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EVALUATION OF ERGONOMIC DESIGN OF DESK AND CHAIR FOR PRIMARY SCHOOLS IN ERBIL CITY

Rawaz Najmaddin Abdullah [1] and Adeeb Noori Ahmad [2*]

[1] *Department of Architecture Engineering, College of Engineering, Tishik International University-Hawler, Kurdistan, IRAQ.*

[2] *Department of Architecture Engineering, College of Engineering, Salahaddin University-Erbil, IRAQ.*

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ABSTRACT

Classroom ergonomic chairs and desks are important elements for students in terms of comfort and concentration in the schooling environment. This is very important for pupils that spent most of the time in classroom furniture. Most of the furniture is not able to fit for different ages students in different body figures in the classroom in some primary schools in Erbil city. This study evaluates the existing school furniture ergonomically as compared to students' anthropometric measures, i.e., examining if dimensions of primary school furniture agree with pupils' anthropometric measures for first to sixth graders. Anthropometric dimensions in eight schools for 487 students of grades 1-6 were measured, and their data were analyzed via IBM®SPSS Statistical Package and MS Excel®. The results showed that group of grades 1-3 pupils have major mismatch accordance to the anthropometric measures (sitting elbow height, stature, sitting shoulder height, popliteal height, knee height, buttock-popliteal length, shoulder breadth, hip breadth, and upper limb length) and classroom furniture dimensions more than group of grades 4-6.

Disciplinary: Architecture and Human Factors and Ergonomics.

1. INTRODUCTION

Pupils during their lives, approximately spend most of the day at schools, and 80% sitting down in classrooms doing their schools work, for example, reading, drawing, writing, and other activities, which lead pupils for a long time constantly sit on their seats. Pupils requirement needs to have suit school furniture, in consideration that spends an amount of time at school, especially whereas sitting [1]. Although numerous studies have demonstrated that pupils commonly used inappropriate furniture to their anthropometric measures [2]. School learning can be influenced by mismatch as awkward body postures can hurt pupils 'learning enthusiasm and interest, even during stimulating

*Corresponding author (Adeeb N.Ahmad) Email: adeeb.ahmed@su.edu.krd.

and interesting lessons. Commonly, sitting postures of pupils are affected by design characteristics of furniture, activities performed in the classroom, and measurement of anthropometric pupils in schools. School furniture design is one of the factors to decrease wariness and incredibly assists to enhance the concentration of pupils during their study. Advancement of such symptoms among pupils of school [3]. Also, Additionally, another study discovered that pupils between (1 and 2) that seated in fit furniture essentially well performed and better on an in-hand manipulation test as a comparison to their furniture who seated that was too big for them [4]. Henceforth, the design of ergonomic is essential to fit furniture classrooms, reduce mismatch while deliver a enhanced learning environment [5].

Although dimensions of anthropometric for pupils are various than the elders. Hence, the design of furniture classrooms should be separated for them to follow the ergonomic criteria, concentrating on pupils' adjustability and comfort. Any chair design that needs aesthetics, relaxation, and comfort characteristics for pupils. A chair used for pupils could differentiate easily by the factors that related to relaxation and comfort while she/he often finds it hard to differentiate between the features of ergonomics of chair. For example, most of the features of ergonomic are assumed indistinguishable and discomfort in sitting because they cannot be perceived [6]. This study examines if primary schools' furniture dimensions match students' anthropometric measures for first to sixth graders because there is not ergonomically designed chair in a classroom environment; the results demonstrate an abnormality in postures. This causes generate muscular back, neck, and head pains, enhanced physical strain, loss of restlessness, and concentration in an attempt to find a better position to get an active learning environment.

2. ERGONOMIC

Ergonomic is the study that related to the performance of peoples in their working atmosphere and helps to figure out how to design products which work both for and with peoples. It is 'scientific discipline concentrating between the interaction of peoples and other elements of system' [7]. Ergonomic classroom furniture contribute to the pupils' motivation and attention during lectures. Along with the motivation and attention matters, also a poor furniture design is reasonable for the problem related to pupils' body parts such as joints, the spine, and ligaments [8]. The fundamental functionality of an ergonomic furniture classroom environment delivers pupils' expectations such as comfort, enough writing space, school bag space, relaxation, etc. to achieve different ergonomics features or qualities. The ergonomics primary task in the school environment is to adapt classroom of the physical conditions and subjects into bio morphological and psychophysiological features of pupils and to select such a technological functionality solution of the learning space that is extremely adapted to the pupils the psychophysical structure of a particular age [9]. Designed of chair school, conformity with the principle of ergonomic has a great influence on the working place effectiveness and abilities of pupils. Concentration, Visible calmness, reduced fatigue, and the correct position of the body illustrate that suitable height of the table according to the chair suitable [10]. Generally, existing chairs pupils are mostly designed traditionally are not much designed according to the principles of ergonomic [11].

