digital text display types on attention and cognitive levels through mobile reading activities.

Literature Review

Effect of text display type with small screen on reading performance

Getting information through mobile reading activities is a common activity that people do every day. However, the amount of information obtained through mobile reading is limited because the devices used have small screens such as cellphones. However, these limitations can be overcome by speed reading activities to gain an understanding of certain information (Malakul & Park, 2023; Song & Bruning, 2016). Besides that, another habit that is often done is reading which is often done in various positions such

as sitting, standing, walking, and lying down (Wang et al., 2019; Zou & Ou, 2020). Of course, the different types of text display and reading positions might affect the results of the reading itself. Through this research, researchers will reveal the effect of this type of text display and reading position on reading results. Text views have different types, namely Paging, Scrolling, Auto-scrolling, Times Square (or Leading), and RSVP (Dolean et al., 2021; Ebadi & Ashrafabadi, 2022). These five types of text display are currently commonly used on mobile devices and computers for reading activities to make it easier for readers to carry out reading activities practically and can be done anytime and anywhere. Of the five text display types, the three most frequently used text views on small-screen mobile devices are static and times views, and scrolling. Mobile reading static type uses navigation controls to facilitate readers in selecting and organizing reading text (Li & Ma, 2021; Oakley et al., 2022). Dynamic text usually displays text at a steady pace on the screen while reading. However, this research only focuses on static, dynamic, and mixed text display types used on smartphones or tablets.

In a static view, short text requires more paging and has superior reading performance results, than longer text which requires more panning. In addition, previous research confirms that text display by scrolling is inadequate in supporting information retrieval and is less than optimal for reading comprehension skills (Cheng, 2019; Ding et al., 2021). Screens that move automatically make it difficult for readers to get information on moving text. This is reinforced by the theory that shifting screens on mobile reading makes attention, reading results, and reader comprehension less than optimal or disrupted (Hadianto et al., 2022; D. Liu & Chen, 2020). When the screen moves automatically, the reader's concentration is not on the text but on the screen movement, so that the reader's understanding is less than optimal. However, there is another opinion that this type of static text view requires more reading time than scrolling text view. In addition, there are other opinions that the cognitive level of this type of paging or scrolling is not affected, and this type of text display also does not affect student learning satisfaction. In addition, it was found that differences in the cognitive styles of students who used paging and scrolling did not show significant differences in their learning outcomes, all students displayed equally good learning outcomes (Arrington et al., 2014; Brown et al., 2021). One of the dynamic text displays is times square which moves the reading from right to left, RSVP dynamic text display which presents several sentences of text on the screen at a certain time, and scrolling which moves the text from top to bottom at a constant speed (Hadianto et al., 2021; Kuzmičová et al., 2020).

The results of reading comprehension with the times square text display are lower than the paging text display. In addition, the display of times square text is also not effective and efficient. In addition, it was found that dynamic text has lower readability than static text. Text that moves automatically at high speed causes identification errors that affect the quality of the reading process. Readers use visual and mental abilities in the process of reading static and dynamic texts at the same time (Child et al., 2019; Slattery & Yates, 2018). Therefore, an integrated static and dynamic text display is needed. So, through this research, the researcher designed mixed text displays with static and dynamic displays and saw their effectiveness.

The role of attention and cognitive level on reading ability

Attention is an aspect of cognitive psychology which is defined as the process of selecting and filtering information and preventing the intervention of external factors to be further processed by human cognition (Chen et al., 2021). From this definition (Chen et al., 2021), attention is a cognitive process that focuses on one aspect and ignores other aspects that have the potential to interfere. Attention is also a series of activities that facilitate humans to easily interact, complete tasks, accept and learn new things. This attention is also referred to as a resource or tool for information processing. Attention is divided into several types, namely focused attention, shifted attention, selective attention, and divided attention (Johann et al., 2020; Shadiev & Huang, 2020). This research focuses on sustainable attention which is intervened by static and dynamic text display types. Continuous attention is a condition of individual readiness in receiving stimulus for further processing so as to gain new knowledge in the short or long term. This attention becomes part of the learning process that is integrated with memory and interactive communication processes during the learning process. The interaction that occurs in the student's brain during the memory process is the interaction between the cognitive system, memory, and the effects of attention (Gutiérrez-Colón et al., 2020; Özbek & Ergül, 2022). Memory in every human being usually has a limited capacity, so it is this attention that plays a role which information will be processed. The process of identification and memory produced in this learning process will not exist if it does not involve continuous attention while participating in learning activities.

