The Differences between Eye Control and Touch Games in Children's Learning

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ABSTRACT

This study comparatively analyzed the effects of eye control and touch on the learning outcomes of children's educational games. According to the task completion time and performance, the article analyzes the performance of eye control and touch control on children's educational games through the method of ergonomics experiment. It is found that the performance of girls is generally better than that of boys, and the completion time of girls is shorter than that of boys. There is no obvious difference in ergonomics between the performance of eye control and touch control. The article also compared the results of the ergonomics experiment with the results of the summative test, In the results of the summative test, the improvement of the eye control group is higher than that of the touch group, which shows that the use of eye control in children's educational games is more effective .

Keywords: eye control; touch; interaction; children's education

INTRODUCTION

Educational digitalization is one of the main concerns of future education reform and development, and educational games conform to the development of educational digitalization. Studies have shown that using games can achieve better learning results and learning motivation in the learning process than using non-game methods. Compared with adults, children have a lower cognitive ability to understand game content and rules. Therefore, the naturalness and effectiveness of the interactive methods in children's educational games are extremely important. The current domestic children's educational games mainly use traditional interactive methods such as a mouse, keyboard, and touch. Traditional interaction methods are easily boring and fatiguing, which reduces children's concentration and learning effects. Therefore, it is necessary to introduce new interactive methods for children's educational games and conduct research on the performance of traditional interactive methods and new interactive methods in educational games.

Psychologist Treichler found that in the process of acquiring knowledge, 83% of knowledge is mainly obtained through human vision. Currently, eye control interaction technology is becoming mature, and research shows that using eye control can enhance game immersion and improve the game experience. This study designed an educational game that can be based on eye control and touch to study the impact of eye control and touch interaction on children’s education. The behavioral performance and subjective evaluation of the students are analyzed in the study.

METHODS

The subjects in the experiment were 40 first-year students of Yuhua Foreign Language Primary School (20 boys and 20 girls). Students with similar academic levels were selected to ensure that the student's knowledge level was at the same level. The subjects were in the age range of 6-7 years old, all were right-handed, with normal or corrected vision (both above 1.0), and no color blindness or color weakness.

This experiment uses a Tobii 4C eye tracker. The display uses a NEW TAP touch screen model NT-24, a 23.8" full HD 1080P, and the best-supported resolution is 1920*1080 (16:9). The touch sampling rate is 120Hz, and the color gamut is sRGB96%.

EXPERIMENT 1: EYE CONTROL/TOUCH ERGONOMICS EXPERIMENT OF CHILDREN'S EDUCATIONAL GAMES

Experimental materials

The answering materials for the experiment are English word and mathematical calculation questions that designed based on the first grade textbook of Nanjing City, Jiangsu Province. There are 15 questions in English and mathematics. Among them, touch group and eye control group are different in content and similar in difficulty.

The educational game experiment material is shown in Figure 1. According to Li Lu's research, the area of children's buttons based on the PC interface should be at least 2cm×2cm. Because the trigger operation in this experiment requires eye control and touch, the size of the button is designed to be 2cm×2cm. The answer interface for math and English is shown in Figure 1-a/b, and the feedback interface for incorrect and correct answers is shown in Figure 1-c/d.

a. Mathematical topic operation interface

b. English topic operation interface

c. Feedback interface for wrong responses

d. Feedback interface for correct responses

Figure 1. Educational game experiment material

Experimental parameters

In this experiment, gazing is selected as the eye-control interaction method, and long-press is used as the interactive method of the touch. Research on the operation performance of target selection based on different gaze times shows that prolonging the gaze time can effectively reduce the selection error rate, and the long-press time is generally 2000ms. Both gaze and touch in this experiment set 2000ms as the trigger time to ensure the consistency of the trigger time of the eye control group and the touch group.