3. METHODOLOGY

3.1 SAMPLES FOR ANTHROPOMETRIC DATA COLLECTION

The samples from which the anthropometric data were obtained consist of 487 pupils grades 1-6 from eight elementary schools in Erbil city (four Private (Pr); International of Choueifat (A), Montessori (B), Runakie international, (C) and Cambridge international (D) and four public schools (Pb); Fakher Mergasori (E), Mawlawe (F), Shayda (G) and Aryna (H)). Participants were chosen randomly from grader 1-3 and 4-6 group pupils. Information about the study was given to the school administration and teachers.

3.2 METHODS AND EQUIPMENT USED FOR MEASUREMENT

All measurements are taken for eight primary schools Pb and Pr with the pupils wearing regular school uniforms and shoes. The consents of the students were obtained before starting the measurements. The data were collected on a working day for three months during mid-2019. The equipment, tape, and steel rule was used for dimensions measurements with an accuracy of 0.1cm.

3.3 MEASUREMENTS

In this study, two types of measurement were applied.

3.3.1 FURNITURE DIMENSIONS MEASUREMENT

For the ergonomic evaluation in this study, measurements of the existing locally made classroom desk and chair are carried out. Figure 1 gives the definitions and their characteristics [12].

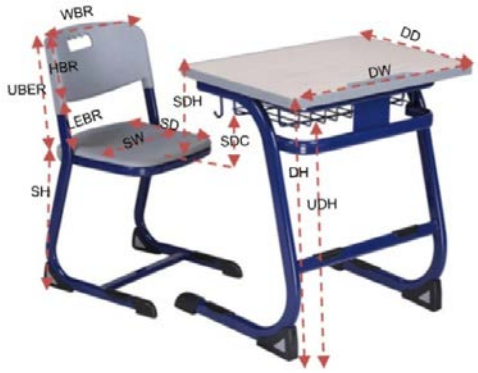

Figure 1: Furniture dimensions studied.

- **Seat Height (SH)**: the perpendicular distance from the floor to the middle point of the front edge of the seat.
- Seat Depth (SD): Horizontal distance of the seat surface from the front edge to the back edge.
- Seat width (SW): Horizontal distance of the seat surface from the left side to the right side.
- Lower Edge Back Rest Height (LEBH): the vertical distance between the lower edge of backrest and seat.
- Upper Edge Backrest Height (UEBH): the upright distance between the seat and the upper edge of the backrest.
- Height of Back Rest: the horizontal distance between two lateral edges of the backrest.
- Desk Top Height (DH): the vertical distance from the floor to the top of the rear edge of the desk.
- Desk Top Depth (DD): the distance from the back to the front of the top surface of the desk.
- Desk Width (DW): Horizontal distance of the desk surface from the front side to the backside.
- Underneath Desk Height (UDH): the vertical distance from the floor to the lowest structure point below the desktop surface at the end of the knee zone.
- Seat to Desk Height (SDH): the horizontal clear distance underneath the desktop from the rear edge of the desktop or front edge of seat measured at seat/knee height.

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3.3.2 ANTHROPOMETRIC MEASUREMENT

For classroom furniture ergonomical designs, the anthropometric dimensions are considered as the foundation. So, the measurements of anthropometric are dependent on the methods of Pheasant and Haslegrave [13] and defined by Dianat et al.[14], which are shown in Figure 2.

a) **Stature (S)**: the perpendicular distance between the top of the head and the floor.
b) **Popliteal Height (PH)**: the upright distance from the foot relaxing surface to the posterior surface of the knee.
c) **Hip Breadth (HB)**: the horizontal distance between the right side of the pelvic and the left side when sitting.
d) **Buttock Popliteal Length (BPL)**: the horizontal distance from the back of the knee to the back of the buttock.
e) **Subscapular height (SSH)**: the perpendicular distance between the sitting surface of the object and the tip of the shoulder.
f) **Sitting Elbow Height (SEH)**: the vertical distance from the sitting surface to the bottom of the elbow when sitting.
g) **Should breadth (SB)**: with sliding right and left upper plaque on the backrest.
h) **Knee Height(KH)**: the vertical distance from the top of the right knee cap to the floor.
i) **Thigh Thickness (TT)**: the perpendicular distance between the highest point on the top of the right thigh to the sitting surface of the object.