Several previous studies (Ardasheva et al., 2018; Chen et al., 2021; Arrington et al., 2014) have confirmed that understanding information and processing information really requires attention. Reading skill is a receptive language skill which in its process involves various components and is strongly influenced by various aspects. One that contributes to reading is attention. This attention has a strong relationship with reading comprehension ability. In previous studies it was found that this attention was correlated with a range of values of 0.40-0.55 with the results of students' reading abilities (Meguro, 2019; Ravand & Robitzsch, 2018). Although there are several studies that examine the role of attention in reading skills, there is still no research that explains the process of attention influencing reading skills in cellular reading contexts with various text displays. In addition to attention, the cognitive load given to students greatly influences the effectiveness of the results of reading. This cognitive load is very dependent on the instructional design of the learning process. In addition, cognitive load is also related to working memory which is strongly influenced by instructional design of teaching, working memory capacity, and reading media.

Cognitive load is divided into several types, namely intrinsic, foreign, and close (Albus & Seufert, 2023; Hautala et al., 2022). Intrinsic is the countryside of the material being studied such as material content that has a high level of difficulty. Foreign cognitive load is new information conveyed to students, but this cognitive load can be minimized by good teaching materials. Close is a cognitive load that is generated through the construction process and the schemas that students have (Samiei & Ebadi, 2021; Song & Bruning, 2016). Appropriate instructional design modifications in the learning

process will be able to minimize extraneous cognitive load and optimize cognitive load closely. Cognitive load theory can facilitate teachers in designing learning designs in conveying material so that students are encouraged to optimize their intellectual abilities. Foreign cognitive load is also usually determined by several aspects such as the type of text, text presentation, and text display (Tengberg, 2018; Zou & Ou, 2020).

The difference between this study and previous research lies in the integration of both types of text display (static and dynamic), considering cognitive features and looking at the effectiveness of mobile reading. In addition, through this study the researchers also used Neurosky's attention detector based on human brain waves through three types of text display and three sitting positions, namely sitting, standing, and walking. The static text display used is Paging, dynamic text used is Auto-scrolling, and mixed text. The abilities targeted in this study are reading comprehension, attention, and cognitive levels. So, in this study the researcher formulated the problem, namely how does the digital text display types affect reading skill, attention, and cognitive in digital reading?

METHOD

The method used in this study is a quasi-experimental with the aim of investigating the effectiveness of types of text displays in mobile reading on reading skill, cognitive load, and attention of students (Y. Liu & Gu, 2020). The concept of mobile reading in this study is the use of smartphones and tablets that implement three types of text display, static, dynamic, and mixed. To investigate the comparison of the effectiveness of the three types of text display using word format, times new roman, and size 12. The type of text display used is the first type of text display static paging. This type of text display is controlled by the students themselves by pressing the page up and down buttons. With this type of text display, the reading speed is set by the students themselves. The second text display used is dynamic text type. With this type of text display, students read at a steady pace with the text moving from top to bottom at a rate of 350 words per minute. This type of auto-scrolling is very helpful for students to read without having to adjust or move the text or press any buttons, but this type of text display cannot replay or pause it. So, readers must focus when reading with this type of text display so they don't miss or lose text. The final text display used is mixed text combining static and dynamic types. This text display displays text at a steady pace of 125 words per minute from start to finish, but this display type can also be set by the reader themselves when they want to read quickly.

Participants

This research involved 250 high school level students in the Bandung area, Indonesia. Sampling was carried out using purposive sampling technique. The number of participants was taken from three schools representing the three categories of favorite, middle and low schools. Of the total number of participants, 40% were male students and 60% were female students. The age range of students is between 17-20 years old. All students have mobile devices to do reading activities. In addition, all students also have mobile reading experience using mobile devices, both cellphones and tablets, so that students have no difficulty participating in research experiments.

