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Design and development of appropriate desk and chair for secondary schools in Ondo State, Nigeria using anthropometric variables

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Abstract

Furniture provision is a major component of teaching and learning facilities in schools which is usually done without considering the body measurements of users leading to discomfort for the users. A survey of anthropometric measurements of secondary school students in Ondo State of Nigeria was carried out alongside the size of existing chairs and desks in order to determine the level of mismatch. Obtained data were analyzed and the population of students was grouped into 5th, 25th, 50th, 75th, and 95th percentiles. In Ondo State, Bio-characteristics of the students showed that the average age of students from JSS 1-SSS 3 increased from 10 years for JSS 1 to 16 for SSS3 which conformed with the entry and exit age requirement. Ergonomically compliant furniture was designed with adjustable features using 36.25 cm as the lower limit point and with the upper limit of 46.85 cm for seat height while lower limit was 54.46 cm for desk and upper limit having 67.60 cm. With these measurements, a typical desk and chair was produced by using round pipe and laminated board. Selection of non-adjustable furniture is both impracticable and unsuitable for a large of people; hence provision of adjustable compliant furniture was preferred to accommodate the entire population.

Key words: Anthropometric, Ergonometric, Furniture design, Adjustable desk, Chair

Antropometrik değişkenler kullanılarak Nijerya'nın Ondo eyaletindeki ortaokullar için uygun sıra ve sandalye tasarımı ve geliştirilmesi

Öz

Mobilya tedariki, okullarda genellikle kullanıcıların vücut ölçüleri dikkate alınmadan yapılan ve kullanıcıları rahatsız eden öğretim ve öğrenim tesislerinin önemli bir bileşenidir. Uyumsuzluk düzeyini belirlemek için Nijerya'nın Ondo eyaletindeki ortaokul öğrencilerinin antropometrik ölçümlerine ilişkin bir anket, mevcut sandalye ve sıraların boyutlarına göre gerçekleştirildi. Elde edilen veriler analiz edildi ve öğrenci popülasyonu 5., 25., 50., 75. ve 95. yüzdelik gruplara ayrıldı. Ondo eyaletindeki öğrencilerin biyo-özellikleri, JSS 1-SSS 3'teki öğrencilerin ortalama yaşının, giriş ve çıkış yaşı gerekliliğini karşılayan JSS 1 için 10 yıldan SSS3 için 16'ya çıktığını gösterdi. Ergonomik uyumlu mobilyaların alt sınır noktası 36,25 cm, oturum yüksekliği üst sınırı 46,85 cm, çalışma masası alt sınırı 54,46 cm ve üst sınırı 67,60 cm olacak şekilde ayarlanabilir özellikte tasarlanmıştır. Bu ölçüler ile yuvarlak boru ve lamine levha kullanılarak tipik bir masa ve sandalye üretilmiştir. Büyük bir insan grubu için ayarlanamayan mobilya seçimi hem uygulanamaz hem de uygun değildir; bu nedenle, tüm nüfusu barındırmak için ayarlanabilir uyumlu mobilyaların sağlanması tercih edildi.

Anahtar kelimeler: Antropometrik, Ergonometrik, Mobilya Tasarımı, Ayarlanabilir çalışma masası, Sandalye

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1 Introduction

Students spend much of their time in school and as they mature, they outgrow the furniture causing discomfort if its type is not adjustable (Salminen, 1984). Sitting position was found to be the most troublesome posture in connection with low back pain as students spend most of their period sitting during school hours using furniture that does not match them well which come with negative effect on their health and listening span. Good performance of students also depends on the furniture provided and other learning materials used in the school (URL 1, 2023).

Anthropometric data can be used to design ergonomically compliant furniture for secondary schools students. Salminen (1984) and Yeast (1997) in their studies had shown that high rate of back pain and ankle pain may occur among secondary school students and other ailments in future if poorly designed furniture is used for long period during their developmental age. Aagaard-Hansen et al., (2001) ascerted that the form of a chair is comprised of three factors: function, aesthetics and material. Bendix et al., (1985) also asserted that there are three ways to evaluate a chair: its relation to the body, emblematic or communicative function and its craft. Knight and Noyes (1999) stated that one of the factors which influence the design of furniture for school students is appropriateness for body size which in turn affects the design features for desk and chair.