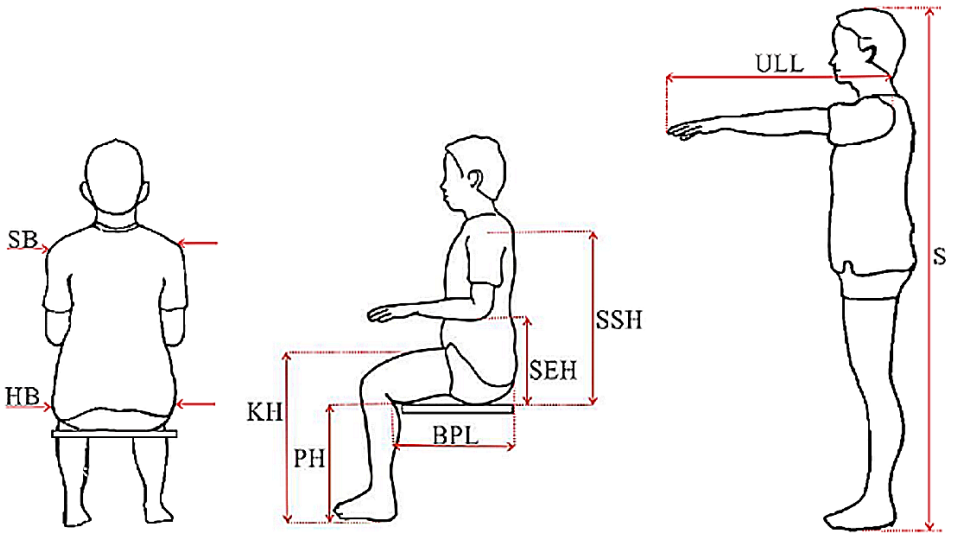

Figure 2: Anthropometric measures investigated.

3.3.3 COMPATIBILITY MEASUREMENT

The measures of anthropometric are related to school furniture based on the methodology developed by Gouvali and Boudolos [15], later revised by Castellucci and coworkers [16] the following anthropometric dimensions which are a study in this work are:

A. Popliteal height (PH) which is related to SH, is referring to the distance between the footrest and popliteal surface,

$$(PH + 3)\cos 30° \leq SH \leq (PH + 3)\cos 5° \quad (1).$$

B. Buttock-popliteal length (BPL) is necessary to determine SD. In order to achieve a comfortable depth, Parcells coworkers [19] suggest the criterion given

$$0.80\ BPL \leq SD \leq 0.95\ BPL \quad (2)$$

C. Hip Breadth (HB) is used to determine Seat Width (SW). Match and mismatch rule is controlled by

$$1.10\ HB \leq SW \leq 1.30\ HB \quad (3).$$

E. Elbow height sitting (EHS) is taken with a 90◦ angle elbow flexion to find the criteria DH. Also, considering that the extraordinary tallness of DH should not be higher than 5cm over the SHE, viz. [13]

$$SEH \leq DH \leq SEH + 5 \quad (4).$$

F. Thigh thickness (TT) is needed to determine SDC. In order to permit leg movement, the minimum perfect seat to desk clearance ought to be 2cm higher than thigh clearance. In this manner, a matching paradigm is supposed by

$$SDC > TT + 2 \quad (5).$$

4. ANALYSIS METHOD

For the purpose of quantitative data analysis, the SPSS (Statistical Package for the Social Sciences) software and Microsoft Excel 2017 was used to provide statistical analysis of data and give details for in-depth data access and preparation, analytical reporting, graphics and modeling.

5. RESULTS AND DISCUSSION

5.1 MEASURED ANTHROPOMETRIC DIMENSIONS

The anthropometric dimensions are very important for designing primary school furniture. because proper posture is a critical factor for the prevention of musculoskeletal disorders [18]. The anthropometric characteristics of 487 pupils of two groups (1-3 and 4-6) in all eight schools were by descriptive statistics are depicted of (Tables 1 and 2). The collected anthropometric data were thoroughly analyzed with the help of IBM SPSS 25 as Statistical Package. According to mention tables for both groups mean and standard deviation (S.D.) were determined. The mean stature for the group (1-3) is 126.56 cm and for the group (4-6) is143cm. Therefore, the mean popliteal height for (4-6) is 43.11 cm, and for (1-3) is 42cm (S.D. 1.915). Popliteal height of the (4-6) as an average greater than compared to(1-3). The average Hip Breadth for (1-3) is 33 cm (S.D. 2.531) and for (4-6) is 37cm (S.D. 3.458). Buttock Popliteal Length of the (4-6) is, on average, 46 cm. It is approximately the same with (1-3) groups. Similarly, Subscapular height for both group (1-3) and (4-6) the average 49, 50 cm respectively, sitting elbow height of group (1-3) is 21cm that smaller than group (4-6) which is 27cm, Shoulder Breadth average 33cm and 36 cm for group (4-6) greater than (1-3), the knee height average is 49 cm in group (1-3) while in group (4-6) is 52 cm, Thigh Thickness (TT) is nearly the same for both groups which are 11 and 12 cm. So this means and S.D. were utilized for finding suggested desk and chair dimensions for pupils in different grades (1-6).

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Table 1: Descriptive statistics for measured anthropometric dimensions for (243) pupils group (1-3).

