



Designing for Children

- With focus on 'Play + Learn'

The affection of cursor frozen time to children's mouse interface

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Abstract: Young children who use the computer mouse for the first time have difficulties to control it. Clicking, double-clicking and dragging are the main challenges. Due to their undeveloped motor skills many move their arm unconsciously while pressing the mouse button. We examined the cursor frozen time to prevent this problem and its affection to usability. We developed a program in which the cursor was frozen for a specified period of time when pressing the mouse button. Tasks of double-clicking, clicking and dragging in different frozen times were given to 17 children and the number of attempts and satisfaction were measured. A design guideline was proposed based on the result.

Key words: cursor frozen time, young children mouse interaction, double-clicking, dragging, imaged-based scale.

1. Introduction

Young children have a higher chance to use computers these days. Children at the age of 4 to 5 using the computer to surf the net, play games and use educational software at home or kindergarten is not hard to see. Their first interaction with the computer is generally done through a computer mouse. However many have difficulties to operate the mouse. Normal mouse tasks – clicking, double-clicking and dragging-and-dropping are a challenge to them.

Many researches have been conducted for improving children's mouse interaction. Many of them examined the children's performance supporting Fitts' model (Gillan et al., 1990), (Inkpen, 2001). However Joiner et al (1998) questioned the usefulness of Fitts' law in children mouse interaction because of children's undeveloped situation. They tested the

children's performance of mouse operations; pointing and dragging, and found that older children were better than younger children regardless of the mouse operation.

Some Studies are related to pointing and clicking (Donker and Reitsma, 2007a),(Hourcade et al., 2004). They showed that target size is a significant factor for increasing the accuracy of a mouse click and aiming speed for children. Others examined dragging with young children (Donker and Reitsma, 2007b),(Donker and Reitsma, 2007c),(Inkpen et al., 1996),(Inkpen, 2001). In their studies, InkPen et al.(1996) and Inkpen(2001) showed that 'point-and-click' method was faster and caused fewer errors than the 'drag-and-drop' method. Reversely to this result, Donker and Reitsma (2007c) showed that 'drag-and-drop' method resulted in fewer interaction errors. They augured that the receptor size and movement direction affected the drag-and-drop error more than the difficulty of pressing the mouse button during movement. These studies are still arguable.

In the present study, we focused on children's undeveloped motor skill. They have difficulties to manipulate the mouse precisely, because children's motor skills are developed gradually with age (Kultz-Buschbeck et al., 1999) and their fine motor skill is not fully developed. As they use the computer more often, their mouse skill will eventually improve (Crook 1992). A study also showed that muscle activity in the forearm, shoulder and neck is different between the young and the old during computer mouse use (Laursen and Jensen, 2000). This implies that young children whose motor skills are undeveloped may unintentionally use different muscles while controlling a mouse, which causes erratic operation. For example, clicking is composed of pressing and releasing. When they press and release the mouse button, they may move the arm simultaneously. Accordingly the cursor is moved from where they intend to point, which may cause error. This will be more seriously shown when 'double-clicking'. Double-clicking is to make the 'Clicking' twice at the same point. If there is a cursor movement during the second 'Clicking' due to children's arm movement, the cursor location will be moved from its first clicking point. This is 'Clicking' and 'Clicking' rather than 'Double-clicking' which causes a double-clicking error. To prevent this unintentional cursor movement, the cursor must be fixed on the first clicking point for a period of time until the mouse button is released on the second clicking. This is what we call 'Cursor frozen time'. In the present study, we examined the affection of cursor frozen time to mouse tasks; double-clicking, clicking and dragging-and-dropping. For that we developed a program where the cursor frozen time can be differently set.

2. Method

2.1 Experimental apparatus

For the experiment, we prepared three experiment tools; a program, a mouse, and Image-based Likert-type scale. The program was developed with C++ for simulating 'Windows' graphic interface on Windows XP platform (Figure. 1). The main difference from the commercial 'Windows' graphic interface was that the cursor could be frozen for a specific period of time from the moment of pressing a mouse button. The frozen time can be set in milliseconds. For example, by setting the frozen time as 1000 milliseconds (one second), the cursor will not move for one second after pressing the left mouse button although you move the mouse quickly on your table.