Specific dimensions have to be taken such as popliteal height, knee height, buttock to popliteal length and elbow height which are essential in determining the dimension of school furniture that will fit the student's general posture while studying in the class. One of the conditions to support the productivity is to ensure that the work spaces and equipments that students use conform to the anthropometric and biomechanical characteristics of the user (Branton, 1969). Anthropometric dimensions vary among nations and ethnic groups and change over time as populations and their environmental conditions change (Bhat et al., 2021). Anthropometric data have been adopted in many communities for furniture of school students design but due to variations in body sizes across geographical zones, it is necessary to take anthropometric measurements of each population for use as a guide when designing furniture for schools. Evans et al, (1992) also stated that school children are at risk due to the wide range of body size, the long sitting posture and the possible adverse development at prolonged exposure to postural stresses.

Researchers have been making effort to find out the mismatch of school furniture with secondary school pupils. Several attempts were carried out on how the body sizes of secondary school pupils fit to furniture in some countries like Vietnamese (Woodson et al., 1992). However, little information is available on furniture design for pupils in secondary school of Nigeria.

This study is aimed to develop appropriate desk and chair for secondary schools in Ondo State in Nigeria with using anthropometric variables.

2 Materials and Method

2.1 Study area

This study was conducted in six selected secondary schools across Ondo State in Nigeria, with two schools from each of the three geo- political zones of North, Central and South. (Figure 1).

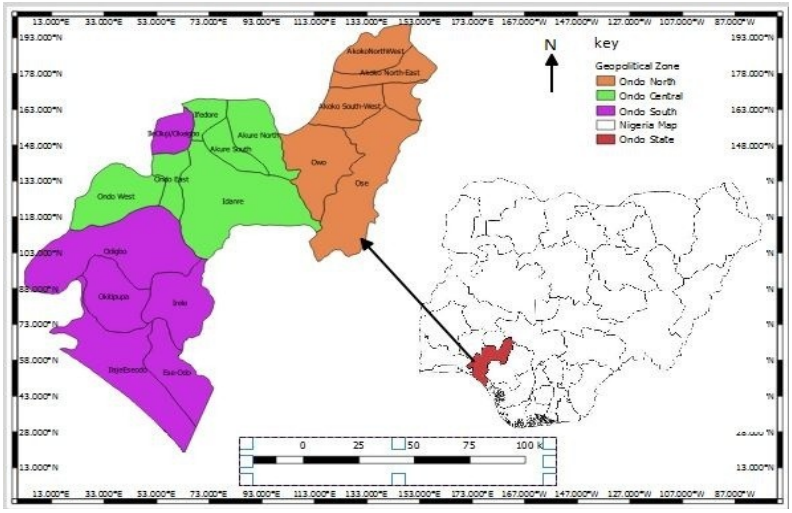

Figure 1: Map of Ondo State showing the study area

Purposive sampling technique was adopted for this study. Six secondary schools in the three geopolitical zones of Owo, Akure and Okitipupa areas in Ondo State Nigeria were selected, out of which two schools were picked from each Local Government Area (LGA), and measurements were taken using measuring tape, height meter rule, and anthropometric data sheet while Sitting-posture Measurement Device (SMD) (Figure 2) was used.

Figure 2. Sitting-posture Measurement Device (Developed by MWP Lab 2015)

2.2 Determination of student body sizes.

The body sizes of each student were taken by using standard anthropometric measurement techniques based on Parcells et al., (1999) as shown in Figure 3. Both the boys and girls were considered for the measurement from each class level and measurements were taken according to the method described by Thariq et al., (2010). Dimensions of students were taken while seated on a flat horizontal surface, their knees were bent 90°, and their feet without shoes rested on the horizontal surface. Also, the heights were taken by standing erect without shoes.