Body dimensions	Min	Max	Percentile			Mean	S.D.
			5th	50th	95th		
S	116	138	118	126	135	126.56	5.3
ULL	50	69	52	59	66	59	4.24
Popliteal Height (PH)	35	43	35	38	43	38	1.787
Hip Breadth (HB)	28	38	29	33	37	33	2.531
Buttock Popliteal Length (BPL)	35	54	37	44.5	52	44.55	4.305
Subscapular height (SSH)	38	60	41	49	56.95	49	4.69
Sitting elbow height (SEH)	16	25	17	20	25	20	2.309
Shoulder Breadth (SB)	28	38	29	33	37	33	2.55
Knee Height (KH)	42	57	43	49	55	49	3.508
Thigh Thickness (TT)	7	14	8	11	13	11	1.763

Table 2: Descriptive statistics for measured anthropometric dimensions for (244) pupils group (4-6).

Body dimensions	Min	Max	Percentile			Mean	S.D.
			5th	50th	95th		
S	130	158	133	143	153	143	6.09
ULL	58	65	59	62	65	62	1.78
Popliteal Height (PH)	38	48	39	43	48	43.11	2.409
Hip Breadth (HB)	30	45	32	37	43	37	3.458
Buttock Popliteal Length (BPL)	41	50	42	46	49	46	2.191
Subscapular height (SSH)	44	58	45	50	56	50	3.278
Sitting elbow height (SEH)	21	33	22	27	32	27	2.81
Shoulder Breadth (SB)	29	44	30	36	42	36	3.587
Knee Height (KH)	48	56	49	52	55	52	2.138
Thigh Thickness (TT)	9	16	9	12	15	12	1.836

5.2 NORMAL DISTRIBUTION ANALYSIS

Anthropometric measurements data are normally distributed. For all collected data of groups (1-3) and (4-6) pupils, the normal distribution curves that it means to examine the shape and spread of all collected anthropometric data and are presented in (Figures 3 & 4).

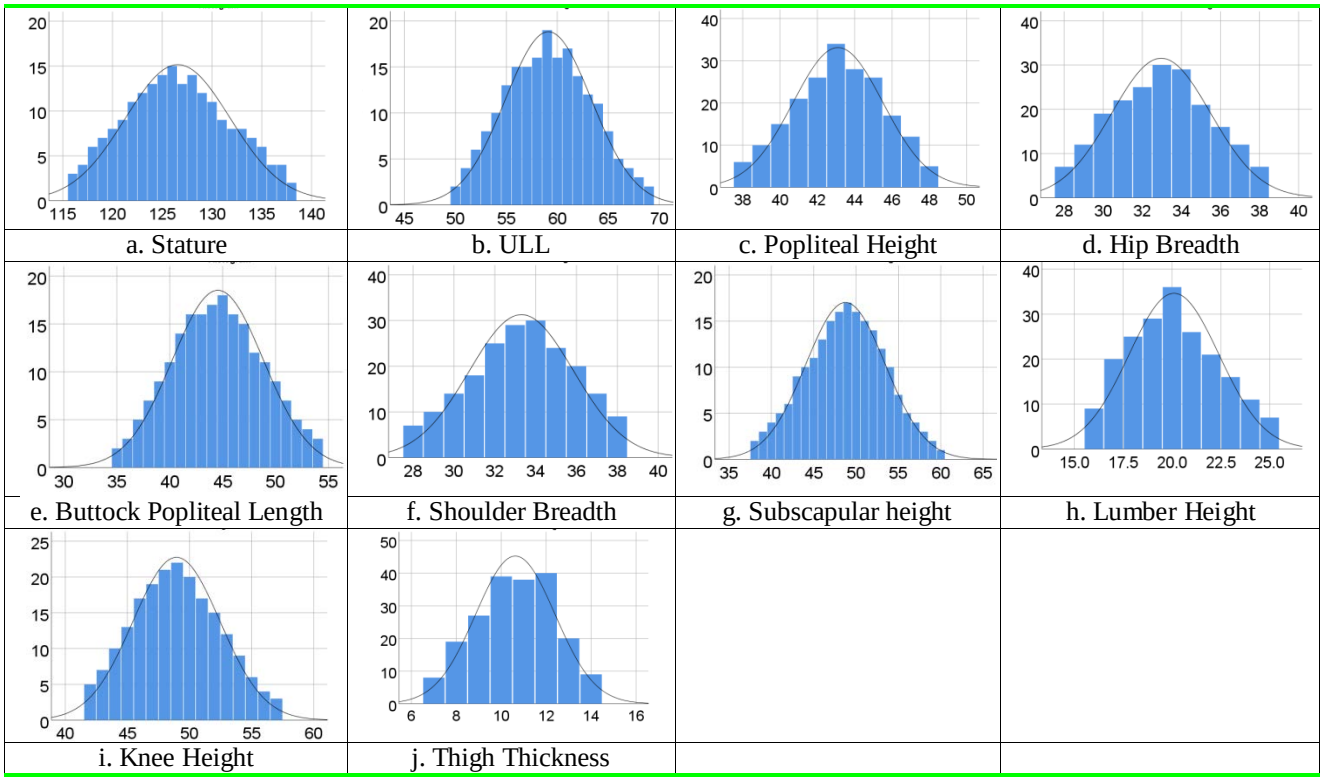

Figure 3: Normal distribution of anthropometric parameter a,b,c,d,e,f,g,h,I and j of group (1-3).

