Research on the Impact of Mobile Reading Tools on University Students' Academic Literature Reading Efficiency (Postprint)

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Abstract

Objective: To investigate the influence of different mobile phone screen sizes and reading applications on the efficiency of academic literature reading among university students. Method: Through questionnaire surveys, interviews, and experimental methods, we analyzed users' time spent reading academic literature, comprehension rate, and retention rate. Results: Mobile phone screen size has an impact on reading time, but no significant effect on reading comprehension rate or reading retention rate; application user experience has an impact on reading comprehension rate, but no significant effect on reading time or reading retention rate. Limitations: The types and number of experimental users were limited, and the assessment methods for reading comprehension rate and retention rate were not sufficiently objective. Conclusion: Screen size and reading applications affect different aspects of reading efficiency; optimizing mobile reading tools and application user experience can improve users' reading efficiency.

Full Text

Preamble

Impacts of Mobile Reading Tools on College Students' Academic Reading Efficiency

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Abstract

[**Objective**] This study investigates how different cell phone screen sizes and reading apps affect college students' efficiency in reading academic literature.

[**Methods**] We analyzed users' reading time, comprehension rate, and memory rate through questionnaire surveys, interviews, and experiments. [**Results**] Screen size significantly affected reading time but showed no significant impact on reading comprehension or memory rates. App user experience influenced reading comprehension rates but had no significant effect on reading time or memory rates. [**Limitations**] The participant pool was limited in both size and diversity, and the assessment methods for comprehension and memory rates lacked objectivity. [**Conclusions**] Screen size and reading apps affect different dimensions of reading efficiency. Optimizing mobile reading devices and app user experience can enhance overall reading efficiency.

Keywords: Mobile Reading, Reading Efficiency, Reading Tool, Academic Literature Reading
Classification Number: G250

Introduction

With the improvement of reading devices and apps, mobile reading has flourished, and college students represent the primary user group of mobile devices. A 2015 Pearson survey revealed that 85% of college students owned smartphones and 52% owned tablets, indicating that students possess the necessary equipment for mobile reading. According to the "13th National Reading Survey" released by the China Institute of Press and Publication Research, in 2015, 60% of Chinese adults used mobile phones for digital reading, 8.8% used e-readers, and 11.3% used tablets. Among digital reading users, individuals aged 18-29 accounted for 38.6%, making them the primary demographic. Since most college students fall within this age range, they constitute a significant proportion of mobile reading users.

Mobile reading tools encompass all hardware and software that support mobile reading. Hardware includes devices such as smartphones, tablets, and e-readers, along with their physical attributes like screens, CPUs, and batteries. Software includes mobile applications. The screen, as an indispensable hardware component, provides users with their most direct tactile experience and is the physical attribute they interact with most during reading. Reading apps serve as software tools that facilitate mobile reading, and these tools and their properties can significantly influence reading efficiency.

Understanding how college students use mobile devices for academic reading can help better meet the research needs of professional users, while exploring the impacts of screen size and reading apps on academic reading efficiency can inform the development of mobile reading tools.

Literature Review

Reading research has yielded substantial results since the late 19th century, evolving toward interdisciplinary integration and attracting scholars from lin-

guistics, psychology, education, library and information science, and other fields. From the perspective of reading studies, existing research can be categorized into three areas: reading ontology, reading subjects, and reading objects.

1. Reading Ontology Research examines fundamental concepts, reading models, reading services, and development trends. For instance, Huang Jungui reflected on nationwide reading issues, clarifying the concept and characteristics of reading. Hu Shi and Xiao Lijie studied ancient book reading patterns in new media environments, analyzing current status and future promotion models. Reading services, particularly those provided by libraries such as reading promotion and guidance, have become mainstream services. Fan Bingsi elaborated on fundamental theoretical issues in reading promotion. With the development of smart devices, mobile reading has emerged as a key trend, and Gao Xiaojing et al. explored this trend using two mainstream news apps as examples.

2. Reading Subject Research focuses on individuals with reading cognition and practice abilities, primarily examining reading behavior, psychology, and abilities among specific user groups or in particular contexts. Reading subjects can be categorized by age (children, adolescents, young adults, middle-aged and elderly) or by special needs (visually impaired, hearing impaired, etc.). User reading behavior—encompassing reading speed, methods, purposes, and preferences—has been a major focus. Pinto et al. studied Spanish university students' reading methods and frequencies, controlling for gender, age, socioeconomic factors, and disciplinary background. Li Wu et al. investigated mobile reading usage and gratification among Shanghai college students, controlling for gender, grade, discipline, and phone type. The reading psychological process combines cognitive and regulatory processes. Lu Jing et al. analyzed how large open reading spaces in university libraries affect readers' psychology and proposed improvements. Reading ability research, closely related to reading literacy, has often been based on PISA and PIRLS assessments. Wen Hongbo et al. examined how family environments affect middle school students' reading abilities using reading tests and questionnaires.