Experimental process

Each participant needs to complete 30 questions by eye controlling (15 questions each in mathematics and English) and 30 questions by touching (15 questions each in mathematics and English), the experimental process of a single trial is as follows as shown in Figure 2. The independent variables of the experiment are eye control and touch control, and the dependent variables are the answer score and completion time. The eye control group has a total of 30 (questions) * 40 (the number of subjects) = 1200 trials, and the touch group has a total of 30 (questions) *40 (number of subjects) = 1200trials.

Figure 2. Flow chart of a single trial experiment (eye control/touch control)

Participants in the eye control group stared at the answer button for 2000ms, and then the page jumped to the settlement page of the question. After 3000ms, the page automatically jumped to the next question. Participants have a 30-second break before entering next test. The task flow of the math and English was the same, and there was no time limit. The experiment content of the touch control group is the same as that of the eye control group.

Data analysis

According to the experimental results, the average score of the touch group is 94.93, the average score of the eye control group is 94.54, the average completion time of the touch group is 1.77, and the average completion time of the eye control group is 1.83. Using the T-test method to analyze the difference in the scores and completion time of the eye control group and the touch group, it is found that the completion time of the eye control group and the touch group are not significantly different, and the scores of the eye control group and the touch group are not significantly different.

The T-test method was used to analyze the difference in gender between the eye control group and the touch group. As shown in Table 1, Table 2, and Figure 4, the eye control scores have significant differences in gender, t(78)=2.202, p=0.031, girls The scores are better than boys; there is a significant difference in gender of touch scores, t(78)=2.907, p=0.005, girls' scores are better than boys. The difference in gender of eye control time is significant, t(78)=-2.404, p=0.019, the eye control time of girls is shorter than that of boys; the difference in gender of touch time is significant, t(78)=-2.294, p=0.025, the touch time of girls Shorter than boys.

		Number of cases	Mean	Standard deviation	Standard error of the mean
Eye control performance	Female	40	95.9	4.494	0.711
	Male	40	93.18	6.409	1.013
Touch control performance	Female	40	97.25	3.998	0.632
	Male	40	92.6	9.292	1.469

Table 1. Gender differences in eye control and touch performance

		Number of cases	Mean	Standard deviation	Standard error of the mean
Eye control completion time	Female	40	1.72	0.377	0.06
	Male	40	1.95	0.476	0.075
Touch control completion time	Female	40	1.66	0.38	0.06
	Male	40	1.87	0.438	0.075

Table 2. Gender differences in eye control/touch completion time

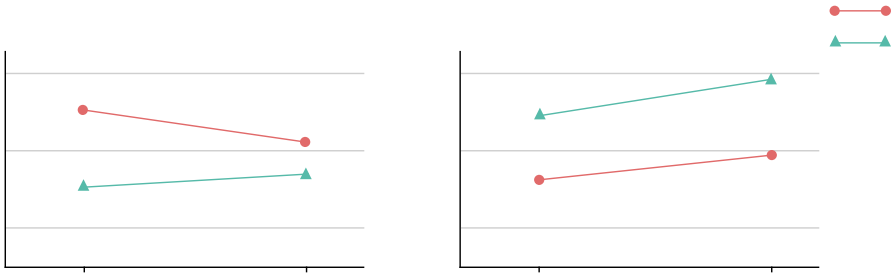

Figure 3. Gender difference chart of eye control/touch performance and completion time

Discussion

Through data analysis, it is found that in the case of gender distinction, the final score and completion time of the eye control group and the touch group in this educational game is significantly different. The final scores of the girls in the two groups are significantly better than the boys, and the completion time is also shorter than boys. Based on Karlak Manuela's study of gender differences in learning motivation, it is found that girls in the same age are better than boys in motivation dimension and motivation intensity, and men's cognitive ability is lower than that of female's.

All the children in the test are willing to participate in this educational game experiment and complete the experiment, which because of the naturalness of eye-control interaction. The children in the eye control group do not need to use their fingers for additional operations, ensuring that the eye control interaction and touch interaction have consistent high efficiency. This verifies Jacob's theory that the eye-computer interaction method can be widely used in general human-computer interaction as a substitute for the mouse, keyboard, finger click, and other instruction input terminals. The results of the use of eye control and touch in educational games show that there is no significant difference in the efficiency of the two interactive methods. As an interactive method of educational games, eye control are also viable.