Research procedure

At the beginning of the activity, before students carry out formal reading activities using mobile devices, all students receive a 15-minute debriefing on how to use the type of text to be read. When the mobile reading activity was carried out, the researcher used a mindset headset to investigate students' sustained attention. Each student reads 10 articles presented on their respective mobile devices. Mobile devices all use touch screens to make it easier to use all three types of text display. All students are not given a time limit to read, so that students can complete reading activities depending on their individual speed. To ensure that students' fatigue does not affect their reading results, they are given a two-hour break after completing the reading activity. The break time is used so that students do not feel tired when participating in post-test activities to investigate their level of understanding of reading and fill in the cognitive load assessment format to determine the level of students' cognitive load. In addition, at the end the researcher conducted interviews with several participants.

The usual reading positions for readers are walking, sitting, standing, running, up and down stairs. However, in this study, researchers only used sitting, standing, and walking positions in carrying out reading comprehension activities. There are three sitting position settings used in the study, namely the first sitting position, students sit in chairs and use tables to read articles using their mobile devices. Second, standing reading position, students stand and lean against the wall while reading using their mobile devices. Third, walking reading position, students walk with a predetermined route while reading using a mobile device. The types of text display used in this research are static, dynamic, and mixed with the three positions, namely sitting, standing, and walking.

Research Instrument

There are three instruments used in this study, namely an instrument to measure reading comprehension ability, to assess sustained attention, and an instrument to assess cognitive load. The following describes in detail each of the three instruments.

Brain wave detection instrument to assess students' sustained attention

Researchers used a Neurosky mindset headset with contact sensors with students' foreheads which could measure students' sustained attention in real terms using raw electroencephalography (EEG) data. The size of the sensor data is in the value range 0-100 which indicates the level of student focus. To strengthen the function of the attention detection headset, an attention model is needed by combining the attention signal and the resulting sensor data to assess the level of attention. Apart from this research, previous studies have also used student attention detection headsets. From previous research, this tool can accurately assess the level of attention and can prove a positive relationship between the attention that is assessed and what is reported. The validity and reliability of the MindSet NeuroSky headset have been proven and meet the criteria to be used to measure attention level. MindSet NeuroSky is that students' emotions can be used to measure the level of difficulty experienced when reading. So, this tool meets the standards for use in research.

Instrument for measuring reading comprehension ability

Researchers used questions to assess students' understanding of the reading. This test assesses memory, comprehension, and application abilities. Retrieval of students' reading comprehension skills was carried out after the mobile reading intervention. The questions used to assess reading comprehension skills totaled 20 questions. This type of memory question assesses students' ability to remember the information and facts contained in the article. Types of comprehension questions measure students' ability to understand implied information, organization of information, and interpretation of facts and information. This type of application question assesses students' ability to solve problems based on the information and facts contained in the article. This instrument was developed by himself based on these three cognitive levels. The validity and reliability of the questions were carried out empirically and expert judgment.

Scale to measure students' cognitive load

Researchers used the cognitive load scale to see the effect of the type of text display on students' cognitive load. This scale is adopted from Sweller (1998) which is specifically used to measure students' cognitive load. This assessment consists of a subscale to measure load and a subscale to measure student effort in understanding reading. This scale consists of 10 items with a Likert scale that has a range of 1-8 points. The composition of the items used are five items to measure students' mental load (intrinsic load) and five items to measure external mental load (extrinsic load or tight load). The total score on each subscale is 15 points. Based on the results of the validity and reliability tests, the Cronbach's α value on this scale was 0.94. With Cronbach's α values on each subscale are 0.88 and 0.87. From the results of the analysis, this cognitive load scale has high reliability, so it meets the criteria for use in research.

FINDINGS

Effect of reading position and type of text display on students' attention

Descriptive statistical data on the effect of the type of text display on students' sustained attention is presented in table 1. Based on the results of a two-way ANOVA analysis, the F value was found ($F = 0.90$, $p = 0.750 > 0.05$) which can be seen in table 2. From the value, It can be interpreted that there is no significant relationship between reading position and the type of text display. However, this reading position had a significant effect on students' sustained attention with scores ($F = 14.80$, $p = 0.000 < 0.05$). Based on the results of the multiple comparison Scheffe test, it was found that students' attention in a sitting reading position was more significant than in a standing and walking reading position. It was also found that static text display types were superior to mixed text types in increasing students' attention. Dynamic text types also have a significant influence on students' attention compared to mixed text types. So, this mixed text has the lowest influence on students' sustained attention compared to the other two texts.

