

An evaluation of ergonomic factors in children interaction with mobile devices

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ABSTRACT

This research evaluates the interaction of children aged between 4 and 5 with mobile devices considering various ergonomic factors such as brightness, weight, size, color and their effect on usability and comfort; The results in 5 year old children show that light, medium sized (350 grams/8 inches) devices are tolerant to high handling and suitable for accelerometer games. Children of 4 years prefer larger devices, however this represents a high risk for the device and we recommended the use of smaller and lighter devices (350 grams and 8 inches). Devices presenting high temperatures due to consumption of processing resources were rejected by the children, this is worsened by increased danger to the device and child by the possibility of falls and superficial burns respectively. We recommended operating temperatures between (0-20 °C). No relevant results regarding color were found.

Keywords

Usability;Ergonomic;Education;Mobile; Software Engineering

1. INTRODUCTION

Children need products designed from the beginning specially for them. [19] The CCI or Children Computer Interaction is the part of HCI Human Computer Interaction, defined as the discipline that deals with the design, evaluation and implementation of interactive applications to be used by children and the study of surrounding phenomena [22]. The interaction of children with mobile devices such as netbooks, tablets and smartphones, [25] is increasingly popular [42]; Those are known as high-cost electronic toys among parents [34], however the constant price decline and mass availability [9] makes them ideal as educational tools [6] [7] [43]. There are increasing educational tablets designed for children such as the Samsung Galaxy kids [38], Toshiba Android Tablet [40], Microsoft Surface Games [27], Google Nexus [17], iPad [2] and others [11] [30]. It is known that children love to spend time with the device in educational [14] tasks, which is why devices that do not affect the comfort of the child's interaction are required with the applications running on educational sections, this being a challenge for the designers of Mobile applications [5] [29] [41] [22] [3] [23]. After reviewing the state of the art we found works evaluating the usability of gestures in mobile devices applied to children [31] [33] [1] [21], we found on the HCI side that there are studies that approach the use of mobile devices and offer recommendations, but this research is appropriate only for the local and geographical context. Factors such as size, weight, temperature, brightness and color are evaluated from 16 children with the applications "Learning colors" [24], "Labyrinths Puzzles for

Children" [32]. A second part of the study focuses on how ergonomic factors are affected by age, the evidence found will be used to propose optimal physical requirements and factors for the design of educational games.

2. PREVIOUS CONCEPTS

2.1 Ergonomics

Ergonomics is a scientific discipline that interacts with other disciplines to address human needs and their performance [28], studying the factors involved in the man-artifact interaction (Machine Operator) considering the environment, their objective is to provide guidelines that will serve the designer to optimize the work to be executed by the operator-artifact set. It is understood as social "operator" a user or person handling the device, and as "environment" the physical environment surrounding the set [16].

Ergonomics also applies to the interaction of children ...

Children are different from adults in that their motor skills are not mature enough because they are still in the process of growth [12], younger children have a lower cognitive ability than older children [18], it is not until 4 or 5 year of age that successful development or retardation are strong enough indicators of what a child will be able to do later [39], researchers have found that it is important to provide children the opportunity to discover, be creative and solve problems [44]. According to Piaget, young children in pre-operational stage (2-7 years) can not mentally manipulate information and therefore are in need of tangible learning materials [36].

2.2 Usability

Usability is defined as "the effectiveness, efficiency and satisfaction with which a specific group of users can perform a specific set of tasks in a particular environment" (International Standards Organization -ISO-). Guillermo Franco, [13], simplifies this definition, with a pedagogical purpose, ensuring that usability describes "ease of use": When assessments are conducted usability users can choose between two main options: laboratory testing or testing in real environments. On one hand, laboratory tests are carried out in controlled environments where the context variables can be easily monitored and controlled, thus various works [20] [4] state that the captured data can be of higher quality. However, they do not properly simulate a context with an acceptable realism and therefore certain problems can not be recorded. On the other hand, several authors [19] [8] [10] indicate that by testing in real environments most problems that may occur are captured because every context variable that can affect the interaction is considered. Although these tests are difficult to manage, authors like Kjeldskov and Stage [35] argue that the

usability of mobile applications can only be evaluated with tests in real environments.