On the screen, there are eight icons. The five icons – 'Testing Icons', in the far left column are the ones for testing double-clicking and dragging. The icon size was designed within '96 X 100 pixels', which is doubled the biggest icon size of Windows XP – 48 x 48 pixels (Microsoft, 2009). This was done because our experiment was not to test the size relevance to performance but test the relevance of cursor frozen time and the test was for children. Thus we wanted to make the double-clicking done more easily in that area which had less probability of the cursor's going out than the standard area by unintentional mouse movement. When the cursor is inside that area, the cursor shape is changed from an arrow shape to a pointing hand shape indicating that you can pick it. When you make a double-click on it, a new empty window is opened in the middle of the background. That window is a dummy, which means that no function is defined to it. What you can only do with it is to close it by clicking the 'X' mark – 'Closing icon', on the top right corner. This is for testing 'Clicking'. And the icon size is '24X24 pixels' which is the same size with that of Windows XP. Clicking errors regarding unintentional mouse movement will occur in two cases. When the user presses the mouse button in the closing icon area, the cursor can be moved out from the area by unintentional mouse movement before completing the pressing. It will select the area outside of the icon and cause an error. In the other case, the mouse button pressed in the area which is then released outside of the area due to unintentional mouse movement could cause an error as well. Thus to measure the clicking error, the size should not be enlarged. This is the reason why we kept the same icon size with that of Windows XP to test 'Clicking'.

On the right side of the screen, the recycle bin icon is located. You can put the 'Testing icons' in it by 'Dragging-and-Dropping'. The recycle bin is not opened in any way. Instead the 'Reset Icon' returns all icons to the initial condition.

The cursor frozen time is controlled by the 'Setting icon'. If you double-click on it, a window for setting cursor frozen time will be opened.

For the experiment, we used a laptop computer having 15.4 inch LCD monitor. The display resolution was 1024 X 768 pixels, and the experimental program was fully opened in that resolution.

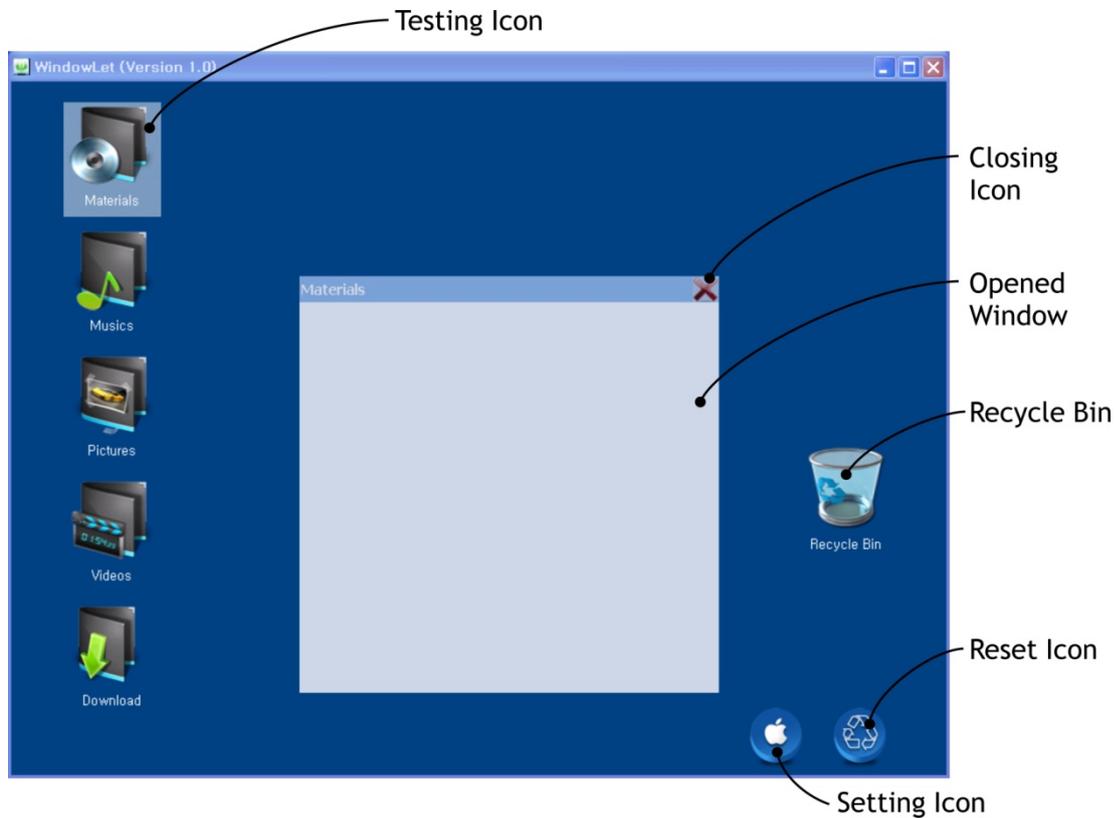


Figure.1 Program developed for experiment

For the mouse used in the experiment, we purchased an optical mouse with two buttons with a scroll wheel and a USB connector – Logitech M-UAG96B. We removed the scroll wheel and fixed the right side button in order to prevent participants from accidentally touching them during the experiment, because the experiment was done only with the left side button.