Table 1
Continuous attention analysis results in various mobile reading positions and text displays

Type text on screen	Sitting		Standing		Walking		Total	
	Attention		Attention		Attention		Attention	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Static	60.09	6.54	62.50	5.90	56.53	4.12	52.70	6.31
Dynamic	60.76	5.40	61.36	6.80	53.54	4.43	52.81	6.70
Mixed	50.45	7.57	50.68	7.46	51.21	3.40	48.60	7.20
Total	55.98	7.82	50.56	6.83	48.88	3.80	51.15	7.13

Table 2
Comparison of the results of the continuous attention analysis and the two-way ANOVA Scheffe test

Aspect	Degree of freedom	Sum of squares	Sum of mean squares	F	Sig.	Result of Scheffe test
Reading position	3	856.78	490.54	14.80***	.000	Sitting > standing Sitting > walking
Type text on screen	3	684.65	378.80	10.70***	.000	Static > mixed Dynamic > mixed
Reading position × Type text on screen	5	95.10	24.60	0.90	.750	
Error	241	6178.47	30.725			
Total	250	7635.90				

Effect of reading position and type of text display on reading comprehension

In the second part, the researcher examined the effect of the three reading positions and types of text display on students' reading comprehension abilities, which were tested with three types of questions, namely memory, comprehension, and application. The following describes in detail the effect of the three reading positions and text display on reading comprehension with each type of question.

Overall reading comprehension

The test results for the effect of reading position and type of text display on overall reading comprehension ability tested with the type of memory, comprehension and application questions are presented in table 3. There was no interaction between reading position and type of text appearance on the overall understanding of reading ability based on a two-way ANOVA test ($F = 2.54$, $p = 0.214 > 0.05$). In addition, it was found that reading position and type of text display had no significant effect on overall reading comprehension ability ($F = 0.10$, $p = .825 > .05$; $F = 1.40$, $p = .480 > 0.05$).

Table 3
Ability to read comprehension with the three reading positions and types of text display

Type text on screen	Sitting position		Standing position		Walking position		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Static	4.92	1.20	5.12	1.10	5.52	1.20	5.21	1.20
Dynamic	5.30	1.40	4.78	1.14	5.45	0.90	5.34	1.15
Mixed	5.21	1.30	5.21	1.13	4.62	1.51	4.91	1.30
Total	5.15	1.30	5.35	1.06	5.12	1.30	5.12	1.20

Ability to read comprehension of items about the type of memory

The results of the analysis of reading comprehension ability were tested using the type of memory questions and with various types of text displays are presented in table 4. No significant interaction effect was found between reading position and type of text display on reading ability comprehension was tested with memory questions with scores ($F = 0.40$, $p = 0.820 > 0.05$) from the ANOVA test results. The value of F can be seen in table 5. However, the effect of reading position and type of text display has a significant effect on the type of memory questions with a value of ($F = 3.70$, $p = 0.029 < 0.05$; $F = 6.90$, $p = 0.006 < 0.05$). In addition, it was found based on the results of the multiple comparison Scheffe test, the walking reading position showed a better effect than the sitting position on reading comprehension ability from the memory aspect. The type of static text display also makes a better contribution than mixed text to students' ability to solve memory type questions.

Table 4
Ability to read comprehension on types of memory questions in various reading positions and types of text display

Type text on screen	Sitting position		Standing position		Walking position		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Static	2.60	0.55	2.72	0.50	2.91	0.45	2.70	0.50
Dynamic	2.40	0.60	2.60	0.55	2.82	0.50	2.55	0.60
Mixed	2.20	0.90	2.50	0.56	2.40	0.60	2.36	0.76
Total	2.40	0.70	2.61	0.55	2.70	0.55	2.54	0.76

Table 5
Comparison between reading comprehension performance on types of memory questions with three text display and the results of the two-way ANOVA Scheffe test with multilevel comparison post hoc

Aspect	Df	Sum of squares	Sum of mean squares	F	Sig.	Result of Scheffe test
Reading position	3	3.42	1.23	3.70*	.030	Walking > sitting
Type text on screen	3	4.81	1.90	6.90**	.006	Static > mixed
Reading position × Type text on screen	5	0.50	0.15	0.40	.831	
Error	241	0.40	61.56			
Total	250	570.24				