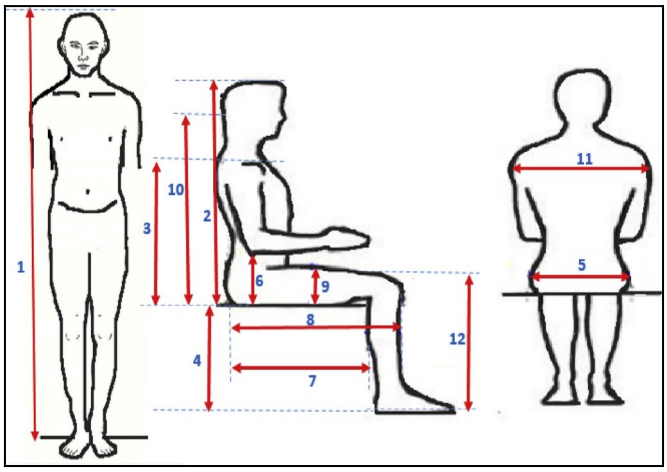

Figure 3. Anthropometric measurements required for classroom furniture design

According to Parcells et al., (1999): Anthropometric measurements required for classroom furniture design were as follows:

1. Standing Height (STH) : It is the vertical distance from the footrest to the vertex.
2. Sitting Height (SH): Vertical distance from the tip of the head to the surface of the sitting object (stool).
3. Sitting Shoulder Height (SSH): Shoulder height refers to the vertical distance from the subject's sitting surface to the top of the shoulder at acromion, shoulder is relaxed, with the upper arm hanging freely.
4. Popliteal Height (PH): Distance taken vertically with 90° knee flexion, from the popliteal space, which is the posterior surface of the knee or popliteal space.
5. Hip Breadth (HB): Maximum horizontal distance across the hips in the sitting position.
6. Sitting Elbow Height (SEH): Vertical distance from underside of the elbow
7. Buttock Hip Length (BHL)
8. Buttock-Knee Depth (BKD): Distance measured horizontally from the front of the kneecap to the back of uncompressed buttock.
9. Thigh Clearance (TC): Distance measured vertically from the stool surface to the highest point on the top of the right thigh.
10. Eye Height (EH): Eye height refers to the vertical distance from the inner canthus of the eye to the sitting surface.
11. Shoulder width (SW): Maximum horizontal distance across shoulders in the sitting position.
12. Sitting Knee Height (SKH): Vertical distance from the top of the knee quadriceps muscles to the footrest.

2.3 Existing tables and chairs characteristics of selected schools

Dimensions of existing chairs and desks were taken using measuring tables for SH, SW, DH, UDH and ERH. T-test was carried out to test for comparison with anthropometric measurements and dimensions of tables and chairs in the six selected schools as reflected in Figures 4 and 5. The following mismatch criteria were used for this study according to Motmans, (2006);

1. Seat Height = $0.88(PH+2) \leq SH \leq 0.95(PH+2)$ ……..eqn (1)
   Panagiotopoulou *et al*., (2004)

2. Seat depth (SD) = 0.8BPL ≤ SD ≤ 0.99BPL……eqn (2)
   Gouvali and Boudolos, (2006)
3. Seat width (SW) = HB < SW……..eqn (3)
   Troussier *et al*., (1994)
4. Desk height (DH) = SEH ≤ DH ≤ 0.8517 SEH + 0.1483SSH……...eqn (4)
   Parcells *et al*., (1999)
5. Under-desk height (UDH) = SKH +2 < UDH…….eqn (5)
   Motmans, (2006)

2.4 Development of appropriate design of desk and chair

The student's population was grouped into 5th, 25th, 50th, 75th and 95th percentiles according to BIFMA 2002 procedures, which was used to design appropriate furniture for the students population. The 5th percentile was used as the lowest limit, while the 95th percentile was taken for the upper limit for the adjustable mechanism to take care of the entire students' population.

2.5 Experimental design and data analysis

Randomized Completely Block Design (RCBD) was used for the experimental design. Analysis of variance was carried out. The collected data were presented with Statistical Package for the Social Science (SPSS) and Excel Microsoft Software to obtain the descriptive statistics and analysis of variance (ANOVA). Duncan Multiple Range was used to test for the significant different at 0.05 level of significance.

3 Results and Discussion

3.1 Bio-characteristics of students in Ondo state secondary schools

In Table 1, the bio-characteristics of the students revealed in Ondo State that the average entry age for Junior Secondary School one (JSS 1) was 10 years and leave at 16 years after completing SSS 3. This also showed an increase in height across the class levels. The height of the human body is a major determinant of other body parts as ascertained by Panero (1979). All the students across the geopolitical zones of Ondo State carry similar features hence furniture supply could be generalized for secondary schools in Ondo State. However, values were higher for male than for female in weight and height this conformed to general human physiology (Murphy et al., 2007). This is an implication that not one size of furniture will suit the whole population hence regular review of school furniture sizes is needed to ascertain its suitability after a period of time.

