Evaluating the match/mismatch between the mouse dimensions and the hand anthropometry of the primary school students

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Abstract. The use of PC for primary school students is widely spread. This condition leads the PC and its accessories manufacturer to produce various types of device, e.g. mouse, keyboard and flash drive. The present study aimed to evaluate the match/mismatch between the mouse dimensions and the students' hand dimensions. Four types of mice easily found in the market were included in the analyses. A hundred and seventy-four students of the primary school participated in the measurement. Three hand dimensions relevant to the mouse dimensions were selected to measure. Findings of the study show that the dimensions of the mice available in the market are incompatible with the hand dimension of the primary school students. Only a small percentage of the students is possible to use the mouse easily and comfortably. It should be emphasized that the suitable mouse for the primary school students is a crucial need.

1. Introduction

Nowadays the use of a personal computer (PC) is widely spread not only for businessman, government officers, or university students but also for housewives and children. It is easy to find many schools holding an academic test using PCs. The use of a PC at the primary schools is being common since the Indonesian government declared the implementation of a computer-based national evaluation. Furthermore, some schools have implemented computer-based tests for their semester evaluations. Increased computer use has led to some mental, physical, and health risks [1]. Several studies confirmed the relationship between the computer use and the musculoskeletal problems, especially on the upper extremity [2-4]. Studies confirmed that the repetitive motion, static load, muscular fatigue, limited rest break, and fixed postures during computer work increased the risk of musculoskeletal disorders [5-6]. In addition, the posture of the wrist, arm, and neck during interaction with the computer, the workstation design and the duration of interaction were also confirmed to affect the risk of the musculoskeletal symptoms [7].

Although the interaction between the primary school students and the computer is limited and its duration is quite short, few studies have observed its effect [8-13]. Evidence showed that the mouse use contributes to the musculoskeletal problems [4]. It should be noted that psychological factor also contributes to the musculoskeletal symptoms as well as the physical factor [13]. Considering the effect of the computer use for children, few ideas have been proposed to control its risks to the physical, psychological and common health, especially to the musculoskeletal problems. It needs a wise from all
stakeholders to educate the children about the positive and negative effects of a computer use [11]. In the case of the physical factor, the children should be protected from the musculoskeletal risks. Regarding the crucial risk on the musculoskeletal as well as the psychological factor as mentioned above, this study was aimed to identify the match/mismatch between the interface and the corresponding body size of the primary school students. Findings of this study would be very useful for everyone who plays some important roles related to computer use for primary school students, particularly for individuals who are responsible for providing some computer accessories to the children.

2. Materials and Methods
The present study was done in three steps, namely: gaining the mice dimensions, measuring the relevant user’s hand dimensions, and comparing the mice dimensions and the users’ hand dimensions. In the first step, there were four types of mice available in the market manufactured by Logitech(TM) that were included in the evaluations, namely: M557, MX Anywhere2 (MXAS2), M238 and M187 (Figure 1). Three mouse dimensions were gained from the Logitech(TM) official website [14], namely: mouse length, mouse width, and mouse depth. Definitions of the three mouse dimensions are presented in Figure 2.

![Figure 1. Types of mice included in the analyses. (a) Logitech M557. (b) Logitech MX Anywhere S2 (MXAS2). (c) Logitech M238. (d) Logitech M187](image)

The second step was measuring the users’ hand anthropometry. Considering the work of Hughes and Johnson [10], the present study involved three hand dimensions namely: the perpendicular distance between tip of the middle finger and root of the thumb, the distance between the outer side of the index finger root and the outer side of the ring finger root, and the width of the thumb and the depth of the index finger. Definitions of the three hand dimensions are indicated in Figure 3.

![Figure 2. Mouse dimensions measured.](image)

![Figure 3. Hand dimensions measured.](image)
The measurements were done to a number of students recruited from various primary school at the sub-regency of Kamal. There is no specific requirement, except they should have a normal body growth and normal stature. They participated in the present study voluntarily and without any rewards. The measurements of the selected hand anthropometry were done at the site where the students were studying. All of the measurements were done using a measuring tape and a digital calliper. After gaining the mouse dimensions and the relevant hand dimensions of the participants, the third step was comparing those corresponding dimensions to identify the compatibility between them. The relationship between the three hand dimensions and the relevant mouse dimensions is indicated in Table 1.

| Mouse dimension | Hand dimension                                      |
|-----------------|-----------------------------------------------------|
| Mouse length (M1) | Tip of the middle finger to the root of the thumb (H1) |
| Mouse width (M2) | Outer side of the index finger root to the outer ring finger root (H2) |
| Mouse depth (M3) | Width of the thumb and depth of the index finger (H3) |

The evaluation of compatibility between the mouse dimensions and the relevant hand dimensions was done by considering the principle of ergonomics product design, especially the principle of the design for extreme measures. Based on this principle, it is possible to formulate that the mouse length (M1) should not greater than the distance between the tip of the middle finger and the root of the thumb (H1). It was commonly known that the M1 should accommodate 95 percent of the H1. This principle was also applicable in comparing the M2 and the H2 as well as the M3 and the H3.