Reading Comprehension Ability with Comprehension Type Question Items

Students' reading comprehension ability in solving comprehension type questions as a result of various types of text display in mobile reading is presented in table 6. There is a significant relationship between reading position and type of text display on reading comprehension ability from the results of the one-way ANOVA test ($F = 3.20$, $p = 0.020 < 0.05$). In addition, it was found that the type of text display and sitting reading position had a significant effect on students' reading comprehension skills tested with comprehension questions with a score of ($F = 4.40$, $p = 0.052 < 0.05$). However, standing reading position with these three types of text display did not have a significant effect on reading comprehension ability with a score ($F = 2.89$, $p = 0.157 > 0.05$). The position of walking reading with the three types of text display has a significant effect

on the ability to read comprehension with walking values (F = 4.50, p = 0.040 <0.05). Furthermore, based on the results of the Scheffe test it was found that mixed text display types made a more significant contribution than static text types with a sitting reading position. It was also found that dynamic text display type contributed more significantly than mixed text type with running reading position.

Table 6
Ability to read comprehension with comprehension type questions and the three types of text display and reading position

Type text on screen	Sitting position		Standing position		Walking position		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Static	2.21	0.73	2.62	0.78	2.20	0.80	2.30	0.81
Dynamic	2.62	0.71	2.52	0.72	2.74	0.62	2.61	0.60
Mixed	2.71	0.70	2.80	0.51	2.12	0.90	2.55	0.75
Total	2.53	0.75	2.60	0.60	2.30	0.81	2.52	0.70

Table 7
Comparison of reading comprehension ability tested with the type of comprehension questions and the one-way ANOVA Scheffe test

Reading position	Item	Df	Sum of squares	Sum of mean squares	F	Sig.	Result of Scheffe test
Sitting position	Between group	3	4.20	2.14	4.40*	.052	Mixed > static
	Within group	247	25.32	0.50			
	Total	250	29.52				
Standing position	Between group	3	2.40	0.70	2.89	.157	
	Within group	247	19.55	0.41			
	Total	250	21.95				
Walking position	Between group	3	4.42	1.80	4.50*	.040	Dynamic > mixed
	Within group	247	29.42	0.62			
	Total	250	33.84				

Table 8
Comparison of reading comprehension ability on the types of comprehension questions with several text displays and reading positions as well as the results of the Scheffe test from one-way ANOVA

Type text on screen		Df	Sum of Squares	Sum of mean squares	F	Sig.	Result of Scheffe test
Static	Between group	3	2.43	0.89	1.89	.150	
	Within group	247	28.35	0.50			
	Total	250	30.34				
Dynamic	Between group	3	0.52	0.32	0.72	.656	
	Within group	247	20.60	0.45			
	Total	250	21.12				
Mixed	Between group	3	6.35	3.80	7.12**	.008	Sitting > standing >
	Within group	247	26.50	0.51			
	Total	250	32.85				

The results of a comparative analysis of the students' reading comprehension ability tested with the type of comprehension questions, three types of text display, and reading position are presented in table 8. Based on the test results it was found that reading position and type of static text display did not have a significant effect on reading comprehension ability with a value of (F = 1.89, p = 0.150 > 0.05), the type of dynamic

text display and the three reading positions also did not have a significant effect on reading comprehension ability with a score (F = 0.72, p = 0.656 > 0.05). However, mixed text display types and the three reading positions contributed significantly to students' reading comprehension ability (F = 7.12, p = .008 < .05). Furthermore, based on the results of the Scheffe test it is known that sitting reading position and mixed text display types have the most significant contribution to reading comprehension skills tested with comprehension questions, followed by standing reading position, and lastly the lowest effect on reading comprehension is walking reading position.

Reading ability Comprehension is tested with the type of application questions

The results of the reading comprehension ability test using application questions, various reading positions and types of text display are presented in table 9. It was found that there was no significant effect of the interaction between reading position and type of text display form two-way ANOVA test, (F = 1.90, p = 0.130 > 0.05) which can be seen in table 10. In addition, reading position has a significant effect on students' ability to solve application type questions with a value (F = 6.12, p = .009 < .05), but the type of text display did not contribute significantly to reading comprehension ability in solving application type questions with a score (F = 0.60, p = 0.645 > 0.05). Furthermore, to determine the effect size, the researcher conducted the Scheffe test. Based on the results of the Scheffe test, the sitting reading position has a superior effect on the ability to read comprehension of the type of application compared to the standing reading position.