Figure. 2 The mouse for experiment



Figure. 3 Experiment apparatus

To measure the children's feeling at cursor frozen times, we wanted to ask their inconvenience with 5 point Likert-scales. However children were not supposed to make suitable answers to their feeling with normal Likert-scales, because they were not developed enough to read and understand them and their responses are in an extreme manner when rating emotion-based tasks with Likert-type scale in verbal questionnaire (Chambers and Johnston, 2002). So we devised an 'Image-based Likert-type scale'. The idea was based on children's general expression about their food preference. Young children usually have distinctive preference to food. For example, they prefer ice cream or banana over green pepper or cucumber. We collected images of various eatable from ice-cream to drug pill and printed them in about 9cmX8cm and laminated them. In the experiment, children were shown 10 to 15 images and were asked to select the most preferred one and then the most unpleasant one. These two images were corresponded with '5-Strongly agree' and '1-Strongly disagree'. We asked them again to select an image which is less preferred to the first selected image but more preferred to the second image they selected. This was for '3- Neither agree nor disagree'. The '2-Disagree' and '4-Agree' were selected in the same way. In this way, every child had 5 images for the scales from the most preferred to the most unpleasant.

2.2 Participants

We visited two kindergartens and 17 young children (mean age: 4 years and 5 months, sd: 5.8 months); 7 from the one kindergarten and 10 from another kindergarten, participated. All participants had no experience of using a computer mouse. Nine out of 17 children were boys and the others were girls.

2.3 Experiment Design

2.3.1. Tasks

We designed five experiment sets with different cursor frozen times; 0ms, 200ms, 400ms, 600ms and 800ms. For each cursor frozen time, 3 tasks; double-clicking, clicking and dragging-and-dropping, were designed. Double-clicking was tested by opening the five 'testing icons', clicking was tested by closing the opened windows and dragging-and-dropping was tested by moving 'testing icons' into the 'recycle bin'. In a given cursor frozen time, the participant opened a 'testing icon' by 'double-clicking', then closed the 'opened window' by 'clicking' and then move the 'testing icon' into the recycle bin by 'dragging-and-dropping'. This was done for the all five 'testing icons'. The experiment order was counter balanced among experiment sets.

2.3.2. Measuring the number of attempts

What we measured was the number of attempts till the participant succeeded all tasks. For example, if a participant succeeds on opening an icon during the 2nd ‘double-clicking’ trial, the number of attempts for ‘double-clicking’ will be 2. In this way, the number of attempts for ‘double-clicking’ ‘clicking’ and ‘dragging’ for 5 icons were counted.

2.3.3: Measuring children’s feeling

After completing each experiment set, the children were asked how inconvenient the experience was. The ‘image-based Likert-type scale’ was used to measure it.

2.3.4. Variables

The independent variable in the experiment was ‘cursor frozen time’ and the dependent variables were ‘the number of attempts to completing tasks’ and ‘degree of inconvenience’.

- *Independent variable: Cursor frozen time*
- *Dependent variables: Number of attempts to completing ‘double-clicking’
Number of attempts to completing ‘clicking’
Number of attempts to completing ‘Dragging-and-dropping’
Degree of inconvenience*

2.4 Procedure

A pilot test was conducted with a boy to elaborate on the experiment design and testing strategy. The way of asking the inconvenience of the experiment was needed to be rephrased to make it understandable to him. In the main experiment, we were introduced to the children in the kindergarten and played with them for about 30 minutes. The experiment started on a children desk in a quiet room. Children who had no computer experience came into the room one by one. In the beginning of the experiment, we told them that we would teach and play with them on how to use the computer (Hanna et al., 1997). We gave them an introduction on how to move and open the icons and how to close the ‘opened window’.



Figure. 4 The mouse for experiment

After about 3 minutes of practice, the child started the tasks for each experiment set. We used a clean white copy paper as the mouse pad to keep the friction consistent. As a result, the number of attempts for 85 cases (5 icons X 17 participants) for each task in every experiment set was recorded, and the degree of inconvenience was measured after completing each experiment set. The experiment for a child lasted for about 30 minutes.

