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Development of a Typing Skill Learning Environment with Diagnosis and Advice on Fingering Errors

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Abstract

Existing application software for touch typing training cannot diagnose fingering errors. Given this fact, we developed a skill learning environment for touch typing training that can diagnose fingering errors by recognizing fingers with color markers using image recognition technique. This study developed two systems: a learning support environment for an experimental group and a learning environment for a control group. We evaluated the effect of the learning environment that can diagnose fingering errors for the experimental group, by comparison with the other learning environment for the control group.

Keywords: Touch typing; Blind touch; Skill; Learning environment; Fingering; Open CV; Mistype; Typing;

1. Introduction

Some application software for learning touch typing skills has been developed. In the literature, one report [1] describes a touch-typing training tool that can detect whether a trainee looks at a display or a keyboard during training. Another system [2] provides computer-network-based touch typing training that uses the principle of competition among students. Another report [3] describes a learning environment for touch typing skill using augmented reality technology.

Some online touch-typing training systems have also been developed. Two, which are shown on their respective web sites [4] [5], are online training systems displaying the use of a keyboard and fingers. The system presents texts to be typed, and indicates the key and the finger used for the purpose by highlighting

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them on the picture for typing each character. However, the systems cannot diagnose fingering errors by which a learner hits the correct key but with the incorrect finger.

We developed a typing skill learning environment that can diagnose fingering errors. Then we used this system to assess the typing of group of experiment participants. Moreover, we developed a learning support system for a control group, which is similar to conventional typing training application software. We compared the typing skill improvement rates of the respective groups.

We did not use an existing touch typing learning support system, but instead developed an original environment for the control group because we wanted to give the same test texts to both groups.

2. Developed Systems

We developed two systems: a learning environment for the experimental group and a learning environment for the control group.

2.1. Learning environment for the experimental group

The experimental group system consists of a PC, a display monitor, a keyboard, and a web camera supported by metallic bars over the keyboard, as shown in Figure 1.

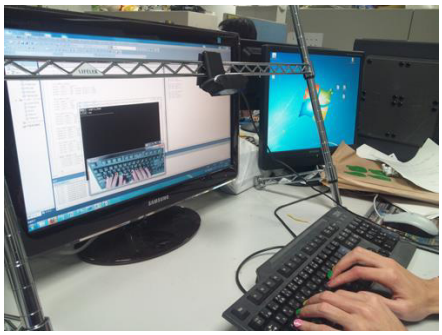

Fig. 1. Learning environment for the experimental group

The system selects a text from a database at random. Then it shows a learner the text in a console window on the display monitor. The learner types the text using the keyboard. The typed text is also shown in the console window on the display monitor. When the learner mistypes a character, the system indicates the mistyping error by not showing the typed character on the console window.

Furthermore, when the learner has typed a correct character but using a wrong finger, the system signals the fingering error and indicates, using a message, the correct finger to be used. Figure 2(a) presents a scene in which the system explains the fingering error by a message on the console window. When a learner has had a mistyping error or a fingering error in the experimental group, the learner cannot proceed without typing correctly.

The system uses image recognition technique to sense the finger positions by Open CV. A learner places colored markers on the fingernails, as shown in Figure 2(b). The web camera monitors positions of learner's fingers by tracing the colored markers. Colored markers of the finger tops are recognized by the image recognition process. The colored markers consist of two pink markers, two green markers, two yellow markers, and two blue markers. Correspondence between each finger and each color is fixed. Therefore, the system can

identify each finger top position by each color. The system can sense the coordinate value of each finger position, and can ascertain whether a key is hit by the correct finger or not.

The system shows a hint window on the display monitor in which a picture of learner's typing taken by the monitoring web camera is shown. Moreover, in the picture, the system shows a line between the finger and the key which should be used for typing the next character. Figure 2(b) shows the hint window.

Fig. 2. (a) Console window showing the text and message. (b) Hint window for a learner in the experimental group

2.2. System for the control group

The system for the control group consists of a PC, a display monitor and a keyboard. The system for the control group shows text for typing, text typed by a learner, and messages for mistyping errors as well as the system for the experimental group. However, the system for the control group does not indicate any message for fingering errors. Figure 3 shows that the hint window of the system indicates a key to be hit next and a finger to be used next by a picture. The system for the control group represents typical existing application software for learning touch typing skills.

No existing touch typing learning support system was used. For this study, we developed an original environment because we had planned to use the same test texts with both groups.

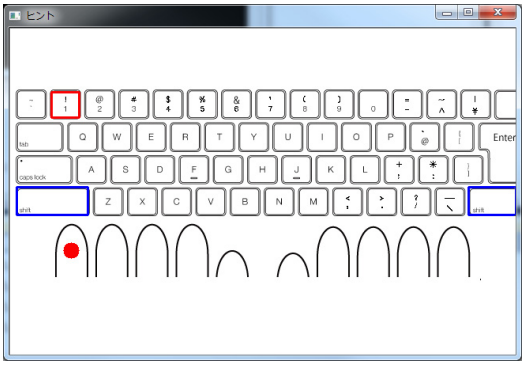

Fig. 3. Hint window for the control group

3. Evaluation Experiment

We evaluated the system for the experimental group by comparison with the system for the control group.