Table 1. Summary of Bio-characteristics of students in the different GPZ's and class levels

Geopolitical Zone (GPZ)	Gender	Ages	Weight (kg)	Height (cm)
Ondo Central	Male	10.30-15.80	37.30-61.20	145.70-164.70
	Female	9.70-15.70	38.80-60.20	147.80-163.00
Ondo North	Male	10.30-16.40	32.00-60.90	147.80-164.40
	Female	10.80-16.10	32.80-57.20	146.80-163.30
Ondo South	Male	10.60-16.20	33.20-64.30	147.10-166.00
	Female	10.80-16.10	34.10-61.60	147.30-164.70

The analysis of variance (Table 2) showed that there was no significant difference in age and gender across the geopolitical zones while there was significant difference among the class level at 5% probability level. The students' height and weight were significantly different for the students' age and gender across the geopolitical zones.

Table 2. ANOVA for the age, weight and height of students from the different GPZ

Parameter	Sources of Variation	Sum of Squares	Df	Mean Square	F	P	Sig.
Age	LGA	1.906	2	0.953	1.014	0.364	ns
	Class Level	1370.956	5	274.191	291.89	0	*
	Gender	0.711	1	0.711	0.757	0.385	ns
	Error	329.717	351	0.939			
	Total	1703.289	359				
Weight	LGA	2026.667	2	1013.333	49.6	0	*
	Class Level	27322.925	5	5464.585	267.47	0	*
	Gender	7.225	1	7.225	0.35	0.552	ns
	Error	7171.158	351	20.431			
	Total	36527.975	359				
Height	LGA	12.95	2	6.475	0.41	0.667	ns
	Class Level	10539.733	5	2107.947	132	0	*
	Gender	5.378	1	5.378	0.34	0.562	ns
	Error	5605.039	351	15.969			
	Total	16163.1	359				

*Values ≤ 0.05 are significant, ns: Not significant

3.2 Anthropometric measurements of Ondo State secondary school students

The summary of the anthropometric measurements of students taken across Ondo State shown in Figure 4 revealed that in Ondo North, Popliteal height ranges from 40.47 to 40.96, 40.23 to 44.85, 24.92 to 38.53, 65.17 to 70.76 and 55.34 to 58.92 cm 18.77 to 19.78 cm for PH, BL, BW, SHE+PH, SKH and ERH respectively, the value obtained in Ondo Central ranges from 40.14 to 42.68, 36.17 to 44.37, 33.01 to 37.22, 68.81 to 70.57, 49.35 to 60.24 and 16.72 to 19.47 cm for PH, BL, BW, SHE+PH, SKH, and ERH respectively. The value obtained for Ondo South ranges from 39.68 to 43.27, 39.55 to 45.09, 35.99 to 47.88, 66.76 to 60.37,55.43 to 59.64 and 18.37 to 20.01 cm for PH, BL, BW, SHE+PH, SKH and ERH respectively.

