Interface Design of Three Modules for Child-Computer Interaction

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Abstract: The paper presents three educational module designs entitled tactile, haptic and multi-mode interaction different in open-ended solutions to the problems. For creative problem solving (CPS), module II is fully open-ended designed. The underlying theory is based on scaffolding inquiry and discovery learning. Module III is most helpful for CPS.

Keywords: Interactive technology, interface design, young children.

Introduction

Apple iPad and Kinect has been introduced in preschools since 2010 [1, 2, 4]. Preschool teachers spend much time in preparing tangible materials in need of storage. Interactive technology is more sustainable and space-saving. Through motion sensing, Kinect enables children to use their gestures rather than a mouse or controller to interact with the content on the screen. Kinect makes children's learning experiences become extraordinary and immersive.

1. Interface Design for Three Modules

1.1 Interface Design for Embodied Interaction

Hsu (2011) mentioned about the implications of Kinect that a user can make sounds and movements on the screen synchronized by his/her gestures and its movement detected by Kinect [3]. Figure 1 shows that children played in front of the screen to move the screen's object into the right position. The story related to the proverb of Wolf and Three Pigs. Children's mission was to build up the wall in order to prevent the invasion of the wolf. There were five materials on the screen such as brick, paper cartoon, wood, plastic bottle, and stack. Each material comprised different texture and weight. Therefore, children should make a decision on the choice of material and move it to the right position. The computer programming allowed children to stick to a chosen material about one second, then he/she smoothly moves and stack it onto the baseline on the screen. The children tended to use the different materials to construct the wall, by piling up one on top of another. While stacking up the materials, they realized that different texture and weight make it rigid and solid. The time limit for playing one game is 100 seconds per round.

1.2 Interface Design for Haptic Interact

For most of young children, drawing on iPad is an exciting experience. Module II was designed to empower children drawing on touchscreen. The story narrated about the Adventure of Henry in Forest. The first scene demonstrated that Henry encountered the heavy rain but he had nothing to prevent from being got wet. He needed to think about how to solve the problem. Seated Children drew a picture by which Henry can prevent himself from being wet. Children might draw an umbrella, a big leaf even a tree. The second scene illustrated that Henry was going to cross over one quickly flowing river without a bridge available. Children started brainstorming for creative problem-solving. Figure 2 showed a cooperative learning for CPS in which two children discussed what the cause of the problem was and what solutions were possible. They drew the solution projected via PC transmission. With the right solution, such as a bridge, Henry successfully crossed over the river to right side.


Figure 1: Module I


Figure 2: Module II


Figure 3: Module III

1.3 Interface Design for Multi-Mode Interaction

In Module III, we developed a combination of interactive technology, namely Kinect and iPad shown in Figure3. Children were doing cooperative learning for CPS. On the left-hand side, two children figured out what the problem was with a falling hot-air balloon and discussed possible solutions for CPS. Through wireless transmission, the solutions were popping up on the screen whilst one of children will wave his hand to move any right solution onto the right location for CPS. As a result, the hot-air balloon was rising up toward the sky. For Module III, children used their hand detected by the Kinect to grasp the yellow square received from the iPad and move it to the right location on the balloon by appropriate gesture. Even though, the red square cannot match the broken problem, this game could continue the progress till the problem was solved.

2. Method

We conducted an experimental study with 86 children (42 boys and 44 girls) mixed-age 4-6 at three (one private and two primary supplementary) preschools. First of all, we set up two video cameras in advance. For technical trial, we asked two children to play with the interactive games. And meanwhile, we adjusted all equipment including hardware and software. During the study of module I and module II, children participated in a 40-minutes interactive learning activity. In module III, children joined cooperative learning with iPad and Kinect. After the above session, we asked children to fill up a worksheet.

3. Results

3.1 Effect of Interactive Devices

For module effectiveness, evaluation of worksheets were developed with problems to be solved corresponding to digital contents of each module. After data collection and analysis, the results were summarized in Table 1 and Table 2.

Table 1: ANOVA on module effectiveness evaluation

Source of variation	*SS*	*df*	*MS*	*F*
Between	8010.023	2		8.737***
Within				
Within-Subjects	65353.167	85		
Error (module)	77928.397	170	458.402	
Total	151291.587	257		

$F_{(.95)(2,170)}$ =3.00, ***p<.001

Table 2: Paring comparison summary

	Module I	Module II	Module III
Module I	—	.024*	.000***
Module II	—	—	.025*
Module III	—	—	—

p<.05,***p<.001

Table 1 shows that the learning effectiveness of three modules reach significant differences at F(2,170) =8.737, p=.000<.001. The means of the learning effectiveness within three modules are Module I=31.76, Module II=39.616 and Module III=45.35. It indicates that haptic interaction can better promote children's creative problem solving (CPS) than the embodied interaction does. Multi-mode interaction shows the best effectiveness in enhancing children's CPS. Table 2 illustrates that an extremely significant difference has been reached between Module I and Module III. It means that multi-mode interaction plays much better influence than embodied interaction. Young children possess better problem-solving skills by haptic interaction [5]. Five- and six-years-old children perform better in CPS than those who are 4-5 years old.

4. Conclusion and Future Work

Interactive technology has been popularly applied in grade 1 to grade 10. However, it is rarely implemented in early childhood education. According to participatory design, we advised preschool teachers to discuss with kids about questions to be solved. According to children's ideas, we planned, designed and developed digital contents. For integration of hardware and software, we conducted technical trial and usability testing with a couple of children. We accomplish the design of haptic, embodied interaction, and multi-mode interaction modules for young children. Based on CPS approach, any possible solutions to the problems designed in three modules are open-ended without fixed answers. Our results provide some evidences that children become creative thinkers in problem-solving. The modules are significant in enhancing CPS. Posteriori comparisons show that pairing comparisons are significantly different. Especially, multi-mode interaction results the best effectiveness on CPS.

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