3.1. Overview of the experiment

The 12 participants, who are university students, were divided into an experimental group and a control group. Each group included six participants. Subjects of each group trained themselves for typing using each dedicated system. We performed a pre-test and a post-test before and after the training. We calculated each participant's improvement rate by subtracting each score of the pre-test from each score of the post-test.

3.2. Goal of the experiment

A goal of the experiment was to verify a learning effect by the learning environment for the experimental group. The learning environment for the experimental group detects not only a learner's mistyping errors but also fingering errors. We assessed the effect by comparison to the effect of the system for the control group. Another goal was to verify the learner's awareness and improvement of attitude for fingering errors. We performed a questionnaire survey of both groups for the learner's awareness and improvement of attitude for fingering errors. Then we compared the results of the surveys.

3.3. Workflow of the experiment

At the beginning, we performed a questionnaire survey about touch typing and fingering. Subsequently, we conducted a pre-test of both groups. Subjects in both groups typed some texts to assess their typing skills using no learning environment. After the pre-test, participants in the experimental group trained themselves for 15 min using the learning environment for the experimental group, which can detect not only mistyping errors but also fingering errors and which can display advice on how to correct the errors. However, participants in the control group trained themselves for 15 min using the learning environment for the control group, which can detect only mistyping errors. After the training, we administered a post-test to both groups in the same way as the pre-test. Finally, we performed a questionnaire survey.

3.4. Questionnaire survey before Pre-test

We administered a questionnaire survey to participants on their typing skill before the pre-test. The questions in the survey were the following. Choices or units for answers are indicated in the parentheses below.

(1) How many years and months have passed since you began to use a PC? (years, months)
(2) What percentage of keys of numbers, symbols, and alphabet characters can you hit by touch typing? (Less than 30%, 30–60%, 60–90%, More than 90%)
(3) Can you perform correct fingering during touch typing? (I do not know correct fingering. / It depends on keys. / I can do it almost.)
(4) Have you used any learning environment for typing skills? If you have used it, how long have you used it? (months)

3.5. Pre-test

For the pre-test, we showed participants only the console window, as shown in Figure 2(a), and asked them to type as they usually do. When a participant had a typing error, the system rejected the mistyped character and displayed an error message. However, when a participant had a fingering error, the system did not indicate it to the participant and the system accepted the character that was typed using a wrong finger. Texts to be typed in the pre-test were selected at random from a database. The pre-test ended when a participant finished typing all the text selections. We measured the number of mistyping errors, the number of fingering errors, and the duration necessary for typing all of the texts.

Texts to be typed consisted of alphabet characters, symbols, and numbers. In addition, the set of the texts includes every character at least twice.

3.6. Skill training for touch typing

After finishing the pre-test, participants in the experimental group trained themselves for 15 min using the learning environment for the experimental group, which can detect not only mistyping errors but also fingering errors and which can display advice on how to correct the errors. However, participants in the control group trained themselves for 15 min using the learning environment for the control group which can detect only mistyping errors.

We told the participants of both groups that they should train themselves for correct fingering and typing as fast as possible and that they should avoid mistyping. We also told them that they should be conscious of the home position for touch typing. Moreover, we told them specifications of the learning environments. For example, either the shift key is usable even if both of shift keys are highlighted in the hint window, or no hint will be indicated if the next key to be hit is a space key.

Subjects in both groups trained themselves using the same text selections as those in the pre-test.

3.7. Post-test

After the training, we conducted post-tests with both groups in the same way as the pre-test. The post-test included the following conditions: that participants should be conscious of correct fingering and that they should type as quickly as possible.

Texts to be typed in the post-test differed from the texts in the pre-test because we wanted to avoid a situation in which the participants kept memorizing each text.

Finally, we administered a questionnaire survey.

4. Results of experiment

This chapter presents a description of results of the experiment.

4.1. Results of the experiment

Table 1 presents results for the experimental group. Table 2 shows the results for the control group. In the column of participant ID in the tables, ‘Pre’ represents pre-test, and ‘Post’ represents post-test.

The total texts to be typed included 447 characters in the pre-test and 354 characters in the post-test. Fingering errors were counted only if a participant typed a correct character using a wrong finger.

