DESIGN IDEALS
art | architecture | environment
VOL.3 ISSUE 2, 2021

01

COMPATIBILITIES OF ANTHROPOMETRIC MEASUREMENT ON CHAIRS AND STUDY TABLES FOR PRIMARY SCHOOL STUDENTS IN MALAYSIA

*Norizzah Nabi Khan
Imam Abdulrahman Bin Faisal University, Saudi Arabia

ABSTRACT

The study's aim is to improve the compatibility of chairs and study tables used by primary school students. This study emphasises the planning and development of chairs and study tables' design that are appropriate with the anthropometric (size and shape of the physical size) of the student's body and to produce guidelines for the design of chairs. Thus, the corresponding study on the design of chairs and study tables was conducted by analysing the furniture size, body size, and student's posture using anthropometric methods. International standards were used as a reference to analyse the measurement. It is found that male and female students have different sizes and postures while using the table and chair. The assessment on the application of ergonomics in primary schools in the city and rural areas was to uncover the differences anthropometric of study chairs and table and level of exposure and awareness of teachers, parents, and manufacturers on the importance of ergonomics to the students due to back pain trauma and MSD – Musculoskeletal Disorder. This research examines the compatibility problems in the design of chairs and study tables for primary school students in two states in Malaysia, Penang and Selangor. The study was conducted using the anthropometric method in design chairs and study tables in conformance with the student's anatomy. The study's outcome highlighted the problems and risks identified through the study, related to the incompatibility between the size of a chair and study table and the students' body size according to the levels.

Keywords: Anthropometric, ergonomics, posture, anatomy, static, MSD,
*Corresponding Author: nbkhan@iau.edu.sa

INTRODUCTION

Primary school students spend most of their time sitting on chairs and study tables while attending classes during school hours. As most of the subjects taught in schools require students to be sitting on their chairs and using their study tables, similar to working adults, children also require the use of chairs and study tables appropriate in terms of comfort and usability.

Like other products, the chairs and study tables in school should incorporate the ergonomic features that will make the furniture more user-friendly and comfortable when used. For furniture such as chairs and study tables, the ergonomic features require anthropometric data of the user incorporated at the design stage. Jan Dul & Bernard Weerdmeester (2001) statement in Ergonomics For Beginners: A Quick Reference Guide (Technology & Engineering) states that 'ergonomic design is a branch that studies the interaction between everyday life and works with objects used'.

However, few studies have focused on the effect of school furniture on the body posture of students when performing the tasks required in classroom Soares MM (1998), Ergonomics of the Contributions of the product to the school furniture design: college portfolio, one case study."Suppose students are made to sit on chairs that do not suit or match their anthropometric aspects for an extended period; this will make them feel uncomfortable and find difficulty in their learning activities. In addition, it will also affect their physical posture in the future. A study done by Andrew Scheifele , September 2019 at the University of Waterloo, Canada, showed in their article Ergonomics Program that '*Injuries and disorders of the musculoskeletal system (the muscles, tendons, tendon sheaths, nerves, bursa, blood vessels, bones, joints/spinal disks, and ligaments) that can be caused or aggravated by various hazards or risk factors in the workplace.*'

LITERATURE REVIEW

Primary Student

Primary school students are usually children between the ages of 7 to 12 years old. *School-age* is the stage that marks the beginning process of children's development into adulthood. The World Health Organization (WHO) officially defined a child as those under the age of 18. The international definition of the age range is also adjustable in Malaysia. According to the figures released by the Department of Statistics, in 2020, (a total of 23.4% of the total population aged between 1 to 14 years old, a slight decrease from 27.3% in 2010. A child goes through stages of dynamic developments with different profiles and needs as follows: baby's age is of 0 to 11/2 years, for early-aged children ages prefix is 2 to 6 years old, of middle-aged children (primary school category), is 7 to 9-year-old, pre-teenage or as well as the final stages of children are 10 to 12 year old, and the age of youth and adolescents is 13 to 18 year old.

