

# Comparison of Comfort between Paper and Electronic Mediums in Handwriting Tasks

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## ABSTRACT

Handwriting performances of paper, LCD tablet, and electrophoretic electronic paper were evaluated. Measurements of handwriting speed and subjective evaluations were performed for note-taking tasks. Experimental results suggested that the electronic paper is advantageous in achieving both high performance and low eye fatigue in handwriting tasks.

## 1. INTRODUCTION

Liquid crystal type tablet terminals and electrophoretic type electronic paper (e-Paper) terminals are both expected to be promising tools in various reading scenes<sup>1)</sup>. These terminals are also expected to be applied to textbooks and notebooks that can be hand-written like paper<sup>2)</sup>. We tried to clarify the superiority and inferiority of the electronic mediums in terms of working efficiency and comfort in handwriting tasks compared with paper. We conducted evaluations of working performances during note taking tasks in lecture scenes.

The test subject uses paper, an LCD tablet, and an electrophoretic type e-Paper for transcription tasks. We conducted a comparative analysis of the usability of mediums through evaluations of writing speed and subjective answers.

## 2. EXPERIMENTAL METHOD

We prepared four similar texts on Japanese history lecture of a university. Lecture contents were displayed on a whiteboard by using a projector. Subjects were ordered to transcribe the displayed lecture contents by using one of the three handwriting mediums (paper, LCD tablet, e-Paper). The order of usage of the three mediums was rotated for the subjects for the purpose of compensation of supposed effect of getting accustomed to the simple tasks. We asked the subjects to answer questions on handwriting difficulty, comfort, and eye fatigue just after each writing task every time.

Table 1 shows details of experimental conditions. Arrangements of the handwriting task is shown in Fig. 1. Typical texts for handwriting tasks are shown in Fig. 2.

Table 1. Experimental conditions

Test site	Meeting room of Tokai Univ.
Illuminance	1400 [lx] on desktop
Subjects	University students (16 subjects)

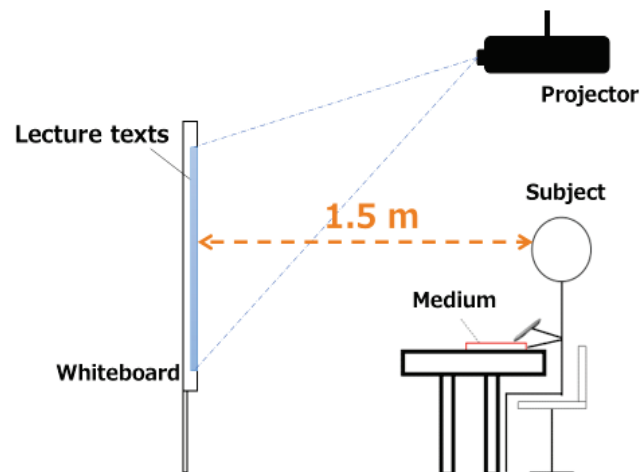
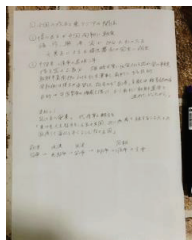
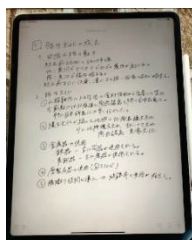
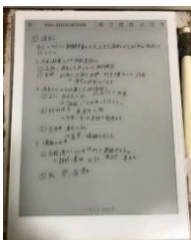


Fig.1 Arrangement for handwriting task

Table 2. Three mediums for handwriting tasks

Paper	LCD Tablet	e-Paper
A4 size plain paper	iPad Pro 12.9 [in] (Apple)	Supernote 10.3 [in] (Ratta)
		

<p>①弥生文化の成立</p> <p>1 中国大陸の動き</p> <ul style="list-style-type: none"> <li>・紀元前6500～5500年頃</li> <li>北：黄河でアワやキビなどの農耕が起る。</li> <li>南：長江で稲作始まる。</li> <li>・紀元前3 Cには秦・漢による統一国家の成立が始まる。</li> </ul> <p>2. 弥生文化</p> <p>①水稲耕作による生活→食料採取から生産へと変化</p> <p>※前期には北海道と南西諸島を除く日本列島に。特に日本海側は早く伝わった。</p> <p>②縄文文化が続いた地域→北海道 縄文文化</p> <p>7 C以降 弥生文化、オホーツク文化</p> <p>南西諸島 貝塚文化</p> <p>③金属器の使用</p> <ul style="list-style-type: none"> <li>・鉄器…主に武器が使用される。</li> <li>・青銅器…主に祭器が使用される。</li> </ul> <p>④磨製石器の使用(包丁など)</p> <p>⑤機織り技術の導入→紡錘車の使用が始まる。</p>
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Fig.2 Typical texts for handwriting tasks

### 3. RESULTS

Figure 3 shows the results of averaged writing speed on each medium. Levels of significance “p” are also indicated in Fig. 3; difference is significant when  $p \leq 0.05$ , marginally significant when  $p \leq 0.1$ .