Table 1. Results of the experimental group

Subject ID	Number of fingering errors	Number of mistyping	Duration time (S)
E1 (Pre)	206	29	322
E1 (Post)	50	42	378
E2 (Pre)	6	23	291
E2 (Post)	7	7	203
E3 (Pre)	252	7	441
E3 (Post)	77	23	329
E4 (Pre)	181	42	238
E4 (Post)	26	8	331
E5 (Pre)	15	25	350
E5 (Post)	4	23	266
E6 (Pre)	22	11	261
E6 (Post)	12	15	211

Table 2. Results of the control group

Subject ID	Number of fingering errors	Number of mistyping	Duration time (S)
C1 (Pre)	3	31	282
C1 (Post)	6	18	232
C2 (Pre)	39	146	337
C2 (Post)	19	51	298
C3 (Pre)	38	22	272
C3 (Post)	18	28	211
C4 (Pre)	70	61	347
C4 (Post)	41	26	237
C5 (Pre)	81	33	350
C5 (Post)	23	94	486
C6 (Pre)	43	24	210
C6 (Post)	40	9	207

4.2. Improvement rate

We calculated improvement rates related to the number of fingering errors, the number of mistyping errors, and the duration. The equation of the calculation is the following.

$R = (\text{Pre} - \text{Post})/\text{Pre}$

There, R is the improvement rate. Pre is each participant's value in the pre-test. Post denotes each participant's value in the post-test. The improvement rates indicate their reduction ratios. We calculated it because simple subtraction between pre-test and post-test does not reflect improvement well in case that each value in the pre-test is comparatively small.

Figure 4(a) shows the improvement rate of the experimental group. Figure 4(b) presents the improvement rate of the control group.

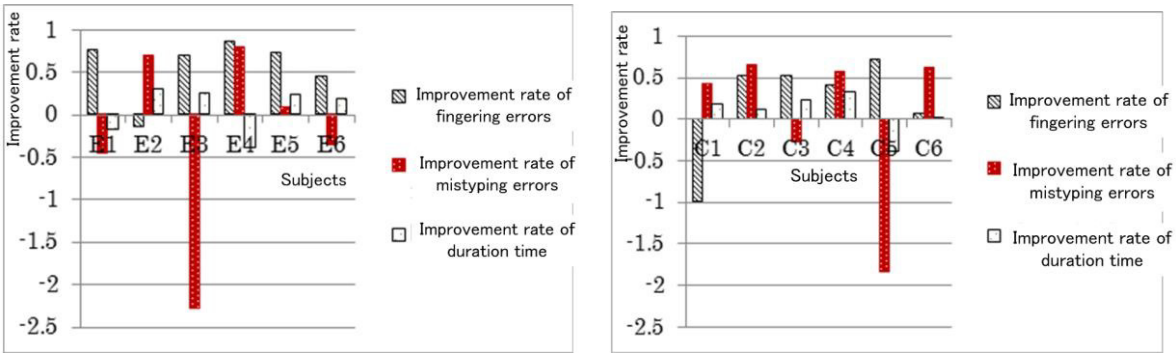

Fig. 4. (a) Improvement rate of experimental group; (b) Improvement rate of control group

4.3. Results of questionnaire survey

We also administered a questionnaire survey. Table 3 and Table 4 show the results of the survey for each group. Each number in each table represents one of the quantities of 5 Likert scale by each participant as follows.

1. No
2. Probably no
3. Middle
4. Probably yes
5. Yes

Two questions were asked: "Is it easy to use the system?", and "Were you able to notice and to correct fingering errors during the experiment?

Table 3. Results of the questionnaire survey of the experimental group

Question / Subject ID	Is it easy to use the system?	Were you able to notice and to correct fingering errors during the experiment?
E1	4	3
E2	4	3
E3	4	5
E4	5	5
E5	5	5
E6	4	5
Average	4.33	4.33

Table 4. Results of the questionnaire survey of control group

Question / Subject ID	Is it easy to use the system?	Were you able to notice and to correct fingering errors during the experiment?
C1	5	4
C2	3	4
C3	5	3
C4	3	3
C5	4	1
C6	4	2
Average	4.00	2.83

4.4. Consideration

The results of the questionnaire survey show that the learning environment for the experimental group was able to notify learners of fingering errors and how to correct the errors.

However, we were unable to find any significant difference of improvement rates between the groups. One reason might be that the training time was only 15 min, although a long time is usually needed to improve skills. The other reason is that participants who already had quite a high level of touch typing skill before training could not achieve much improvement.

5. Conclusion

For use in this study, we developed two systems: a learning support environment for the experimental group and a learning environment for the control group. We evaluated the effect of the learning environment that can diagnose fingering errors for the experimental group by comparison with the other learning environment for the control group. The questionnaire survey result shows that the learning environment for the experimental group was able to notify learners of fingering errors and how to correct the errors. However, results showed no significant difference of improvement rates between the groups.

If we increase the number of participants and gather only novices as participants, then it might be possible to find a significant difference of improvement rates between the groups. We will perform another experiment with such refined conditions to verify the learning effect quantitatively.

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