Primary Schools in Malaysia

Primary schools are institutions comprised of middle-level children (7 - 9-year-old) and pre-teens stage (10 – 12-year-old). Primary schools in Malaysia are two types: national school and national-type school (Chinese and Tamil). Both types of schools do not have many differences in terms of education, co-curricular and examination; the only difference is the language of delivery. Primary education is a continuation of pre-school education. In primary school learning, students take six years and end with the UPSR (*Ujian Penilaian Sekolah Rendah*) examination and a Primary School Achievement Test to determine the performance to admit in the selected secondary schools. In addition to reading, writing and counting, students will be exposed to other subjects such as science, physical education, design skills, and Islamic and moral education. In primary school, learning is phased into two levels, i.e. First level, which is from Standard 1 - 3 and the second level, which is Standard 4 - 6.

Chairs and Tables

A chair is a furniture designed to sit on, commonly used by one or more people. It has a backrest, and sometimes it has an armrest. The chair usually has four legs to support the seat on the floor. Chairs that have no backrest and armrest are called benches. At the same time, the table is a piece of furniture needed to make it easy for users to do any work on it. For example, tables are used for reading, eating, cutting stuff, writing, studying, and other purposes. Thus, the table is an item of intermediate furniture between humans and other products. Chairs and study tables are the essential equipment for the students and their learning sessions in school.

Ergonomics

Ergonomic is an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely. Ergonomics is also called biotechnology, human engineering, and human factors. The purpose of ergonomics is to ensure that any equipment, facilities, processes and systems used by humans in an activity are appropriate and compatible to interact with users. The aim is to ensure that each task is comfortably, safely, and effectively done. Most people understand and relate to ergonomics. However, in terms of ergonomics, children are different from adult's ergonomics. Therefore, the design of the furniture and facilities need to be scrutinised to avoid any risk or injury to the child, such as muscle disorders, recurrent pain and trauma pain in the long run. Ergonomics focuses on the appropriate height for children's furniture, width, length, materials and design itself.

Anthropometric

Anthropometry (from the Greek' Anthropos meaning humans, 'metron' meaning measure, literally meaning "human size"), in reference to the size of the physical anthropology of the human individual, to determine the variation of human physical (citation needed). Today, anthropometry plays an important role in various fields, especially manufacturing, design, ergonomics and architecture. In these fields, statistical data on the measurement of body dimensions of a population is needed to produce an optimum product. In daily lifestyle, nutrition and composition that varies in each community can lead to a change in the distribution of the size of the body (for example, in the form of an epidemic of obesity), and there should be a periodic adjustment of anthropometric data collection. Pheasant and Haslegrave (2006), states that *"Anthropometry is a human body measuring science that covers the size of body size, shape, strength and working capability which combines all concepts to produce ergonomic products that can enhance comfort, safety, health and productivity in working or non-working environments"*.

METHODS / PROCEDURES

The study was conducted through several methods. At the initial stage, the issue raised in the problem statement was from secondary sources such as journals, thesis and websites. Issues highlighted were the corresponding anthropometric study of chairs and study tables with primary school children in Malaysia. The second method is through unstructured interviews. The selected respondents were from primary school students, teachers, designers and furniture manufacturers. This method was carried out to obtain information for chairs and study tables compatibility with students based on anthropometric studies. Then, the student's body (anthropometry), chairs and study tables are measured to study the correspondence between a chair and study table with students. The next stage was observing the phenomenon through the documentation of the environment and the use of chairs and study tables by students.

Data Analysis

The research was conducted in four schools within two states, Penang and Selangor. About 480 students were selected as respondents, and data on their body measurements were obtained to analyse the compatibility of anthropometric data with chairs and study tables (refer Table 1). This study applies to students between the ages of 7 to 12-year-old who shared the same dimensions in the design of chairs and study tables. This research also focuses on the existing chairs and study tables in primary school, which is limited to identifying the existing weaknesses and problems. In addition, this research also examined the application of ergonomic assessment in primary schools in city and rural areas to find out the differences, level of exposure and awareness of teachers, parents and the manufacturers (furniture) on the importance of students' ergonomics.