3. Results and Discussion

A hundred and seventy-four students (87 male) of primary school at the sub-regency of Kamal participated in the measurements phase. They were aged in the range between 8 and 12 years old with the mean of 9.7 years old (SD = 1.5 years). All of them have a normal body stature and dominantly use their right hand to perform their daily activities. The mean, standard deviation and the selected percentiles of the three hand dimensions, and the mouse dimensions are shown in Table 2 and 3, respectively.

| Dimension | Mean | SD  | 5th %tile | 50th %tile | 95th %tile |
|-----------|------|-----|-----------|------------|------------|
| H1        | 99.1 | 10.3| 82.2      | 100.5      | 112.7      |
| H2        | 51.7 | 6.7 | 41.5      | 51.7       | 61.7       |
| H3        | 36.1 | 4.6 | 28.5      | 35.5       | 44.0       |

| Dimension | Mouse Type |
|-----------|------------|
| M1        | M557       |
| M2        | MXAS2      |
| M3        | M238       |
| M4        | M187       |

Comparison between the mouse dimensions and the students' hand dimensions are shown in Table 4. Considering the ergonomic design principle, the 5th percentile data of the students' hand dimensions were compared to the mouse dimensions.
Table 4. Compatibility between the students’ hand dimensions and the mice dimensions included in the present study.

| Dimension | Mouse Type |
|-----------|------------|
|           | M557       | MXAS2 | M238 | M187 |
| For the 5th percentile | | | |
| H1 vs M1  | NC         | NC     | NC   | C    |
| H2 vs M2  | NC         | NC     | NC   | NC   |
| H3 vs M3  | NC         | NC     | NC   | NC   |
| For the 50th percentile | | | |
| H1 vs M1  | C          | C      | C    | C    |
| H2 vs M2  | NC         | NC     | NC   | C    |
| H3 vs M3  | C          | C      | NC   | C    |
| For the 95th percentile | | | |
| H1 vs M1  | C          | C      | C    | C    |
| H2 vs M2  | C          | C      | C    | C    |
| H3 vs M3  | C          | C      | C    | C    |

Note: NC = not compatible; C = compatible

Table 4 indicates that all of the mice included in the analyses are incompatible with the 5\textsuperscript{th} percentiles of the students’ hand dimensions, except for the mouse length of the type M187. It means all of the mice included in the evaluations are too big for the 5\textsuperscript{th} percentile data of the students’ hand dimensions. Further analyses to the 50\textsuperscript{th} percentile, it is possible to see that the incompatibility occurs on the comparison of the H2 vs M2 for the types of M557, MXAS2, and M238, respectively as well as the H3 vs M3 for the type M238. It means the mice dimensions are not fully matched to the 50\textsuperscript{th} of the students’ hand, except the M187 that shows its compatibility with the 50\textsuperscript{th} percentile of the hand dimensions. These results showed that the mice are possible to use easily and comfortably by 50\textsuperscript{th} of the students, while the rest 50\textsuperscript{th} of the students could meet some difficulties or problems to use it. However, for students with the bigger hand dimensions, table 4 shows that they are possible to use the mice easily and comfortably. Results of this study are in accordance with the study of Hughes and Johnson [10] that recommended smaller mice for younger age groups. It is possible to design three or four different sizes, e.g. standard size for adult males, size for adult females, size for adolescents and size for children under 11 years old. It is also possible to design the smallest size for children under six years old. In general, it should be noted that the mice available in the market are too big for the majority of students’ hand dimensions. The findings of the current study showed the smallest computer mouse included in the analyses is too big for 50\textsuperscript{th} of the students. Considering this result, it is possible to suggest the computer mouse manufacturers in order to produce the suitable mouse size for the elementary students. It is crucial since the incompatibility between the mouse dimensions and the students’ hand can lead some musculoskeletal problems [1-3], [5].

4. Conclusion
The present study is aimed to evaluate the match/mismatch between the mouse dimensions and the hand dimensions of the primary school students. This study was done since the compatibility between the device dimensions and the relevant users’ body dimensions are crucial. The findings of this study show that the dimensions of the mouse available in the market are incompatible with the hand dimension of the primary school students. Only a small percentage of the students is possible to use the mouse easily and comfortably. It should be emphasized that the suitable mouse for the primary school students is a crucial need.

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