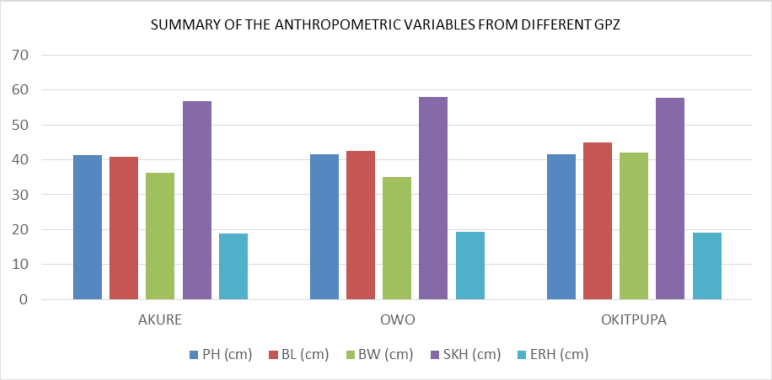

Figure 4. Summary of the Anthropometric Variables from Different GPZ

Anthropometric dimensions for secondary schools students in Ondo state showed variation in class levels which could be due to increase in body size, for Central and North, the result showed that there was no significant difference in the PH from JSS 1 to SSS 3 which implies that the students can use the same chair, while in the South, JSS 2 and SSS 2 can use the same chair; JSS 1, JSS 3, SSS 1 and SSS 3 can use the same chair because there was no significant difference in the PH. The variation in the geopolitical zones for SEH + PH showed that the same desk cannot be used in the schools. For the Central zone, students can use the same desk height are JSS 1 and JSS 2, JSS1 and JSS 3, JSS1 and SSS 1, SSS1 and SSS 2, JSS1, JSS2, SSS1 and SSS 3. For North, all the students from JSS 1 to SSS 3 can use the same desk height while in South, JSS1, SSS1 and SSS3 can use the same desk height, JSS2, JSS3 and SSS3 can use the same desk height. From Table 3, it was discovered that Ondo South has the lowest PH value while Ondo North has the highest PH value among the GPZ while for SHE + PH, North had the lowest and highest values. Previous studies explained that body sizes were different (Pheasant, 1996; Thariq et al., 2010 and Bridger, 1995).

The analysis of variance as presented in Table 3 showed that there was no significant difference in the popliteal height (PH), SEH+PH, SKH and Elbow rest height (ERH) among the geopolitical zones at 5% probability level. However, there was significant difference in the class level, except Buttock length (BL) that showed significant difference both in the GPZ and class level.

Table 3. ANOVA Table for the Anthropometric Variable from GPZs and Class Levels

Variable	Sources of Variation	Sum of Squares	Df	Mean Square	F	P	Sig.
PH	LGA	1.981	2	0.991	0.086	0.918	ns
	Class Level	137.094	5	27.419	2.382	0.04	*
	Error	1979.966	172	11.511			
	Total	2119.041	179				
BL	LGA	94.301	2	47.151	3.148	0.045	*
	Class Level	531.972	5	106.394	7.103	0	*
	Error	2576.239	172	14.978			
	Total	3202.512	179				
BW	LGA	1715.09	2	857.545	14.721	0	*
	Class Level	982.926	5	196.585	3.375	0.006	*
	Error	10019.251	172	58.251			
	Total	12717.267	179				
SEH+PH	LGA	10.34	2	5.17	0.314	0.731	ns
	Class Level	205.632	5	41.126	2.497	0.033	*
	Error	2832.947	172	16.471			
	Total	3048.919	179				
SKH	LGA	47.837	2	23.919	1.377	0.255	ns
	Class Level	285.086	5	57.017	3.283	0.007	*
	Error	2987.433	172	17.369			
	Total	3320.356	179				
ERH	LGA	3.496	2	1.748	0.73	0.483	ns
	Class Level	30.989	5	6.198	2.588	0.028	*
	Error	411.969	172	2.395			
	Total	446.454	179				

*Values ≤ 0.05 are significant, Where: PH Popliteal Height, BL: Buttock Length, BW: Buttock Width, SEH+PH: Sitting Elbow Height+ Popliteal Height, SKH: Sitting Knee Height, ERH: Elbow Rest Height

4.3 Existing desks and chairs assessment

Seat Height, Seat depth, Seat Width, Desk height, Under Desk Height and Elbow Rest Height were investigated while evaluating the existing school desk and chairs for secondary schools in Ondo State. Table 4 represents the summary of the mean value for each of the GPZs. The results from each of the secondary schools show that Ondo Central has the highest value for seat height, seat width and elbow height which are 45.50±0.52cm, 41.00±0.00cm, and 69.00±0.00 cm, respectively. Ondo South has the height mean value for seat depth with 44.25±0.78cm while Ondo North has the highest mean value for desk height and under desk height which are 70.25±026cm, and 62.00±0.00 cm, respectively.

Table 4. Summary of Existing Furniture from GPZs

Furniture Measurement	Ondo Central	Ondo North	Ondo South
Seat Height	45.5	44.75	44.25
Seat Depth	40.5	41.5	44.25
Seat Width	41	40.75	39
Desk Height	70	70.25	67.5
Under Desk Height	60.5	62	59
Elbow Height	69	67.5	67.75

Source: Field Work

It was discovered that both desk and chair used by the students from JSS 1 to SSS 3 was uniform but was not comfortable for students in lower classes because of their height. This means that school students have to sit on higher chairs and therefore, they are not able to support their feet on the floor. This situation may lead to increased tissue pressure on the posterior surface of the knee and consequently may cause serious discomfort or possible disorder (Agha, 2010). This is similar to the findings reported by Gouvali and Boudolos (2006) among Greek school children aged between 12 and 18 years who found that 90.3% of girls and 50% of boys used seats that were too high (Parcells et al., 1999).