Table 1: The anthropometric data collection acquired from four schools, which were two schools from city areas and another two school from rural areas.

Student (Year)	City schools x 2	Rural schools x 2	Total
Standard 1	40	40	**80**
Standard 2	40	40	**80**
Standard 3	40	40	**80**
Standard 4	40	40	**80**
Standard 5	40	40	**80**
Standard 6	40	40	**80**
Total number of students :			**480**

METHODS / PROCEDURES

Figure 1: The existing study tables that are being used in Primary schools in Malaysia.
(Source: Norizzah Nabi Khan, 2015)

Figure 2: Types of existing chairs that are being used in Primary schools in Malaysia.
(Source: Norizzah Nabi Khan, 2015)

Figure 3: Classroom environment when the learning and teaching sessions are being held
(Source: Norizzah Nabi Khan, 2015)

Figure 4: The usage and problems that were encountered by students. Big sized or tall students is not in accordance with the chair design provided because students felt uncomfortable when seated in a long time.
(Source: Norizzah Nabi Khan, 2015)

RESEARCH / PROJECT FINDINGS

Among the types of measures taken during the research process as anthropometric parameters are:

1. Height
2. Biacromial length
3. Arm length
4. Upper limb length
5. Leg length
6. Popliteal height
7. External Malleolus height
8. Hip width
9. Hip length
10. Weight

Proposed measurement guidelines for ergonomic study chairs and desks to all primary school student

This study produce guidelines to solve the problems faced by students for their mismatch of chairs and desks in primary schools.

Based on the research, students' body measurements each year are different. Students' physical bodies grow every year, so the design of statically sized study chairs and desks is not appropriate to their growth by the year or level. Therefore, this research proposes a guideline for measuring chairs and desks that are appropriate-comfortable and ergonomic to primary school students according to the level of the year, starting from year One to year Six.

Prior to producing measurement guidelines for matching and ergonomic study chairs and desks to all primary school students each year, researchers conducted anthropometric measurements on students to ensure that matching study chairs and desk measurements were achieved. Based on this research, the increase in growth of primary school students from year one to year six has three stages, namely level One, intermediate level and level Two, and each level of students will reach a 30% growth level. (Refer to figure 5)

In order to produce the compatibility of chair and study table measurements with anthropometric measurements, primary school students reach the level of 90%, and percentile measurements need to be taken into account. Therefore, based on the data obtained, some parts of the measurements of the study chairs and tables were analysed along with anthropometrics of students to achieve percentile.