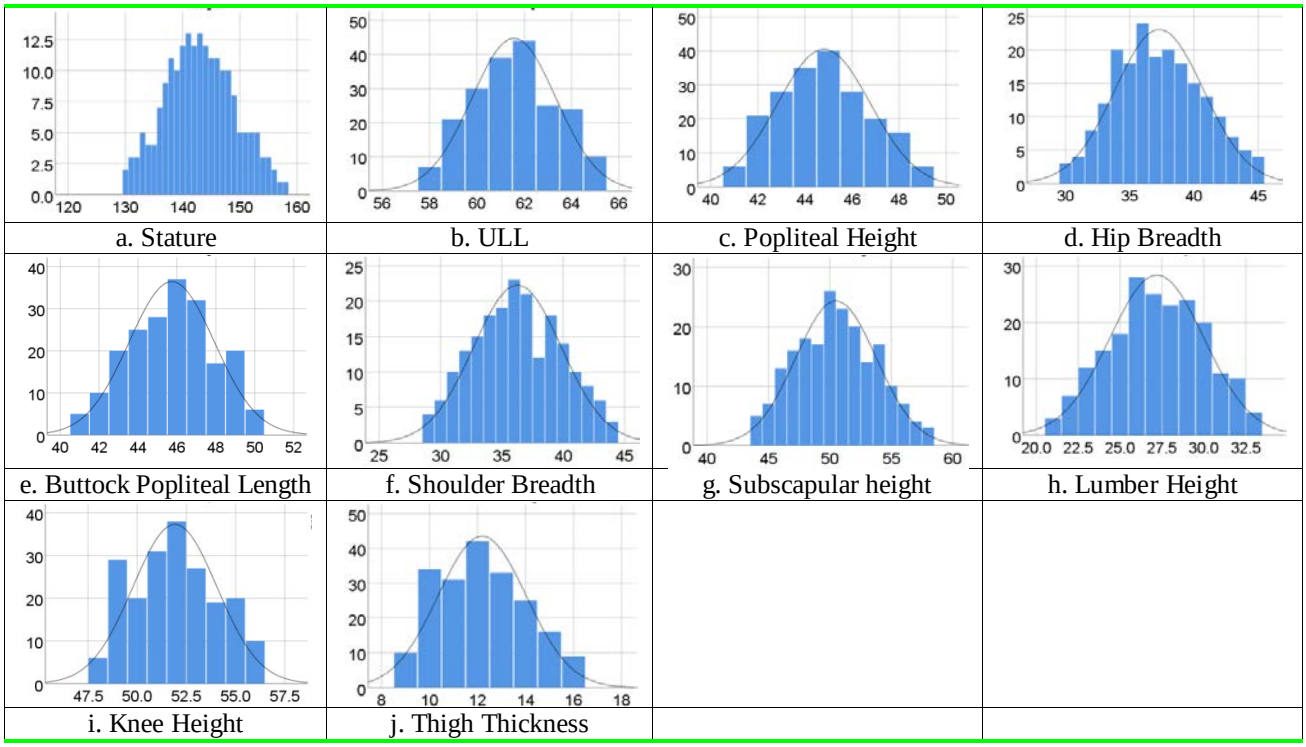

Figure 4: Normal distribution of anthropometric parameter a,b,c,d,e,f,g,h,I and j of group (4-6).

5.3 THE OUTCOMES OF ANTHROPOMETRY IN RESOLVING DESK AND SEAT DIMENSIONS

The anthropometry-based measurements utilized for the design of seats and desks in elementary school. Depending on the computation of the desks' and seats' dimensions, with a few changes from the focus group, and the final sizes are shown in (Table.3). As specified by the anthropometric data used as a reference for new desk and seat designs, different sizes were earlier used for the seats and desks. The appropriate seat and desk sizes are as follows:

For seat size, designing front seat height (A) was based on PH. To get suitable measurements, a 2 cm allowance accounting for shoe height was used [19]. For Group (1-3) and (4-6) is 37cm and 41.2 cm respectively. Size of seat depth determination depends on BPL for (1-3) group 37.24 cm and 42.39 cm for the group (4-6). HB was applied as a reference for determination seat width. The HB was adopted to ensure that pupils with big hips would be able to sit comfortably [20]. So the size in Group (1-3) 39.16 cm and for Group (4-6) 44.7 cm.