Table 5. ANOVA Table for the Existing Furniture Variables from GPZs and Class Levels

Variable	Sources of Variation	Sum of Squares	Df	Mean Square	F	P	Sig.
SH	LGA	9.5	2	4.75	8.061	0.002	*
	Class Level	0	5	0	0	1	ns
	Error	16.5	28	0.589			
	Total	26	35				
SD	LGA	90.5	2	45.25	99.373	0	*
	Class Level	0	5	0	0	1	ns
	Error	12.75	28	0.455			
	Total	103.25	35				
SW	LGA	28.5	2	14.25	31.294	0	*
	Class Level	0	5	0	0	1	ns
	Error	12.75	28	0.455			
	Total	41.25	35				
DH	LGA	55.5	2	27.75	49.333	0	*
	Class Level	0	5	0	0	1	ns
	Error	15.75	28	0.563			
	Total	71.25	35				
UDH	LGA	54	2	27	252	0	*
	Class Level	0	5	0	0	1	ns
	Error	3	28	0.107			
	Total	57	35				
ERH	LGA	15.5	2	7.75	22.256	0	*
	Class Level	0	5	0	0	1	ns
	Error	9.75	28	0.348			
	Total	25.25	35				

Where: SH: Seat Height, SD: Seat Depth, SW: Seat Width, DH: Desk Height, UDH: Underneath Desk Height, ERH: Elbow Rest Height. * Values < 0.05 are significant, ns: Not significant

The analysis of variance (Table 5) showed that for all variables (Seat Height, Seat Depth, Seat Width, Desk Height, Underneath Desk Height, and Elbow Rest Height), indicate that there was significant difference among the Geopolitical zones at 5% probability level while there was no significant difference among the Class levels.

3.3 Level of furniture mismatch

The independent t-test mean comparison of existing furniture and anthropometric measurements of the selected students from JSS 1 to SSS 3 in Ondo State shown in Table 6 revealed that the mean value for seat height of existing furniture had 44.83 cm while the PH was 41.54 cm with difference of 3.3 cm, the mean value for seat depth of existing furniture was 42.08 cm and BL of 41.82 cm. Mean value for seat width of existing furniture was 40.25 cm and BW of 37.81 cm with difference of 2.44cm. The mean value of desk height for existing furniture was 69.25 cm compared with PH + ERH of 60.64 cm with the difference of 8.61 cm. The mean value for underneath desk height of existing furniture was 60.50 cm and SKH of 57.54 cm having difference of 2.96 cm. Mean value for elbow rest height of existing furniture was 18.08 cm compared with the ERH of 19.09 cm. There was no significant difference between the existing furniture (EF) and anthropometric measurements (AM) for seat depth while all other variables showed a significant difference between ER and AM as presented in Table 6. The level of mismatch in the geopolitical zones was moderate for seat height, seat depth, seat width and underneath desk height while desk height showed a high level of mismatch. In other words, those students with a desk height mismatch are either required to lift their arms, which may cause more muscular load, discomfort and pain in the shoulder area Parcells et al., (1999) or have to bend their trunk forward, a posture which increases the spinal load. Most previous studies have shown that mismatch cases especially for younger school children were caused by higher desk height. The frequency of higher desks has been reported for Greek school children aged between 12 and 18 years (61.1% girls and 86.1% boys) (Gouvali and Boudolos, 2006), and for younger school children in Hong Kong (Chung and Wong, 2007), Chile (Castellucci et al., 2010), and in the United States (Parcells et al., 1999). It is interesting that the mismatch percentages varied between the class levels and between boys and girls which highlights the variability in student's body dimensions. The level of school furniture mismatch is addressed by designing furniture using the anthropometric measurements which must be recent and appropriate (Aaras, et al., 1997).