Table 9
Ability to read comprehension on the types of application questions with various types of text display and reading positions

Type text on screen	Sitting position		Standing position		Walking position		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Static	2.20	0.70	0.97	0.42	2.62	0.70	2.31	0.60
Dynamic	2.45	0.65	0.91	0.70	2.02	0.50	2.20	0.60
Mixed	2.31	0.76	0.91	0.80	2.12	0.75	2.24	0.80
Total	2.30	0.70	0.93	0.902	2.31	0.73	2.21	0.843

Table 10
Comparison of reading comprehension abilities with various types of text display and reading positions using the Scheffe two-way ANOVA test and post hoc multiple comparisons.

Aspect	Df	Sum of squares	Sum of mean squares	F	Sig.	Result of Scheffe test
Reading position	3	5.21	3.18	6.12**	.009	Sitting > standing
Type text on screen	3	0.50	0.31	0.60	.645	
Reading position × Type text on screen	5	3.87	0.80	1.90	.128	
Error	241	82.34	.524			
Total	250	88.12				

Effect of reading position and type of text display on cognitive load

The test results for the effect of reading position and type of text display on cognitive load in cellular reading are presented in table 11. Two-way ANOVA analysis found no significant interaction between reading position and type of text display ($F = 0.30$, $p = 0.814 > 0.05$) which can be seen in table 12. In addition, it was also found that reading position did not have a significant effect on students' cognitive load with a score ($F = 1.50$, $p = .324 > .05$), but the type of text display gave significant influence on students' cognitive load. Furthermore, the Scheffe test was carried out to find out which type of text display had the best effect. Based on the results of the Scheffe test it was found that mixed text display types had the best effect on cognitive load with a value of ($F = 17.89$, $p = 0.00 < 0.05$, followed by dynamic text display types, and static text display types .

Table 11
Cognitive load on various reading positions and types of text display

	Sitting		Standing		Walking		Total	
Type text on screen	Cog-load Mean	Cog-load SD	Cog-load mean	Cog-load SD	Cog-load mean	Cog-load SD	Cog-load mean	Cog-load SD
Static	4.21	2.31	3.87	2.70	4.30	2.50	4.22	2.52
Dynamic	5.30	2.53	4.60	2.82	4.91	2.73	4.90	2.60
Mixed	6.13	2.41	5.40	2.70	5.83	2.71	5.73	2.60
Total	5.24	2.60	4.70	2.80	4.82	2.70	4.87	2.71

Table 12
Comparison of cognitive load with various reading positions and types of text display and Scheffe's two-way ANOVA test with post hoc multiple comparisons

Aspect	Degree of freedom	Sum of squares	Sum of mean squares	F	Sig.	Result of Scheffe test
Reading position	3	7.91	4.51	1.50	.324	
Type text on screen	3	82.52	40.14	17.89***	.000	Mixed > dynamic > static
Reading position × Type text on screen	5	3.50	0.712	0.30	.814	
Error	241	512.43	3.40			
Total	250	590.12				

Relationship between reading comprehension ability, sustained attention, and cognitive

The finding of the analysis from the results of the Pearson product-moment correlation test was that there was no significant correlation between the three variables of students' reading comprehension ability, sustained attention, and cognitive load presented at the three reading positions and types of text display. Furthermore, the researchers continued further tests on the correlation of the three variables by selecting 30% of students who had the highest level of attention and cognitive load. Next, the students were divided into superior groups with superior sustained attention, reading comprehension skills, and cognitive load. One more group drawn 30% of students who had the lowest sustained attention, lowest reading comprehension, and lowest cognitive load, and lowest cognitive load. Based on the test results, it was found that there was a significant

correlation between reading comprehension ability and sustained attention in the high group with a score ($r = 0.452$ $p = 0.008 < 0.05$). In addition, a moderate correlation was found between reading comprehension and cognitive load in the low group with a value of $r = 0.381$, $p = 0.004 < 0.05$). The researcher summarizes all the findings of this study in table 13.