3. Reading Object Research focuses on the objects of reading subjects' cognition and practice, primarily including reading technology/tools and reading environments. Studies on reading technology and tools typically examine hardware and software aspects. Zakaria et al. researched optimizing paths for RFID mobile readers using particle swarm optimization and genetic algorithms. Huang Xiaobin and Fu Yuean evaluated the usability of mobile reading terminals using the E-Book Reader as an example. Reading environments encompass all external factors affecting readers. Deng Xiaozhao et al. studied the extracurricular reading environment of rural left-behind children in Chongqing to promote equitable public information resource services.

These three research areas are interdependent and inseparable. Object research cannot be separated from subject and ontology research, nor can subject research be separated from object and ontology research. While organically integrated, each area has its own focus.

In reading efficiency research, scholars primarily study specific languages (e.g., English, Chinese) and particular populations (e.g., visually impaired individuals, students, middle-aged and elderly groups), often integrating subject research. Pečjak et al. examined relationships between reading motivation, efficiency, and classroom activities among third and seventh graders. Miller studied how age and domain knowledge affect reading efficiency. Segura et al. compared reading efficiency among university students, high school students, and art school students. Li Jianjun et al. investigated how font size and word frequency affect low-vision students' reading efficiency and proposed educational strategies.

With internet development and smart device proliferation, reading research has shifted from traditional paper-based reading to digital and mobile reading. Current mobile reading research primarily uses demographic variables (gender, age, disciplinary background) as controls, with few studies using screen size and apps as control variables. Moreover, few studies examine users' mobile reading efficiency for academic literature. Therefore, this paper focuses on using screen size and apps as control variables to study users' academic reading behavior.

3.1 Research Questions

This study addresses two primary questions: (1) Does cell phone screen size affect reading efficiency? If so, which aspects? (2) Do reading apps with different user experiences affect reading efficiency? If so, which aspects?

3.2 Mobile Reading Efficiency Evaluation Metrics

Mobile reading efficiency refers to the amount of reading completed within a certain time or the ratio of effective reading. LaBerge and Samuels' Theories of Automaticity and Perfetti' s Verbal Efficiency Theory identify reading efficiency involving accuracy and speed as central to automaticity theory. During reading, people segment word streams into meaningful phrases or sentences. Texts consist of characters, words, and sentences, and reading a text involves understanding these elements as an integrated whole. According to LaBerge et al., reading accuracy primarily refers to comprehension accuracy. Fry defined "reading efficiency" as the product of reading time and comprehension rate. Li Yongfang viewed reading efficiency as the dialectical unity of reading speed and comprehension rate. Su Guizhen proposed that reading efficiency equals information gained divided by effort and time, suggesting that comprehension, memory (input), time, and effort comprehensively reflect reading efficiency. Since comprehension and memory are closely related, this study posits that reading efficiency primarily relates to reading time, comprehension rate, and memory rate, constructing an evaluation index comprising these three components, as shown in Table 1 .

Table 1 Mobile Reading Efficiency Evaluation Metrics

Metric	Definition	Measurement
Reading Time	Time required to read a text	User timing
Reading Comprehension Rate	Accuracy of text understanding	Percentage of correct answers to comprehension questions
Reading Memory Rate	Completeness of text recall	Percentage of correct answers to memory questions

3.3 Experimental Procedure

Twenty participants were randomly divided into two groups: Group 1 (S1-S10) and Group 2 (S11-S20). In the screen size experiment, both groups read the same academic paper (Gao Xiaojing et al.' s "On the Development Trend of Mobile Digital Reading") using phones with 5.36-inch and 4-inch screens, respectively. In the reading app experiment, based on previous research, we selected the highest user-rated "Duokan Reading App" and the influential "Amazon Kindle" as experimental apps. Both groups used the same phone to read the same text (the "Three S' s of Team Management" section from McKinsey' s team management book), with Group 1 using Kindle and Group 2 using Duokan. We recorded each participant' s reading time and administered a 10-question test after each reading session, with five questions each for comprehension and memory rates, measured as percentages of correct answers. A small-scale pilot experiment preceded the formal study to refine questionnaires and ensure operational feasibility and objectivity.

Before the formal experiment, we surveyed the 20 participants about their mobile reading habits. After completion, participants completed a post-test questionnaire and interviews. The overall experimental procedure is shown in Figure 1 [Figure 1: see original paper].

3.4 Experimental Participants

The experiment involved 20 volunteer students from Wuhan University (male-to-female ratio 2:3), including 4 graduate students and 16 undergraduates. Participants were randomly selected regardless of education level, age, or gender, but all had mobile reading experience. Each participant received a 30 RMB book as compensation.