Table 6. T-test mean comparison of existing furniture and anthropometric measurements

Parameter	Type	Value (cm)	Mean dif.	Std. e. df.	T	Df	Sig.
Seat height	E-F	44.83±0.86	3.29	0.29	11.19	205.49	0.000*
	A-M	41.54±3.44					
Seat depth	E-F	42.08±1.72	0.26	0.43	0.6	133.12	0.547^{ns}
	A-M	41.82±4.23					
Seath width	E-F	40.25±1.08	2.44	0.65	3.73	202.79	0.000*
	A-M	37.81±8.43					
Desk height	E-F	69.25±1.43	8.61	0.39	22.14	161.65	0.000*
	A-M	60.64±4.13					
Underneath desk height	E-F	60.50±1.28	2.95	0.39	7.67	186.67	0.000*
	A-M	57.54±4.30					
Elbow rest height	E-F	18.08±0.85	48.99	0.18	266.06	91.58	0.000*
	A-M	19.09±1.58					

Values are Mean±SD; Where: *Significant at ($P < 0.001$), ns: Not Significant, EF: Existing Furniture and AM: Anthropometric Measure

3.4 Design of ergonomically compliant furniture for secondary school using anthropometry variables

The entire population of secondary school students in Ondo State, Nigeria was classified into 5th, 25th, 50th, 75th and 95th percentile for all the variables needed to design furniture for the schools (Table 7). The seat height of 36.26cm (5th percentile) was the lowest limit while 46.85 cm was the upper limit point. The values of 39.41, 41.2 and 43.22cm were the middle adjustable points. The same parameters were adopted for DH, UDH, ERH and SSH. An ergonomically compliant chair and table were designed using inventor professional and anthropometric mean percentile values for JSS 1-3 and SSS1-3 which ranged from 36.26 to 46.85 cm and 60.64 to 67.60 cm for the chair and table respectively. These formed the range of adjustment for the design as shown above in figure 4 to 5 of the report. The lower limit of adjustment for chair and desk is 36.26 and 60.64cm respectively while the highest limit is 46.85 and 67.60 cm for chair and desk respectively. All the materials used were readily available while simple hydraulic bending machine was used to prepare the bending of the square pipe. Figures 5 and 7 showed the pictorial view of the designed secondary school furniture. The back seat for the chair and desk top / storage compartment were produced from laminated plywood.

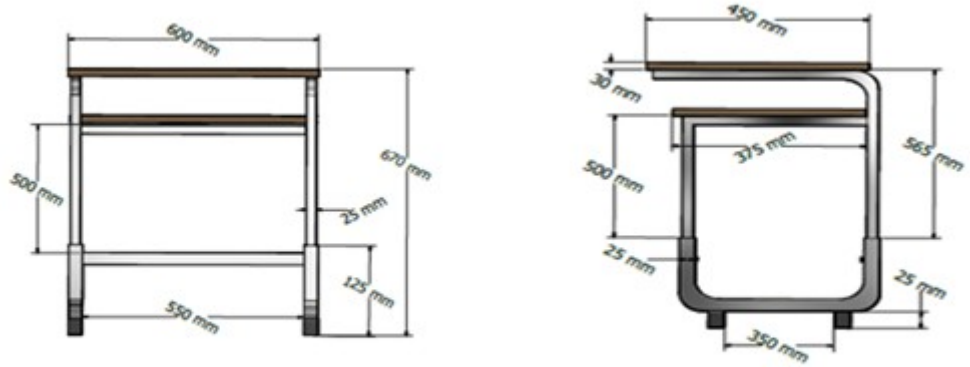

Figure 5. The front and side view of the developed desk.