The subjective evaluation results are shown in Fig. 4, 5, 6, and 7. The results regarding misalignment and delay during writing were both favorably evaluated in the order of paper > e-Paper  $\approx$  tablet (Fig. 4, 5). The results regarding eye fatigue were favorably evaluated in the order of paper > e-Paper > tablet (Fig. 6). The order of general comfortability of handwriting tasks were Paper > e-Paper  $\approx$  tablet (Fig. 7).

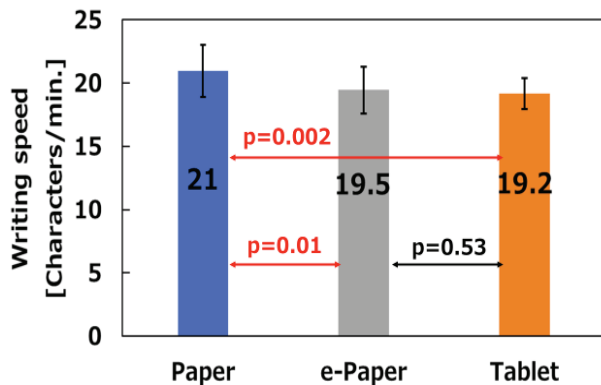


Fig. 3 Writing speed

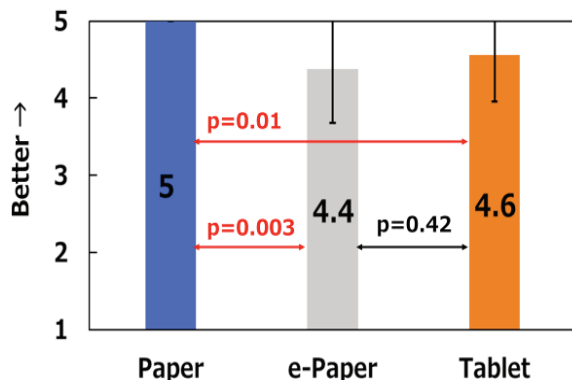


Fig. 4 Misalignment of writing position

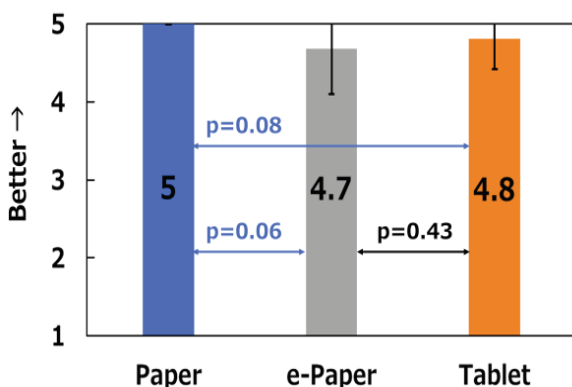


Fig. 5 Pen response

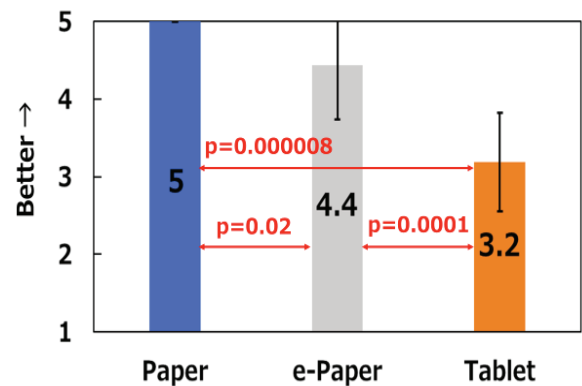


Fig. 6 Eye fatigue

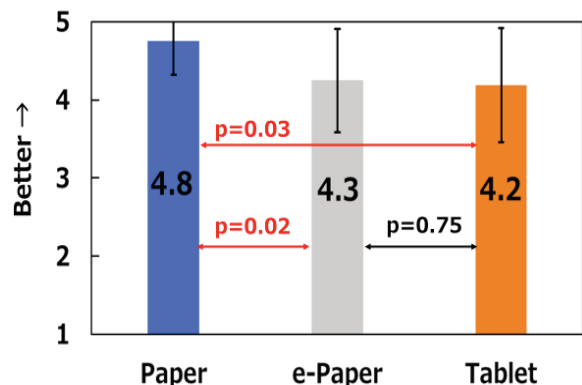


Fig. 7 Writing comfort

### 4. SUMMARY

We compared the workability of handwriting using paper, e-Paper, and LCD tablet, and obtained the following evaluation results.

(1) Measured writing speed were nearly even when using the three mediums.

(2) Subjective evaluations on misalignment of writing position and writing delay were almost even for the two electronic mediums. Evaluated results were rather favorable.

(3) The e-Paper showed nearly low fatigue to paper, while the LCD tablet showed higher fatigue.

(4) The subjective assessment of writing comfort was almost even for the two electronic mediums. Paper showed slightly better comfort than the electronic mediums

These results suggest that e-paper is an ideal electronic medium that assure both less eye fatigue and high writing performance close to those of paper.

### REFERENCES

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