Participants self-assessed their academic reading comprehension and memory abilities using a 5-point Likert scale (1 = poorest, 5 = best). Sixteen participants rated themselves as 4 ("relatively satisfied") and four rated themselves as 3 ("average"), indicating generally positive self-evaluations that facilitated the experiment.

4.1 Control Variable: Cell Phone Screen Size

(1) User Operation Behavior Analysis

Screen recording data were quantified. Following reference [29]' s classification of 13 mobile device interaction behaviors (input, deletion, click, screenshot, swipe, select, copy, paste, zoom in, zoom out, drag, double-click, scan), we selected swipe, zoom in, and zoom out as relevant reading behaviors. Using SPSS descriptive statistics, we calculated average occurrences of these behaviors for 5.36-inch and 4-inch phone users, as shown in Table 2 .

Table 2 Average Operation Behavior Counts During Reading

Behavior	5.36-inch	4-inch
Swipe	0.002*	0.023*

(Note: * indicates significant difference at the 0.05 level.)

Table 2 shows significant differences in zoom operations between screen sizes. Users of 4-inch phones performed more zoom in/out operations than 5.36-inch users. Screen recordings revealed that due to screen size limitations, smaller phones displayed smaller initial font sizes, requiring multiple zoom adjustments to achieve comfortable reading, thus increasing zoom operations.

(2) Reading Efficiency Difference Analysis

SPSS descriptive statistics (means, standard deviations) for reading time, comprehension rate, and memory rate across screen sizes are shown in Table 3 .

Table 3 Reading Efficiency Means and Standard Deviations by Screen Size

Metric	5.36-inch	4-inch
Reading Time	2 minutes 8 seconds	0.06*
Reading Comprehension Rate		
Reading Memory Rate		

(Note: * indicates significant difference at the 0.05 level.)

Table 3 shows significant differences in reading time between screen sizes. Users of 5.36-inch phones read faster than those using 4-inch phones. Combined with Table 2, 5.36-inch users performed 2.8 fewer zoom in operations and 1.8 fewer zoom out operations on average. The frequent zoom adjustments required on smaller screens increased reading time and reduced speed.

(3) Reading Efficiency Correlation Analysis

Correlation among Reading Time, Comprehension Rate, and Memory Rate

Spearman correlation analysis examined relationships among reading time, comprehension rate, and memory rate. In the screen size experiment, the significance value between reading time and comprehension rate was 0.023 (<0.05), indicating a correlation. However, reading time and memory rate (Sig. = 0.221) and comprehension and memory rates (Sig. = 0.786) showed no significant correlations, suggesting these variables operate independently.

Regression analysis for the correlated pair (reading time and comprehension rate) yielded Sig. = 0.028 (<0.05), confirming a significant relationship. The correlation coefficient was -0.505, indicating a negative relationship: less reading time associated with higher comprehension rates. Analysis revealed that four graduate students, who regularly read academic papers and had more research experience, demonstrated faster reading speeds and better comprehension. Participants S3 and S11 noted in interviews that educational level affects reading speed and comprehension, with graduate students generally outperforming undergraduates in academic reading.

Additionally, most fast-reading, high-comprehension users had large-screen phones. Large-screen users required fewer zoom operations, saving time and facilitating deep reading. Frequent operations on small screens may cause frustration and hinder deep reading. Participant S15 (small-screen user) stated: "Too many operations while reading affect my mood."

Correlation between User Behavior and Reading Efficiency

Spearman correlation analysis examined relationships among swipe, zoom in, and zoom out behaviors and reading efficiency metrics, as shown in Table 4 .

Table 4 Correlation Analysis Between Three Operation Behaviors and Reading Efficiency

Behavior	Reading Time	Reading Comprehension Rate	Reading Memory Rate
Zoom In	0.016*		

(Note: * indicates significant difference at the 0.05 level.)

Table 4 shows a significant correlation between reading time and zoom in operations (Sig. = 0.016). Regression analysis yielded Sig. = 0.048 (<0.05), indicating that reading time varies with zoom in behavior. The correlation coefficient was 0.532 (positive), meaning more zoom in operations led to longer reading times and slower speeds. With similar swipe counts across conditions, zoom in operations had the most significant impact on reading time.

4.2 Control Variable: Reading Apps

(1) User Operation Behavior Analysis

Based on auxiliary reading functions and screen recordings, SPSS descriptive statistics analyzed swipe, backtrack, font adjustment, and other behaviors. Users primarily exhibited swipe, backtrack, and marking behaviors, which were analyzed in detail. Average counts are shown in Table 6 .

Table 6 Average Operation Behavior Counts During Reading

Behavior	Kindle	Duokan
Marking	0.03*	

(Note: * indicates significant difference at the 0.05 level.)