Desk size: The front desk height was determined in accordance with SEH, with a added allowance 3-5 cm [20]. Otherwise, the measurement is adjusted to elbow height [19]. In this work, the measurement depended on SEH, added 10 cm for eliminating pressure during writing and reading. For group (1-3) are 72 cm and 81cm in Group (4-6). Size desk width in Group (1-3) and in Group (4-6) is 74 cm and 84 cm respectively. The desk depth size is 57 cm and 64 cm for Group (1-3) and (4-6), respectively.

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Table 3: Seat and desk sizes conforming to anthropometry.

Seat and desk sizes		
Dimensions	Group	Measurement
Front seat height		Mean of PH – (1.645 × S.D.)) + 2 cm
	1-3	38 – (1.645 × 1.787) + 2 = 37 cm
	4-6	43.11 – (1.645 ×2.409) + 2 = 41.2cm
Back seat height	1-3	37 – 2 = 35 cm
	4-6	41.2– 2 = 39.2 cm
Seat depth		Mean of BPL – (1.645 × S.D.)
	1-3	44.55 – (1.645 × 4.305) = 37.24 cm
	4-6	46 – (1.645 × 2.19) = 42.39 cm
Seat width		Mean of HB + (1.645 × S.D.)
	1-3	33+ (1.645 ×2.531) + 2 = 39.16 cm
	4-6	37 + (1.645 ×3.458) + 2 = 44.7 cm
The upper edge of the backrest		Mean of SSH – (1.645 × S.D.)
	1-3	49 – (1.645 × 5.69) = 39.63 cm
	4-6	5o – (1.645 × 3.278) = 44.6 cm
The lower edge of the backrest		5/9 × Upper edge of the backrest
	1-3	5/9 × 39.63 = 22 cm
	4-6	5/9 × 44.6 = 24.8 cm
Height of Backrest		4/9 × Upper edge of the backrest
	1-3	4/9 × 39.63 = 17.61 cm
	4-6	4/9 × 44.6 = 19.8 cm
Backrest length		Mean of SB – (1.645 × S.D.) + 2 cm
	1-3	33 – (1.645 × 2.55) + 2 = 30.8 cm
	4-6	36 – (1.645 × 3.587) + 2 = 32 cm
Front desk height		Mean of SEH + 10 cm + Front seat height
	1-3	(20 + 10) + 37= 67 cm
	4-6	(27 + 10) + 44= 81cm
Back desk height (J)		(Desk depth × tangent of 5°) + front desk height
	1-3	(57× 0.087) + 67 = 72 cm
	4-6	(64 × 0.087) + 81= 87 cm
Desk width (K)		Mean of SB + (1.645 × S.D.) + twice the forearm length
	1-3	33 + (1.645 × 2.55) + 2 (126 × 0.146) = 74 cm
	4-6	36 + (1.645 × 3.587) + 2 (143 × 0.146) = 84 cm
Desk depth (L)		Mean of ULL – (1.645 × S.D.) + 5 cm
	1-3	59 – (1.645 × 4.24) + 5 = 57 cm
	4-6	62 – (1.645 × 1.78) + 5 = 64 cm
Underneath Desk Height (M)		Mean of KH + Shoe Correction + 2 cm
	1-3	49 + 2.50 + 2 = 54 cm
	4-6	52 + 2.50 + 2 = 57 cm
Floor-to-desk clearance (N)		Mean of KH + 1.645 S.D. + 2 cm
	1-3	49 + (1.645 × 3.508) + 2 = 57 cm
	4-6	52 + (1.645 × 2.138) + 2 = 58 cm

5.4 CLASSROOM FURNITURE IN PUBLIC AND PRIVATE SCHOOLS

In Figure 5, each school has only one set of chairs and desks used across all grade 6 sections. Therefore, mainly dual desk, i.e., combined bench and desk design is commonly used design in all the public schools. In this design, the writing desk and seating bench are combined together in one fixed unit, and two pupils share one unit. In each of the private schools, there is a variation of furniture design as in schools A and D they have the combined table with a single chair, also in school A and C have a single chair with a table, that used as a group in school B.

A,D A,C B All Public

Figure 5: variation of furniture design in Private and public schools**.**

As seen in (Table 4), Measurements of the various dimensions of the desks and tables from eight different schools were carried out. The furniture size value of both groups (1-3) and (4-6) are the same in Pb schools. Whereas in Pr schools there is a variation of the seat and desks size values are being used for age groups; the measured dimensions are compared with the suggested dimension.

Table 4: Dimensions (cm) of existing private and public classrooms with suggested furniture.