3. STATE OF THE ART

Research in Ergonomics and Usability on mobile devices, show results of the evaluation in applications and modifications to them, are presented in this paper the information inherent in the practical application of the concepts of usability in the development of interfaces man - machine [31]. The ergonomic for Educational Changes Mobile learning alternatives, have a contextual framework and technology-oriented taking into account the experiences of users and interactions with the context [33], besides interaction and recognition of the challenges in interpreting touch input and gestures of children in mobile devices like the iPad and iPhone are increasingly common, tactile interactions are rapidly surpassing other methods of interaction in terms of frequency and the experience of many users. However, most of these devices are designed for typical general users. Trends indicate that children are using these devices (either from parents or their own) for entertainment or learning. We hope to analyze the impact of these differences in terms specifically to an automated and reliable understanding of what children are meant to do [1]. Ergonomics oriented Product Development and Process Assessment: This study proposes the development process and evaluation of ergonomics oriented products. We comprise three phases: Establishing design requirements, development of concept design and ergonomic evaluation of the prototype. [21]

4. PURPOSE OF STUDY

We desired to evaluate how children of 4 and 5 years interact with mobile devices with varying ergonomic factors such as brightness, weight, size and color and the effect on usability and comfort; The student group is comprised of 16 children from the cradle garden UNSA, We used the educational games: "Learning colors" [24] "Labyrinths Puzzles for Children" [32].

5. METHODOLOGY

The research was conducted qualitative in character, with 16 members, Figure 1 shows the experimental group of five years, the information collected has a tendency to repeat the indicators every 5 members, this information is validated by the Nielsen theory, which indicates: it is necessary to have 5 participants for a investigation because after the fifth user the trend of the findings is repeated.

5.1 Setting up the experiment:

This research was conducted in three phases. The first phase study identifies factors the second phase involves the installation of educational games. The third phase involves the study of 16 children.



Figure 1. Children 5 years interacting with mobile devices.



Figure 2. Children 4 years interacting with mobile devices.

- A. Study factors were established Size, weight, temperature, brightness and color
- B. 16 students randomly from a group of 33 students is selected, being 19 and 14 the number of students of sections 4 and 5 years correspondingly.
- C. The age of the children was delimited
The ages of the 16 pre-school children are all between (4-5 years).
- D. Procedures

The study was conducted in the workplace of children aged 4 and 5 years using the tablet as a collection means. The information is captured by cameras which are configured to record images and video. Teachers guide children through games to become familiar with the applications. It guides children at least once on the use of devices to avoid unwanted bias in the experiment.

- E. Recorded information

In the experiment with the touch gaming device information was collected about preferences, limitations and dissatisfactions that children face when using the device through observation and indirect interview.

F. Screening applications

In order to observe the use of the device educational games which keep children entertained were used to collect information, in particular games related to the subject of colors and laterality were selected as they comply with the expected interaction measure of using mobile devices. There are two main reasons that the games must meet:

1. Games that make use of the accelerometer: The grip of the moving device by children has to be measured by means of the interaction, this is accomplished with the use of the accelerometer to interact with video educational games.
2. Games that require touches for use: The constant use of the device and the time this is sustained by children for different reasons such as weight and size are important for the provision of these devices in children of pre-school level. [15] can be applied to

6. RESULTS AND DISCUSSION

From general observation we can say that kids love working with touch mobile devices, the results are shown in Tables I, II, III, IV, V and VI where the relevant aspects obtained detailing. The data was tabulated in the Likert scale [26] and was collected in an exploratory manner, suitable for children [37]. Comfort and acceptance preference is measured by Likert scale:

***** = Very Good
 **** = Good
 *** = Acceptable
 ** = Fair
 * = Low

The preference in the size of the touch device to the appropriate interaction of children and their educational activities daily in learning sections are observed in Tables I and II.