Table 6 shows significant differences in marking behavior. With similar page counts and reading modes, different reading habits caused this variation.

(2) Reading Efficiency Difference Analysis

SPSS descriptive statistics for the three efficiency metrics across apps are shown in Table 7 .

Table 7 Reading Efficiency Means and Standard Deviations by App

Metric	Kindle	Duokan
Reading Time	1 minute 26 seconds	
Reading Comprehension Rate		0.029*
Reading Memory Rate		

(Note: * indicates significant difference at the 0.05 level.)

Table 7 shows significant differences in comprehension rates between apps. Duokan users achieved higher average comprehension scores than Kindle users, indicating better understanding. Analysis revealed two key factors: First, Duokan users frequently employed marking functions (underlining, highlighting). Participants S6, S13, and S16 noted that marking helps focus attention on important content and facilitates deep reading, thereby improving comprehension. Second, online reviews and personal experience indicate Kindle' s font variety, interface friendliness, and functional diversity lag behind Duokan' s. Kindle' s non-fixed pagination and layout also detract from user experience.

In the pre-test questionnaire, participants rated "APP user experience impact on reading comprehension" on a 5-point Likert scale (1 = minimal impact, 5

= maximum impact). Results: 2 participants rated 5, 5 rated 4, 10 rated 3, 2 rated 2, and 1 rated 1 (mean = 3.25), indicating that users believe app experience moderately affects comprehension. Participant S3 stated: "Poor app user experience affects mood and prevents immersion in reading."

(3) Reading Efficiency Correlation Analysis

Correlation among Reading Time, Comprehension Rate, and Memory Rate

Spearman correlation analysis in the app experiment showed no significant correlations: reading time and comprehension rate (Sig. = 0.923), reading time and memory rate (Sig. = 0.661), and comprehension and memory rates (Sig. = 0.311). This indicates these variables operate independently.

Correlation between User Behavior and Reading Efficiency

Spearman correlation analysis examined relationships among swipe, backtrack, and marking behaviors and reading efficiency, as shown in Table 8 .

Table 8 Correlation Analysis Between Operation Behaviors and Reading Efficiency

Behavior	Reading Time	Reading Comprehension Rate	Reading Memory Rate
Backtrack	0.032*		

(Note: * indicates significant difference at the 0.05 level.)

Table 8 shows a significant correlation between reading time and backtrack behavior (Sig. = 0.032). Regression analysis yielded Sig. = 0.051 (approaching 0.05), suggesting reading time varies with backtrack behavior. The correlation coefficient was 0.481 (positive), indicating more backtracking led to longer reading times because revisiting previous content required page-turning operations.

Conclusion

Experiments controlling for "cell phone screen size" and "reading apps" yielded the following conclusions: First, from the hardware aspect, screen size affects academic reading time, with large-screen phones requiring less time than small-screen phones. Screen size showed no significant impact on comprehension or memory rates. Reading time correlated negatively with comprehension rate, while no correlations existed between time and memory rate or between comprehension and memory rates. Zoom in operations increased reading time.

Second, from the software aspect, apps with different user experiences affected comprehension rates, with Duokan outperforming Kindle. Apps showed no

significant impact on reading time or memory rates. No correlations existed among the three efficiency metrics. Backtrack behavior increased reading time.

Screen size and reading apps affect different dimensions of academic reading efficiency. Screen size significantly impacts reading time, while well-designed apps enhance comprehension. In today' s diverse mobile device market, studying screen size effects can guide users' device selection for research, while app effects can inform developers about optimizing auxiliary functions and automatic font/layout adjustment based on screen size, thereby improving user experience and comprehension.

Limitations include the limited participant pool and subjective assessment methods for comprehension and memory rates, reducing generalizability. Future research should expand participant diversity, develop more refined evaluation metrics, and employ eye-tracking or EEG devices for more objective measurements.

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Author Contributions

Wu Dan: Proposed research questions, designed the study and experiments, revised the manuscript.
Lu Liuxing: Conducted experiments, analyzed results, drafted and revised the paper.

Conflict of Interest

All authors declare no conflict of interest.

Supporting Data

Supporting data are available in the online version of the journal at http://www.infotech.ac.cn:
[1] Wu Dan, Lu Liuxing. sywj.doc. Experimental questionnaire.
[2] Wu Dan, Lu Liuxing. djtm.doc. Experimental test questions.
[3] Wu Dan, Lu Liuxing. sysj.doc. Experimental data.
[4] Wu Dan, Lu Liuxing. fttg.doc. Interview outline.
[5] Wu Dan, Lu Liuxing. ftjl.doc. User interview records.

Note: Figure translations are in progress. See original paper for figures.