EXPERIMENT 2: EYE CONTROL/TOUCH SUMMATIVE TEST OF CHILDREN'S EDUCATIONAL GAMES

Summative evaluation refers to the evaluation made to determine the degree of achievement of the educational goal after a certain semester or teaching phase is over. To explore the differences between eye control and touch in educational games, a summative test was used to test the learning outcomes of the children in different interactive methods.

Experimental procedure

Each participant will fill in the summative test papers after the end of the experiment 1, and a total of 40 test papers will be issued. The test questions are English word matching questions and mathematical calculating questions. The content and quantity of the questions are the same as those in Experiment 1. The question are all multiple-choice questions, and there is no limit to the answering time.

Data analysis

To study whether the subjects have learned knowledge in the eye control/touch educational game, the difference between the answer correct rate of Experiment 1 and the answer correct rate of the summative test is analyzed. Table 3 shows the results of the summative test and the task 1. Figure 4 shows the difference between the results of the summative test and the task 1 test. According to the T-test analysis, the results of the first experiment are significantly worse than the results of the summative in touch, $t(79)=-2.04$, $p=0.045$; the results of the first experiment are significantly worse than the results of the summative in eye control, $t(79)=-5.032$, $p<0.001$.

To clarify how the subjects can achieve better learning results, the difference between the eye control group and the touch group in the summative test was analyzed. According to the results of the T-test analysis, there is a significant difference between the eye control and the touch of the summative test. The performance of eye control is significantly better than the performance of the touch in the summative test, $t(79)=-2.431$, $p=0.017$.

	Number of cases	Mean	Standard deviation	Standard error of the mean
Summative test touch group	80	96.94	4.629	0.518
Summative test eyes control group	80	98.09	3.292	0.368
Experiment 1 touch group	80	94.93	7.483	0.837
Experiment 1 eyes control group	80	94.54	5.668	0.634

Table 3. Results of summative test and experiment one

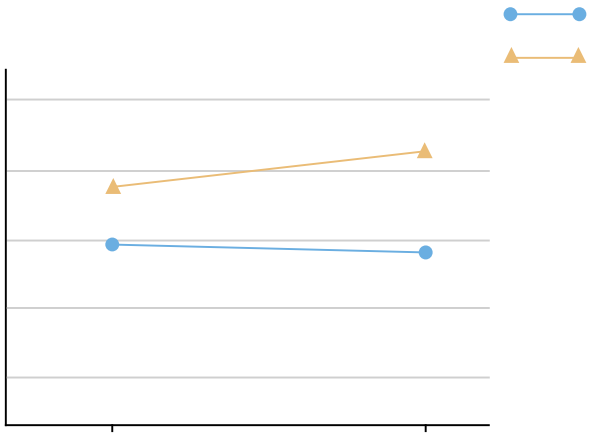

Figure 4. The difference between the summative test result and the test result of Experiment 1

Discussion

From the perspective of the summative test, the traditional paper-and-pencil test is used to test the children's learning results. The results of the summative test objectively reflect the achievement the children had made in a certain stage of learning. It is found that both the eye control group and the touch group are significantly better than experiment 1. The scores of the same test item were improved in the summative test.

From the perspective of the eye control and the touch in the summative test, the performance of eye control are significantly better than those of the touch. The children were more focused and engaged in the experiment when eye control was used, indicating that the use of eye control as an interactive method can strengthen the children's attention stability during learning. Compared with touch, eye control requires gaze selection which can strengthen memory in a way of maintaining intentional attention. This is consistent with Klem and Connell's discovery that students' concentration, patience, and devotion in the learning process can significantly predict the student's final academic achievement, those students with lower levels of devotion have poorer grades. At the same time, the well-known broaden-build theory is verified. The level of investment determines the state of their emotions. The state of high investment along with positive emotions will stimulate individuals to use a wider range of memory data. Making changes from understanding, memory, and cognition to improve performance.

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