Table 13
Some important research findings

Attention		Reading position		Sitting > standing Sitting > walking
		Type text on screen		Static > mixed Dynamic > mixed
Reading comprehension	Overall test sheet	Reading position Type text on screen		
	Types of memory questions	Reading position Type text on screen		Walking > sitting Static > mixed
	Types of comprehension questions	Reading position	Sitting	Mixed > static
			Standing position Walking position	Dynamic > mixed
		Type text on screen	Static Dynamic Mixed	Sitting > standing > Walking
	Types of application questions	Reading position		Sitting > standing
		Type text on screen		
Cognitive load		Reading position Type text on screen		Mixed > dynamic > static

DISCUSSION

Based on the results of this study, it can be emphasized that students' sustained attention in a sitting reading position is better than standing and walking reading positions presented in mobile reading. From the findings of this study, the seated reading position contributes significantly to students' sustained attention which gives directly to students' reading comprehension skills. In addition, the findings of this study were also supported by the results of interviews where the majority of students agreed that reading in a sitting position can focus better so that it can support better reading results. Mixed text display types make a low contribution to students' sustained attention, but produces the most significant cognitive load. This occurs because the mixed text display type displays the text moving at a constant speed until the end. Of course, the speed of the moving text is not in accordance with students' reading habits which causes a high cognitive load (Burin et al., 2020; Shadiev & Huang, 2020). Students stated that the buttons for adjusting the page down and up disturbed the reading process. In addition, students are also afraid of being left behind because their reading speed cannot keep up with the speed of moving text. From the results of the interviews, the majority of students stated that the movement of the text on the mobile device screen was quite slow, but some also stated that the movement of the text was too fast. This aspect causes the level of student attention to be less good and the resulting cognitive load is high (Johann et al., 2020; Kuzmičová et al., 2020).

In addition, the speed of dynamic text movement provides the same response from students as mixed text display types. The research findings are in accordance with previous research which found that dynamic cellular reading types have an influence on the reader's visual performance (Moon & Ryu, 2021; Song & Bruning, 2016). Previous research strengthens that to determine the speed of movement of text according to the ability of the reader (Ravand, 2016; Tengberg, 2018). From the results of the study it was found that the speed of text movement must be vertical with a maximum speed of 310 cpm on mobile device screens. However, taking into account differences in individual reading speed, it is better to use a reading speed setting that can be set by the reader himself. This is different from the static type of text display (Meguro, 2019; Parks et al., 2022). The majority of students stated that their reading skills on static texts were better than dynamic texts because these students' reading habits were the same as reading traditional books. 'Another research finding is that the three reading positions (sitting, standing, and walking) and the type of text display (static, dynamic, and mixed) do not contribute too significantly to overall reading ability (Albus & Seufert, 2023; Oakley et al., 2022). However, there are significant differences in reading comprehension ability in more detail when tested with the three items of types of memory, comprehension, and application. The findings of this study are reinforced by the findings of previous studies which confirmed that static text can be read more quickly than the dynamic scrolling type, but the reading comprehension ability resulting from the two types is not very significant (Hautala et al., 2022; Ravand & Robitzsch, 2018).

The findings of other studies show that the sitting reading position has a better effect than the walking reading position, but reading comprehension with the type of memory questions when the walking reading position is better than the sitting reading position (Albus & Seufert, 2023; Xu et al., 2020). The cause of the walking reading position produces better reading ability than the sitting reading position because the walking position makes the mind more concentrated and clear. However, sitting reading position with mixed text display type has a significant impact on reading comprehension ability with comprehension question types and static text display types. This is because the mixed text display type encourages the reader to adjust their reading speed to a slow and steady pace of text movement. This process makes students' reading comprehension skills better. Cognitive load is built by causal aspects and judgments. The causal aspect refers to the character of the task or environment, the character of the subject, and the interaction between the two aspects. Examples of aspects that cause task character to increase cognitive load are novelty, pressure, and reward systems (Florit et al., 2022; Hautala et al., 2022).