3. Result

Figure. 5 shows the mean values of the number of attempts for each task with cursor frozen times. The one-way repeated measures ANOVA clearly showed that the number of attempts for 'Double-Clicking' had a significant effect of cursor frozen time ($F(4,64)=16.320$, $p<0.005$). And the linear trend for the mean value of double-clicking was significant ($F(1,16)=31.612$, $p<0.005$). This shows that the increase of cursor frozen time causes fewer errors. T-test showed that the difference of the number of attempts between 0ms and 200ms are statistically significant ($t=3.771$, $df=16$, $p=0.001$) and between 200ms and 400ms are also significant ($t=1.933$, $df=16$, $p=0.0035$). However there was no significant difference among 400ms, 600ms, and 800ms. This means that there is a threshold from which children do not cause more errors in double-clicking. Here, this value is 400ms.

The main effect of cursor frozen time on dragging-and-dropping was significant ($F(4,64)=6.525$, $p<0.005$), and there was the linear trend for the mean value as well

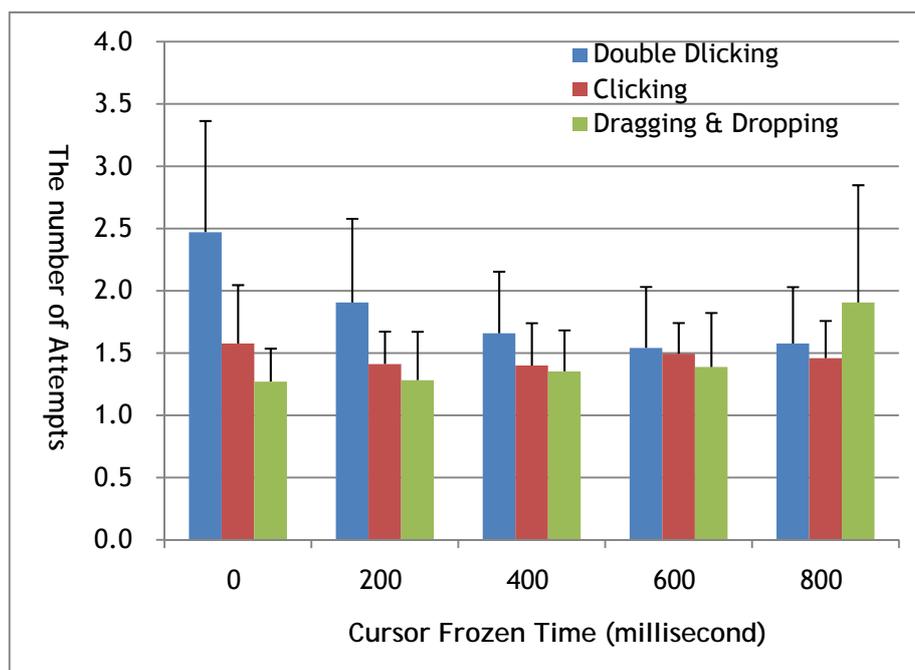


Figure. 5 The number of Attempts with cursor frozen time

($F(1,16)=8.766$, $p<0.009$). Reversely to double-clicking case, the number of attempts was proportional to cursor frozen time, which means that the increase of cursor frozen time causes more errors in dragging-and-dropping. T-test showed that there was no significance among 0ms, 200ms, 400ms and 600ms. However the difference between 600ms and 800ms was statistically significant ($t=2.448$, $df=16$, $p=0.013$). Clicking was not affected by the change of cursor frozen time.

Participants' inconvenience was apparently changed by cursor frozen time (Figure. 6). The main effect of cursor frozen time was significant ($F(4,64)=4.306$, $p=0.004$). Interestingly quadratic trend was significant in this data ($F(1,16)=26.514$, $p<0.0005$). Inconvenience was increased toward both ends, but 200ms had the least value. Form 0ms to 200ms, inconvenience value was abruptly decreased to the least. After 200ms it was gradually increased to 800ms. T-test showed that the values from 0ms and 200ms are significantly different ($t=3.392$, $df=16$, $p=0.002$), and the difference between 600ms and 800ms was significant ($t=1.852$, $df=16$, $p=0.041$). However there was no significant difference between 200ms, 400ms and 600ms. We believe that the most difficulties of 'double-clicking' at 0ms and 'dragging-and dropping' at 800ms cause the higher inconvenience values at both extremes. And the gradual increase of inconvenience after 200ms is believed to be affected by the increasing difficulty of 'dragging-and-dropping' afterward.