Component	Furniture dimensions	Present Dimensions								Suggested Dimensions	
		Private				Public					
		A	B	C	D	E	F	G	H	(1-3)	(4-6)
Seat	Seat Height (SH)	45	40	40	45	40	40	40	40	37	41.2
	Seat Width (SW)	40	40	37	40	90	90	90	90	39	44
	Seat Depth (SD)	40	35	40	40	20	20	20	20	37	42
Backrest	Upper Edge of Backrest (UEBR)	45	30	45	40	32	32	32	32	39	44
	Lower Edge of Backrest (LEBR)	20	15	20	15	12	12	12	12	22	24
	Height of Backrest (HBR)	25	15	25	25	20	20	20	20	17	20
Desk	Desk Height (DH)	80	70	75	80	70	70	70	70	67	81
	Desk Depth (DD)	60	125	45	45	38	38	38	38	57	64
	Desk Width (DW)	100	63	60	90	90	90	90	90	74	84
	Underneath Desk Height (UDH)	70	68	65	65	50	50	50	50	54	57
Interaction between desk and seat	Seat to Desk Clearance (SDC)	20	-	20	20	20	20	20	20		
	Seat to Desk Height (SDH)	30	25	30	35	28	28	28	28	25	29

From the results of the study dimensions depending on the model used (see Table.3), a suggested dimension of desk and chair was obtained to improve the active learning system for pupils as indicated in Figure 6.

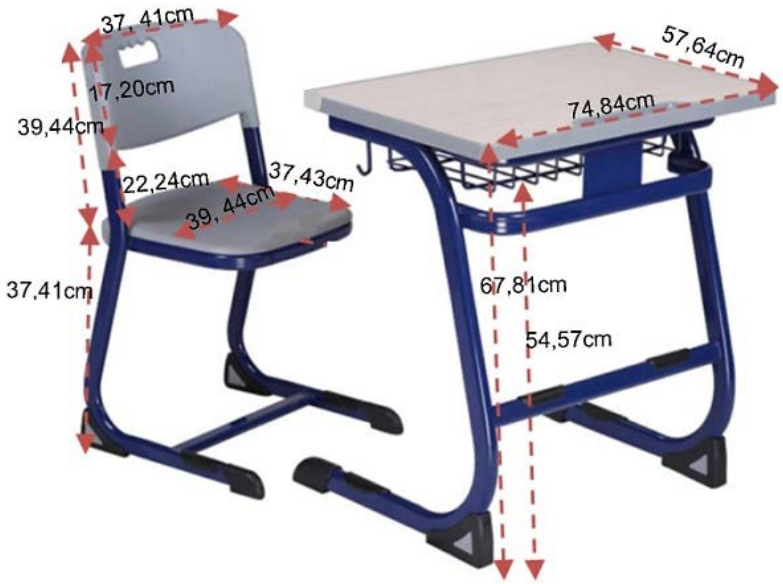

Figure 6: Proposed Furniture dimensions (first number for Group 1-3, and later for Group 4-6).

5.5 DISCREPANCIES BETWEEN ANTHROPOMETRIC AND SCHOOL FURNITURE

Classroom furniture and body dimensions identification of a match or mismatch is important for designing and evaluating furniture. To describe the range in which every furniture dimension is viewed as fitting, related anthropometric measurement, and ergonomic standards can be utilized. Based on the methodology developed by Gouvali and Boudolos [15], later revised by Castellucci et al. [16] and in order to compare anthropometric dimensions of pupils with furniture dimensions for one-way models, two categories were defined to measure compatibility: 'Match' and 'Mismatch.' If the equation does not satisfy, then it is considered as a mismatch, i.e., as the irregularity among the school furniture dimensions and the student anthropometric measurements [4]. For two-way models, three categories were defined as [16]

1. If the anthropometric measure is between the limits, it is considered 'Match',
2. 'High mismatch' when the minimum limit of the criterion model is higher than the anthropometric measure, and
3. 'Low mismatch' when the maximum limit of the criterion model is lower than the anthropometric measure.

Different associations have been established to identify a match or mismatch. For the determination of match percentile and mismatch between the furniture design and anthropometric data, match analysis was utilized, depending on the intervals or mention relation, and this was performed through the compassion between the criteria dimensions of the chairs and desks with the anthropometric data.

5.5.1 SEAT HEIGHT (SH)

As demonstrates in (Figure7), it was indicated that SH was high, i.e., a low mismatch occurred of pupils in Group 1-3 which 100% for both schools A and D but 55%for B, C, and Pb. Whereas in Group 4-6, pupils have a low mismatch 60% in A and D schools, while in B, C and Pb have the highest match 52%.

In outcome, SH is more than PH for all pupils in (1-3) groups which indicates that they unable their feet on the floor and that they are unlikely to experience high tissue pressure on the posterior surface of the knee, SH in all schools is considered appropriate [19] but, however, a slightly lower SH might be slightly more comfortable for many pupils. While in (4-6), SH is suitable for many schools except A and D schools.

