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The performance of mouse pointing and selecting for pupils with and without intellectual disabilities

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ABSTRACT

The purpose of this study was to compare the performance of mouse pointing and selecting in the tasks with different index of difficulty between 20 pupils with intellectual disabilities and 21 pupils without disabilities. A mouse proficiency assessment software was utilized to collect data. Pupils with intellectual disabilities executed tasks more correctly in bigger target even in tasks with the same index of difficulty. The group with intellectual disabilities performed worse in cursor control even when only those correctly completed tasks were used for comparison. However, a similar pattern was observed in the performance of the group without disabilities.

1. Introduction

Computers play an important role in learning for students with intellectual disabilities. Past studies have demonstrated the effectiveness of computerized instruction for such students in aspects concerning functional academics leaning, social skills, and vocational skills (Abbott & Cribb, 2001; Holzberg, 1995; Li, Chen, Lin, & Li, 2003; Ritchie & Blanck, 2003; Wehmeyer, Smith, Palmer, Davies, & Stock, 2004). With the development of inclusive education, more and more intellectually challenged students learn with their non-disabled peers in the regular education environment. They are required to use information computer technology in their learning activities, including doing

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exercises on the e-learning environments and searching information on the Internet. The educational software or e-learning environments are developed in graphical user interface (GUI) currently. However, previous studies have revealed that difficulties arise when intellectually challenged students interact with GUI, particularly for those with more severe limitations (Davies & Stock, 2001; Pushchak & Sasi, 2004; Wehmeyer, 1999; Wong, Chan, Li-Tsang, & Lam, 2009). Li-Tsang, Yeung, and Hui-Chan (2005) found that approximately one third of the 353 adults with intellectual disabilities they tested could use a mouse (double clicking: 31.7%; dragging: 38.8%) through requiring the participants to use the mouse to execute the double clicking and dragging tasks. But almost 90% of those with severe intellectual disabilities could not operate mouse. Meanwhile, researchers found that persons with ID (intellectual disability) could learn how to operate mouse after provided with the training intervention (Li-Tsang, Chan, Lam, Hui-Chan, & Yeung, 2004; Li-Tsang, Lee, Yeung, Siu, & Lam, 2007), even in young age (Shimizu & McDonough, 2006).

Although these studies demonstrated the effectiveness of the intervention and indicated the difficulties the disabled participants met, they failed to report accuracy and speed. Nor did they indicate whether disabled participants performed as well as their non-disabled peers in the maneuver of mouse. The lack of such vital information prevents educational software designers from properly developing user interface. Since these studies did not explore the performance in different settings, it remains unclear whether the participants can correctly execute the tasks in the settings where the target icons are enlarged or the distance between the icons is shortened. Besides, past studies did not provide information on efficiency, such like trajectory of the cursor movement, submovement, and movement variety. Therefore, it is necessary to investigate the related factors that affect the students' performance.

Basically, size of the icons/objects on the screen and the distance between the icons/objects are two of the fundamental factors that should be considered when designing user interface. Based on the principle of human computer interaction, Fitts' law illustrated that size of the object and the distance of the object decide the difficulty of task, named as index of difficulty (ID) (Fitts, 1954). ID is calculated from the size of the target and the distance between the start point and target. ID could be used to represent the size and distance of icons design on the user interface. Based on Fitts' law, the movement time should be the same if the ID of the task is the same deriving from movement time (MT) = $a + b$*ID. But do users with intellectual disabilities perform differently in the tasks with the same ID but different distances and sizes?

Besides, the Fitts' law only mentioned the relationship between movement time and ID of the task. It is interesting to reveal the relationship of ID and accuracy given that it can provide useful information for considering the size of the icons or menu bar and the distance between the icons on the interface by answering these questions.

Accuracy and movement time are outcome indicators for the mouse proficiency only, rather than for the causes of the differences. Understanding the causes of the performance differences could provide essential information for detecting the difficulties or characteristics of the cursor movement. Mackenzie, Kauppinen, and Silfverberg (2001) proposed seven new parameters as new measurement indicators, including target reentry (TRE), task axis crossing (TAC), movement direction change (MDC), orthogonal direction change (ODC), movement variability (MV), movement error (ME), movement offset (MO). Keates, Hwang, Langdon, and Clarkson (2002) added missed click (MC) and ratio of path length to task axis length (PL/TA). However, their studies focused on the participants with motor impairments only. In this study, accuracy, movement time, rate of PL/TA, MU and MV were used to represent the performance of the mouse pointing and selecting for the participants with/without intellectual disabilities.

Therefore, this study aims to explore the performance of pupils with intellectual disabilities in executing mouse pointing and selecting tasks with varied ID; and to compare performances between intellectually challenged students and non-intellectually challenged students. Accordingly, this study intends to answer the questions below: (1) Do performance differences exist between the groups (with/without intellectual disabilities) and between the tasks with different ID? (2) If the difference exists, do the pupils with cognitive disabilities perform differently from pupils without cognitive disabilities in tasks with different ID? (3) If the difference exists, do the pupils with disabilities perform differently in the tasks with various ID?