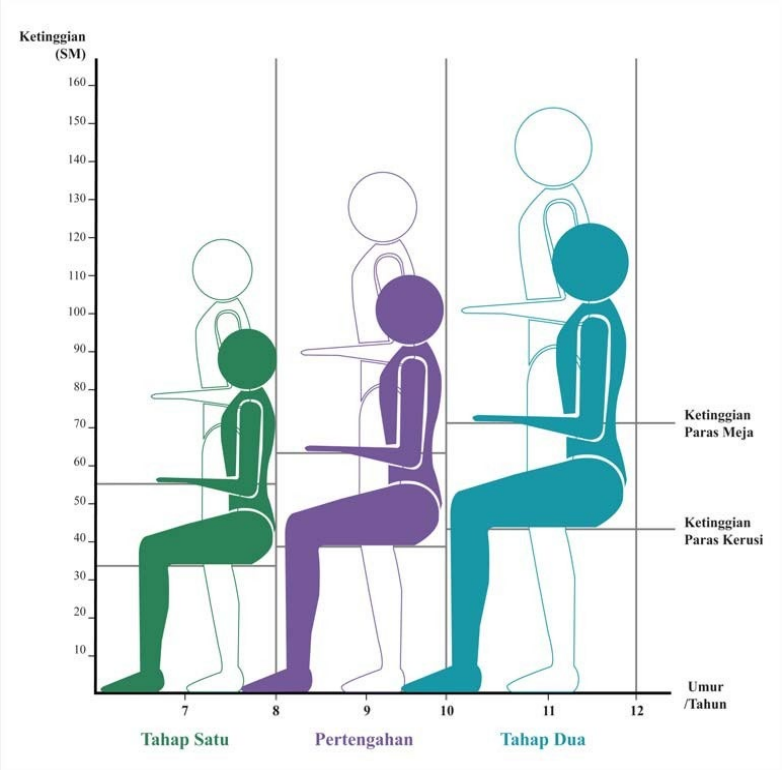

Figure 5: Growth sketch of primary school students according to level in position when using chairs and study desks.
(Source: Norizzah Nabi Khan, 2015)

As shown in Figure 6, the width and length of the study tables were not measured because the researchers found that the measurement of the width and length of the existing study table did not cause any problems to students. The researchers gave the same width and length measurements on each of the proposed tables as 500mm (width) x 700mm (length). The parts that need to be recalculated according to the percentile of the measurement the anthropometrics of primary school students are as follows: Part (A) the full height of the study chair, measured starting from floor level to above the backrest of the chair (refer to Figure 7). This measurement was taken by using anthropometric measurement data on the respondents on the upper body when sitting.

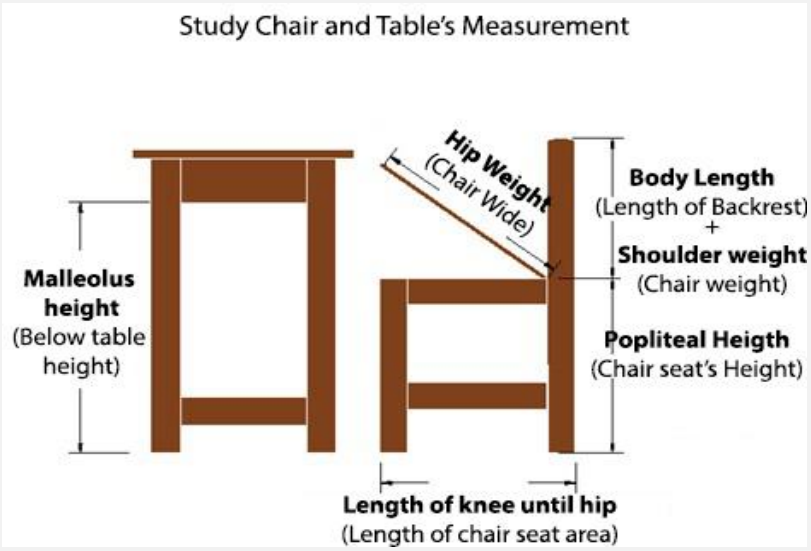

Figure 6: Study chair and table's measurement guide
(Source: Norizzah Nabi Khan, 2015)

Part (B) is the width of the backrest and chair seat, also analysed according to the percentage on the student's hip and shoulder width measurement, for part (C) is the length of the chair seat, the measurement is analysed in percentage on the measurement from knee to hip. Part (D) height from floor level to chair sitting level is the student seat height. The measurement is given by the analysis on percentile through Popliteal height measurement. Part (E) chair backrest height is analysed according to percentage measurement on the student's upper body. Measurement on part (F), i.e. the height at the bottom of the book storage place on the desk, was analysed according to the percentage for the measurement of the malleolus height of the student and the space between the legs of the respondent when sitting with the bottom of the table surface (book storage/drawer). The intermediate space is given as much as 170mm according to the existing table count. Part (G) is the full height of the study table and the student study base, which is analysed according to the percentage of half the height of the student's upper body (Refer to figure 7).