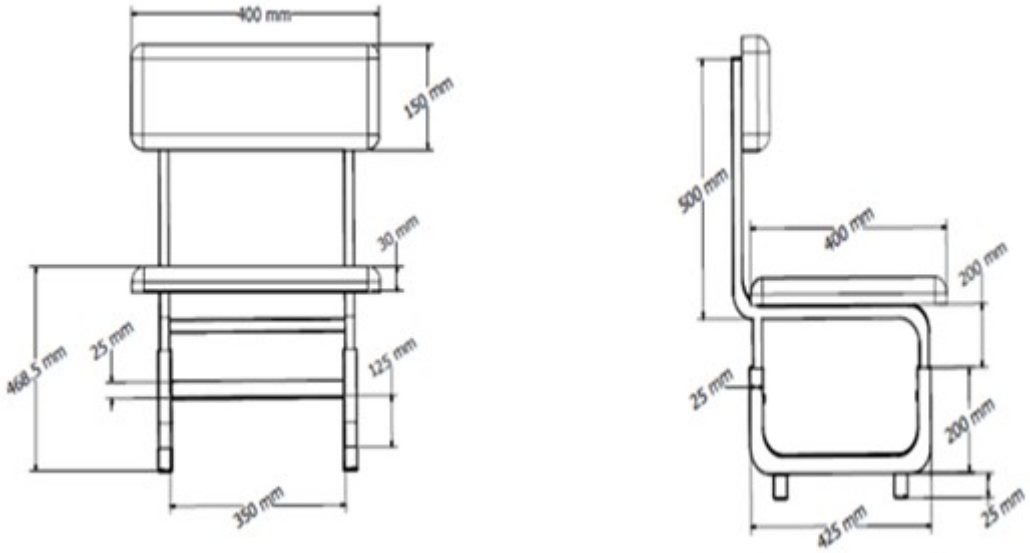

Figure 6. The front and the side view of the developed chair

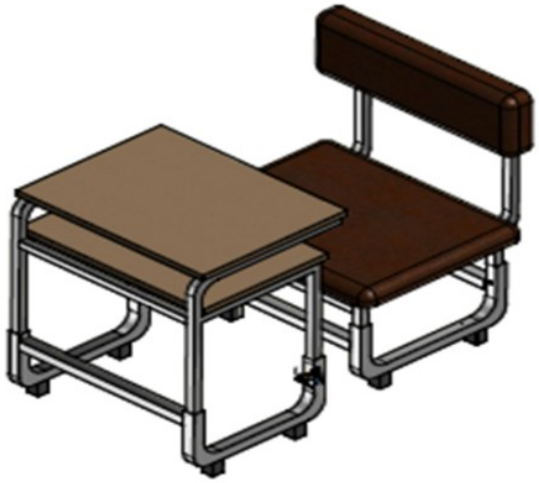

Figure 7. Pictorial view of adjustable school furniture using Professional Inventor Software.

The students' population was grouped using the 5th, 25th, 50th, 75th and 95th percentiles. The 5th percentile with 36.26 cm for popliteal height was used as the lowest adjustable point while the 95th percentile with 46.85 cm which is the upper limit was used for the highest adjustable point for seat height. The 5th percentile for desk height was 54.16 cm used for the lowest point while the 95th was 67.60 cm which was used for the highest point. The 5th for the underneath desk height was 51.01 cm used for the lowest point while 95th was 62.50 cm used for the highest point.

Table 7. Design Parameters furniture in Ondo State

Variable	Lower limit 5th Percentile	25th Percentile	50th Percentile	75th Percentile	Upper limit 95th Percentile
SH or SKH	36.26	39.41	41.2	43.22	46.85
DH or SHE+PH	54.16	58.25	60.2	62.93	67.6
UDH or SKH	51.01	55.53	58.11	60	62.5
ERH	16.39	18.39	19	20	21.25
SSH	20.22	24.22	26.22	28.05	32.15

Inventor Professional was used to carry out the design of adjustable furniture (Figures 7). Students carry their desks and chairs around in the course of activities like sport, end of the year parties etc. which may reduce the life span of the furniture and lead to mix up especially when rigid furniture is used for each of the class levels. In order to ensure that students can use any available furniture, an adjustable device was incorporated into the design to suit any class level as ocassion demands (Pheasant, 1998; Chung, 2007).

4 Conclusion

Arising from the results of the study the following conclusions were reached;

- The level of mismatch between the secondary school students and their furniture interface was due to the rigid construction of furniture of the same size supplied to schools without considering variations among the users.

- Selection of appropriate furniture for a large group of people is both impracticable and difficult thereby anthropometric measurements which are necessary tools to determine the range of body size in the population are ruquired to ensure furniture fitness.
- The provision of adjustable furniture would be preferable to accommodate the population ensuring the safety and physical well-being of the students.
- Therefore, it is essential that secondary schools should be supplied with properly designed furniture to meet the student's body size.

Author Contributions

Jacob Mayowa Owoyemi supervised the project from creating the idea, and monitoring anthropometric measurements up to the final write-up. **Dauda Aliyu** conduct the fieldwork, laboratory/workshop and preliminary write-up while **Adetunji Akinnuoye** carried out data analysis, drawing compilations/editorial work.

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