Size (Inches)				
4'	5'	7'	10'	13.3'
**	**	****	*****	**

Table I. Size preference in children 4 years.

Size (Inches)				
4'	5'	7'	10'	13.3'
**	**	***	*****	***

Table II. Size preference in children 5 years.

The preference of the children of both generations, for large devices specifically of between 7 and 10 inches shown in Tables I and II. The information collected and processed shows that children of both ages, they work properly with touch devices weighing between 276 grams and 400 grams. This information is reflected in Tables III and IV.

Weight (Grams)				
4' (119 gr.)	5' (170 gr.)	7' (276 gr.)	10' (400 gr.)	13.3' (950 gr.)
**	**	*****	****	**

Table III. Device weight for children 4 years.

Weight (Grams)				
4' (119 gr.)	5' (170 gr.)	7' (276 gr.)	10' (400 gr.)	13.3' (950 gr.)
**	**	*****	****	**

Table IV. Device weight for children 5 years.



Figura 3. Children of testing applications with accelerometer

Devices with weights that are beyond the range of 276-400 grams are more prone to accidents by children of both ages and handling is more complex in the different movements of infants when using the device.

The results show that children of pre-school age are repelled by the increase in the temperature of the touch devices when being used, observed this in detail in Tables V and VI.

Temperature (C°)		
Cold (10 - 25)	Warm (25 - 35)	Hot (35 - more)
*****	****	*

Table V. Temperature devices for children 4 years.

Temperature (C°)		
Cold (10 - 25)	Warm (25 - 35)	Hot (35 - more)
*****	****	*

Table VI. Temperature devices for children 5 years.

Children to see an increase in the temperature of the devices show discomfort in developing the learning section leaving on the worktable the device to feel the change in temperature.

The results found as a result of interaction with pre-school level children (4 and 5) in Figures 3 and 4 show the interaction performed to determine the detailed results.

A. Children four years of age.

- They are able to complete the proposed activities on all devices that are provided.
- There is no sense of care for the devices at the time of the proposed activities.
- Self-centeredness is present when performing the activities and they could not easily share devices.
- It results in children level pre-school prefer working with mobile devices to enhance their knowledge.



Figura 4. Girls interacting with application weights holding device

B. Children five years of age.

- Complied more easily with the activities proposed to them regardless of the provided device.
- Although there is still no sense of caring for touch devices.
- You can easily drag a 2D object compared with 3D objects on the touch screen.
- The presence of lower self-centeredness compared to 4 year children.

7. CONCLUSIONS

The results obtained in 5 year children show that devices of light and medium weight and size (350 grams 8 inches) are suitable for accelerometer games and more tolerant to high handling. Four year children prefer larger devices however this represents a high risk for the device and it is recommended the use of smaller and lighter devices (350 grams 8 inches); High temperatures generated by high consumption of processing resources generate rejection by the children and it also poses a risks to the device and the child by the possibility of falls and superficial burns. We recommend an operating temperature of (0-20 °C). Regarding color no relevant

results were found. This study concludes that children have specific needs for their learning activities such as the size and weight of the device and its temperature, color is a personal preference and is not a meaningful indicator. The results also show that mobile devices (350 grams and 8 inches) with temperature not exceeding 20 ° C have ideal characteristics for children to use them in educational games. The evidence found will be used to propose optimal physical requirements and to design educational games on mobile devices environmental factors. You want to extend the investigation to 7, 9, 15 and 18 years old, and expand the topic of ergonomics to usability issues related to navigability and accessibility. In conclusion we can say that the devices with the specifications detailed in the investigation are ideal for use in educational environments where it is interacting with children aged 4 and 5 years.

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