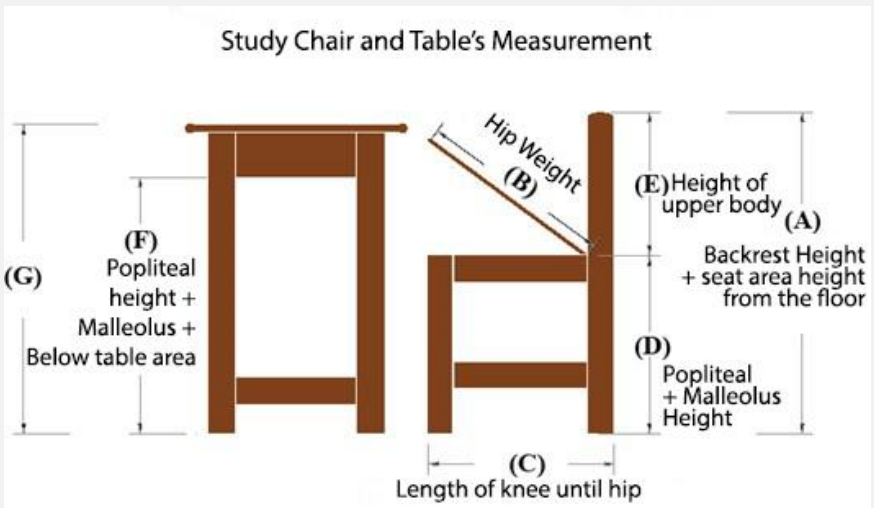

Figure 7: The proposal in the measurement of some parts of the chair and study table was used as a guide to produce measurements that correspond to the students' anthropometrics.
(Source: Norizzah Nabi Khan, 2015)

Proposed overall study chair and table measurements for level One and level Two –

LEVEL ONE'S PROPOSAL

Based on the observations, the measurement in these proposed guidelines is according to the 3rd percentile of anthropometrics for Level One students. As seen in Figure 8, the recommended measurement for the study chair is 715mm (overall height) x 370mm (width) x 370mm (length), and at the overall height of the chair, there are two parts of the height which is the height of the backrest as high as 325mm, and the seat height of the seat is 390mm. Meanwhile, the overall height measurement of the study table recommended for Year One primary school students is 680mm, and the width measurement is 500mm, and the length of the table is 700mm. For the height measurements from floor level to the bottom of the bookcase on the desk, the recommended measurement for Level One students is 560mm.