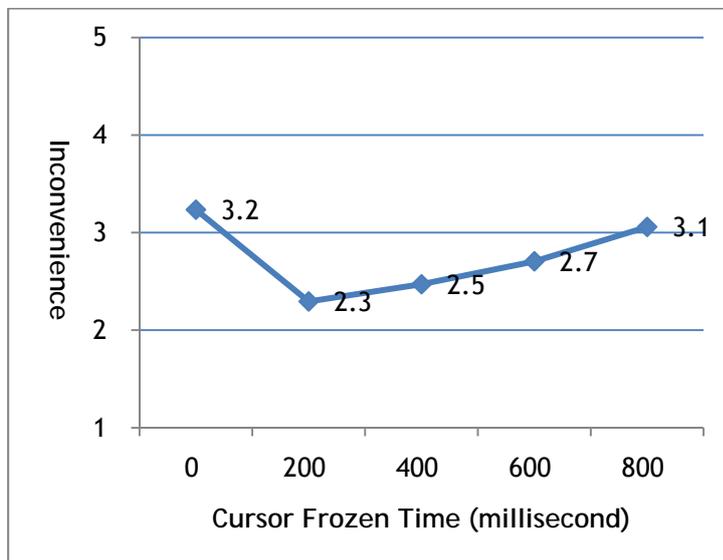


Figure. 6 Degree of Inconvenience

4. Conclusions and Discussion

The results from the present study apparently showed that cursor frozen time affect the mouse interaction of young beginners. Double-clicking needs cursor frozen time but dragging-and-dropping does not. Therefore the cursor frozen time should be very carefully

determined, because of the contradiction of double-clicking and dragging-and-dropping. Regarding 'double-clicking' and 'dragging-and-dropping', cursor frozen time should be more than 200ms and less than 600ms. Based on the inconvenience result, 200ms is recommended. Therefore the best cursor frozen time to young computer beginners will fall into between 200ms and 600mms.

This result is applicable to design the children mouse and software. Software having the function of cursor frozen time will make young beginners more easily adapt themselves to learn how to use the computer. If a mouse is smartly designed, it could activate the appropriate cursor frozen time for double-clicking, but not for 'dragging and dropping', because our results show that dragging-and-dropping becomes worse as the time is increased. It could be very helpful and useful for children to learn how to use a computer with a mouse.

We can assume from the result that the same problem will happen for all computer novices across age groups. Therefore we need to test it with computer beginners in other age groups.

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References

- Crook, C.(1992) Young children's skill in using a mouse to control a graphical computer interface, *Computers and Education* 19, 199-207.
- Chambers, C. T. &Johnston, C. (2002). Developmental Differences in Children's Use of Rating Scales. *J. Pediatr. Psychol.* 27(1): 27-36.
- Donker, A. &Reitsma, P. (2007a). Aiming and clicking in young children's use of the computer mouse. *Computers in Human Behavior* 23(6): 2863-2874.
- Donker, A. &Reitsma, P. (2007b). Drag-and-drop errors in young children's use of the mouse. *Interacting with Computers* 19(2): 257-266.
- Donker, A. &Reitsma, P. (2007c). Young children's ability to use a computer mouse. *Computers & Education* 48(4): 602-617.
- Gillan, D. J., Holden, K., Adam, S., Rudisill, M. &Magee, L. (1990).How does Fitts' law fit pointing and dragging? In *Proceedings of the SIGCHI conference on Human factors in computing systems: Empowering people*, 227-234 Seattle, Washington, United States: ACM.

- Hanna, L., Ridsden, K. & Alexander, K. (1997). Guidelines for usability testing with children. *interactions* 4(5): 9-14.
- Hourcade, J. P., Bederson, B. B., Druin, A., Guimbretiere, Francois. (2004). Differences in pointing task performance between preschool children and adults using mice. *ACM Trans. Comput.-Hum. Interact.* 11(4): 357-386.
- Inkpen, K., Booth, K. S. & Klawe, M. (1996). Drag-and-Drop vs. Point-and-Click Mouse Interaction for Children. In Technical Report 96-20: Department of Computer Science, University of British Columbia.
- Inkpen, K. M. (2001). Drag-and-drop versus point-and-click mouse interaction styles for children. *ACM Trans. Comput.-Hum. Interact.* 8(1): 1-33.
- Kuhtz-Buschbeck, J. P., Boczek-Funcke, A., Illert, M., Joehnk, K. & Stolze, H. (1999). Prehension movements and motor development in children. *Experimental Brain Research* 128(1): 65-68.
- Laursen, B. & Jensen, B. R. (2000). Shoulder muscle activity in young and older people during a computer mouse task. *Clinical Biomechanics* 15(Supplement 1): S30-S33.