Aspects that cause environmental character include noisy environments, extreme temperatures. Aspects that cause the character of the subject tend to be stable, such as the reader's cognitive ability, style, preferences, and level of knowledge or insight. This interaction of subject, task, and environment has an influence on cognitive load that arises through unstable factors such as motivation, outcome criteria, enthusiasm. Cognitive load assessment can be divided into several aspects, namely mental load, effort, and performance (Wang et al., 2019; Zou & Ou, 2020). The reading positions involved in this study include aspects of the causes and characteristics of the

environment. In this study, reading position in the context of cellular reading did not have a significant impact. However, the type of text display has a significant influence on cognitive load. The type of text display that creates the highest cognitive load is the type of mixed text display, followed by dynamic and static display text. So, it can be concluded that the cause that has the most significant impact on students' cognitive load in mobile reading is the display of the text, not the reading position. The cognitive load that appears is a foreign cognitive load. These findings are in line with the theory that inessential cognitive load is caused by texts that contain new knowledge presented in the text (Ebadi & Ashrafabadi, 2022; Xu et al., 2020). So, it is very clear that teachers must consider the type of text display when implementing mobile reading learning in order to minimize cognitive load.

Mixed text display text types cause the highest foreign cognitive load because the text display appears at a constant speed. This is what causes students' reading skills to be unable to keep up with the speed of displaying text. Based on the results of the study, a positive relationship was found between the variables of reading comprehension ability and students' attention in the group of students who had good reading comprehension skills (Burin et al., 2020; Trudell, 2019). However, there is no significant relationship in the group of students with low reading ability. The findings of this study are in line with previous studies. Previous studies have confirmed that student attention is positively related to reading ability (Chen et al., 2021; Johann et al., 2020). In addition, the findings of this study are also confirmed by the theory that students' attention is always positively related to students' reading performance. Other research findings in this study, namely reading comprehension ability correlated significantly with cognitive load in the group of students with low cognitive load, but in the group of students with high cognitive load there was no relationship between these variables (D. Liu & Chen, 2020; Ozeri-Rotstain et al., 2020). The results of this study are reinforced by the theory that students who get appropriate and optimal assignments with student demands will make students better at achieving learning goals. So, cognitive load in learning is very important because it can encourage students to read actively in achieving learning goals. Cognitive load that is too excessive is also not good for students which will make students' abilities not increase (Song & Bruning, 2016; Tengberg, 2018). So it can be emphasized that the cognitive load presented in the learning process must be in accordance with the cognitive abilities of students in processing this new information.

CONCLUSION

Based on the results of the study, it can be concluded that sitting reading position with dynamic text makes the most significant contribution for ongoing attention. This is in contrast to mixed text displays which generate the least amount of attention. The three reading positions and types of text display do not have a very significant effect on reading comprehension ability as a whole, but do have a significant influence on reading comprehension ability from the three types of questions, namely memory, comprehension, and types of application questions. So, the position of reading and the type of text display makes a significant difference to the ability to read comprehension when tested with the three types of memory, comprehension, and application questions. This study also confirms that the type of text display has an influence on cognitive load.

The type of text display that has the highest effect on cognitive load is mixed text display, followed by dynamic and static text. Reading position has no effect on cognitive load. Students' reading comprehension ability has a significant relationship with sustained attention in the group of students with good reading comprehension ability. Cognitive load is also significantly related to reading comprehension ability in groups of students with low cognitive load. So, the three reading positions and the type of text display used in the learning process through mobile reading affect the level of students' reading comprehension, attention, and cognitive load. Therefore, teachers must be good at choosing the type of text display and text material that suits students' abilities so that they can improve their reading comprehension skills optimally and not overstep their cognitive load.

This research implies that parents or teachers must form good mobile reading habits by choosing texts that are appropriate to students' cognitive load. In addition, one must be good at setting reading positions and the type of text display that can optimize the reading ability of students or their children so that they contribute to academic achievement in their schools. Some of the limitations of this research are the limitations of the subject matter, the age range which is only carried out on students who are in the adolescent category, the reading position which is limited to three positions, and the type of text display which is still limited. The researcher recommends several aspects for further research it should be carried out with a larger sample, tested on students who fall into the category of children, for example at the kindergarten and elementary school levels, as part of an effort to form reading habits, a better reading position. expanded, for example by lying down which is often done by children at home. By accommodating these suggestions, further research will obtain more comprehensive and useful data in providing knowledge to parents and educators about mobile reading habits that support their cognitive abilities. In addition, the researcher also recommends that stakeholders develop applications that are able to adjust text speed to mobile reading positions in order to support students' digital reading habits both at school and at home.

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