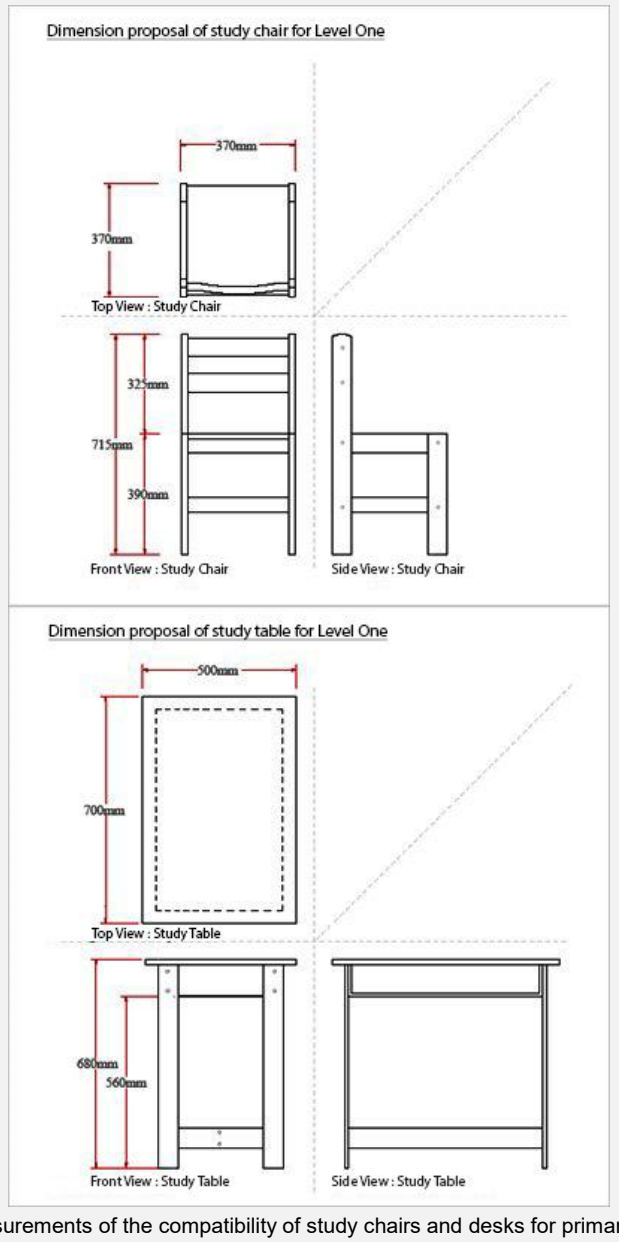

Figure 8: Measurements of the compatibility of study chairs and desks for primary school level One students
(Source: Norizzah Nabi Khan, 2015)

LEVEL TWO'S PROPOSAL

Based on the observations, the measurement recommendations in the guidelines are according to the 3rd percentile of anthropometrics for Level Two students. As shown in Figure 9, the recommended measurement for the study chair is 800mm (overall height) x 500mm (width) x 450mm (length), and at the overall height of this study chair, there are two parts of the height, i.e. the height of the backrest as high as 340mm and the seat height of the seat is 460mm. Meanwhile, the overall height of the study table is recommended for the level Two students of primary school is 750mm more than 20 mm from the height of the table proposed for level One students, and the width and length of the table are the same, 500mm (width) x 700mm (length). For height measurements from floor level to the bottom of the bookcase on the desk, the recommended measurement for Level Two students is 630mm.

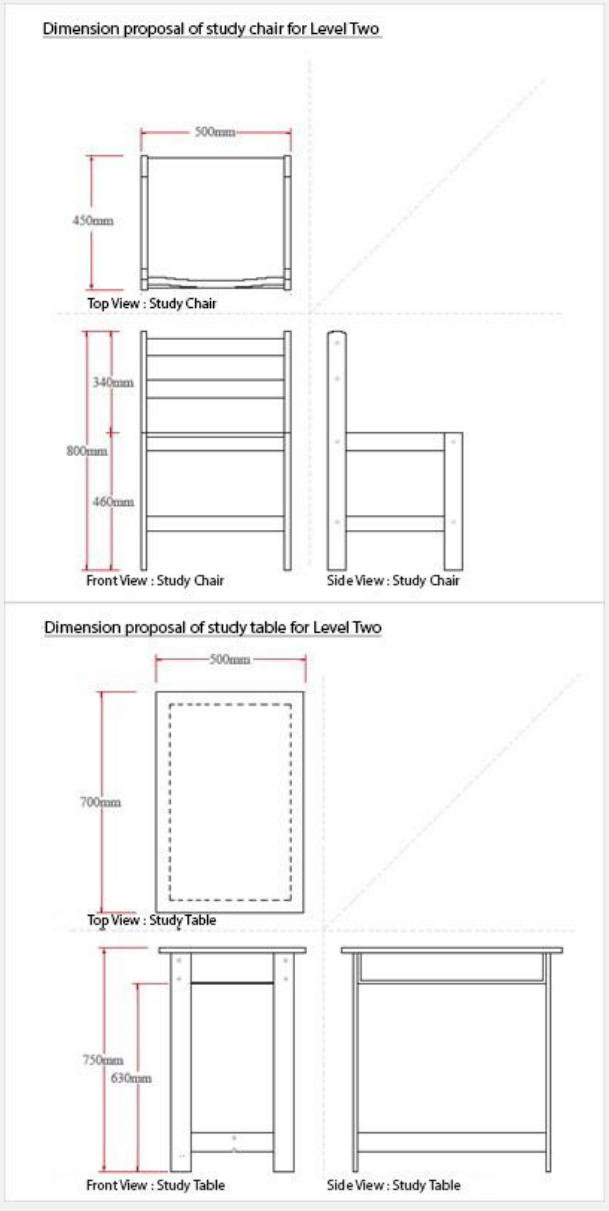

Figure 9: Measurements of the compatibility of study chairs and desks for primary school level Two students
(Source: Norizzah Nabi Khan, 2015)

Table 2: Study chair matrix table to compare both level proposals.

Study Chair	Level ONE	Level TWO
Length (mm)	370	450
Width (mm)	370	500
Full Height (mm)	715	800
Chair seat height (mm)	390	460
Backrest Height (mm)	325	340

Table 3: Study desk matrix table to compare both level proposals.

Study Desk	Level ONE	Level TWO
Length (mm)	700	700
Width (mm)	500	500
Full Height (mm)	680	750
Height until below tabletop (mm)	560	630

CONCLUSION

In conclusion, this research examines the compatibility design problems of chairs and study tables for primary school students in two states in Malaysia, namely Penang and Selangor. The study used anthropometric methods to design chairs and study tables in conformance with the students' levels in school. Among the problems and risks identified through the study is the incompatibility between the size of a chair and study table to the size of the student body according to the levels. In other words, the findings find that the existing design did not achieve the same time level of compatibility to year or level, and it can risk and affect the student's health or causes an illness called Musculoskeletal Disorder (MSD). This study aims to propose the improved design of chairs and study tables for primary school students. The study provides good practice proposals that could be a reference to designers and manufacturers from the furniture industry in terms of safety and comfort in using chairs and study tables to avoid ergonomic injuries. This study is important because it can produce design guidelines for chairs and tables that are ergonomic and practical for students to use.

As a result, the guidelines on the given measurement of study chairs and desks to primary school students can positively impact the students, especially on safety and comfort during use. As shown in Table 3, the Matrix table compares both furniture for the proposal's level one and level two measurements. Significant changes on the furniture parts for both levels are the height, which is to reach the compatible and comfortable for a long period on using the furniture by students.

The matching of the measurements of these study chairs and desks to the students can help students focus on learning more effectively. The guidelines are also a resource for manufacturers to refer to localised chairs and study tables other than foreign sources.

ACKNOWLEDGEMENT

The highest gratitude, *Alhamdulillah*, the Almighty, for giving countless inspiration and perseverance to complete this study. Many thanks to Associate Prof Mohamad Omar bin Bidin as the principal supervisor who has spent a lot of time and patience to guide with total dedication, assistance, and advice to complete this research successfully. Many thanks and appreciation to both parents Mr Nabi Khan bin Md Shariff and Ms Khatijah bt Abdullah, who have given a lot and prayers to make this research a success. Not forgetting the family members and colleagues who provided a lot of help and encouragement throughout the production process of this research. Many thanks to parties who have provided cooperation and assistance in completing this study, such as lecturers and students of the School of Art (PPS-USM), Graduate School (IPS), Furniture Designers, furniture industry manufacturers, primary school teachers SK Bukit Kemuning 2, Sek.Keb. Meru 2, Sec. Keb Juru and Sek. Keb. Seri Permai and students.

REFERENCES

Jan Dul & Bernard Weerdmeester (2001): *Ergonomics For Beginners: A Quick Reference Guide (Technology & Engineering)*. CRC Press; 2 edition, ISBN: 0748408258, 160.

Nurrabiatul Adawiyah bte Jalaluddin (2010*): Assessment on Space and Furniture Ergonomics for Children in Kindergarten. Research Methods Built Environments, 4171, 1-21.*

Savanur, C.S., Altekar, C.R, De. A. (2007). Lack of conformity between Indian classroom furniture and student dimensions: 369 proposed future seat/table dimensions. *ERGONOMICS, 50, 1612-1625*

Siqueira GR, Oliveria AB, Vieira RAG (2008). Classrooms ergonomic inadequacy and discomfort at a private academic institution in Recife- PE. *Brazilian Journal in Health Promotion, 21(1), 19-28*.

Soares MM (1998). Ergonomics of the Contributions of the product to the school furniture design: college portfolio, one case study *"STUDIES IN DESIGN, 6, 33-61.*

Srinivasan J, & Balasubramanian V (2007). Low back pain and muscle fatigue due to road cycling-An SEMG study. *Journal of Bodywork and Movement Therapies, 11(3), 260-266.*