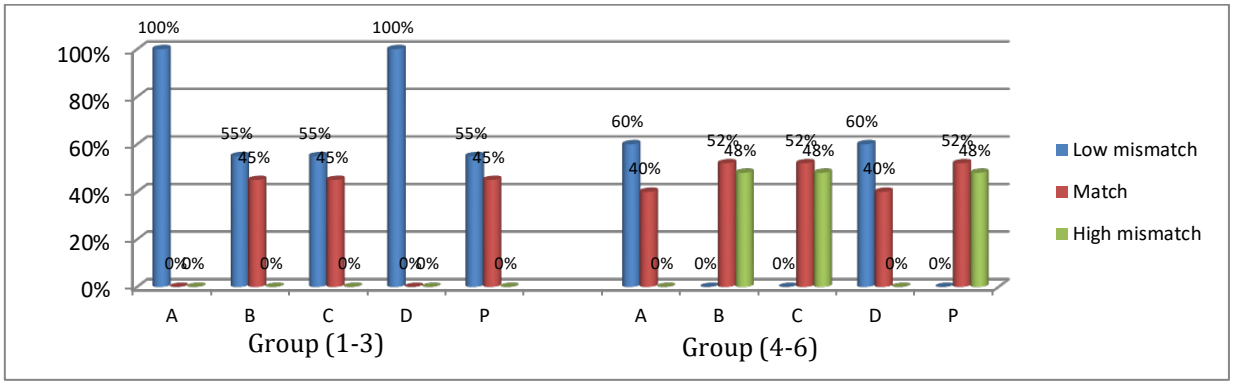

Figure 7: Pupils Percentages of Group 1-3 and 4-6 by match/mismatch level for PH against SH.

5.5.2 SEAT DEPTH (SD)

From the values of SD against (BPL), it was found that SD in Group 1-3 pupils Pr A, C, and D

schools have the same low mismatch 50% while school B shows the highest match 45%. Whereas in Pb, 100% low mismatch. It was illustrated in Group 4-6 pupils have the highest match 90% in A, C and D school samples, though in C and Pb 75%, 100% high mismatch, respectively (Figure8). This result in hindered blood circulation and discomfort because the thighs of pupils were not sufficiently stayed [19,23]. Because Seats were not found to be deeper for same school samples of Groups 1-3 than required for any pupils, in Groups 4-6 most of the schools the seats are comforted, but in Pb, in both groups, it is not sufficient this pointing suggesting that kyphotic postures are far to occur [16].

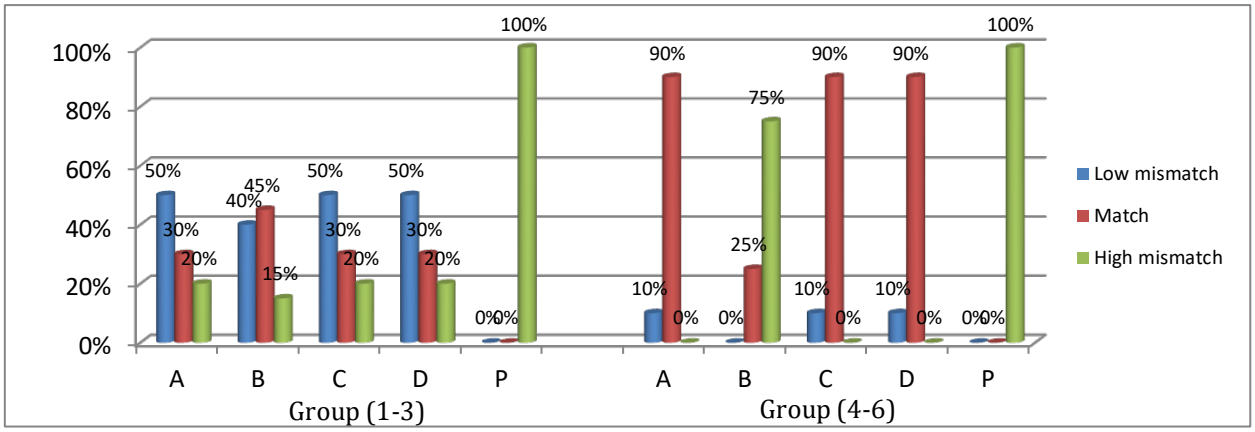

Figure 8: Pupils Percentages of Group 1-3 and 4-6 by match/mismatch level for BPL against SD.

5.5.3 SEAT WIDTH (SW)

In Figure 9, group (1-3) has the same match and low mismatch in Pr schools A, B, and D 40% while school C shows the highest match 56% but Pb schools have the low mismatch 65%. The Pr schools A, B, D, and C have the highest value of high mismatch for (4-6) group, in 50% and 75%, respectively. All Pb schools have a high match of 40%. The result illustrated that in (1-3) groups, the SW suitable seat for pupils in Pr, except in Pb have wide seat mismatch. Whereas Pr (4-6) group has narrow seats. Therefore, those school pupils were not able to dissipate the pressure at the buttocks causing discomfort and mobility restrictions [19]. But in Pb schools are nearly suitable for pupils (4-6) group.

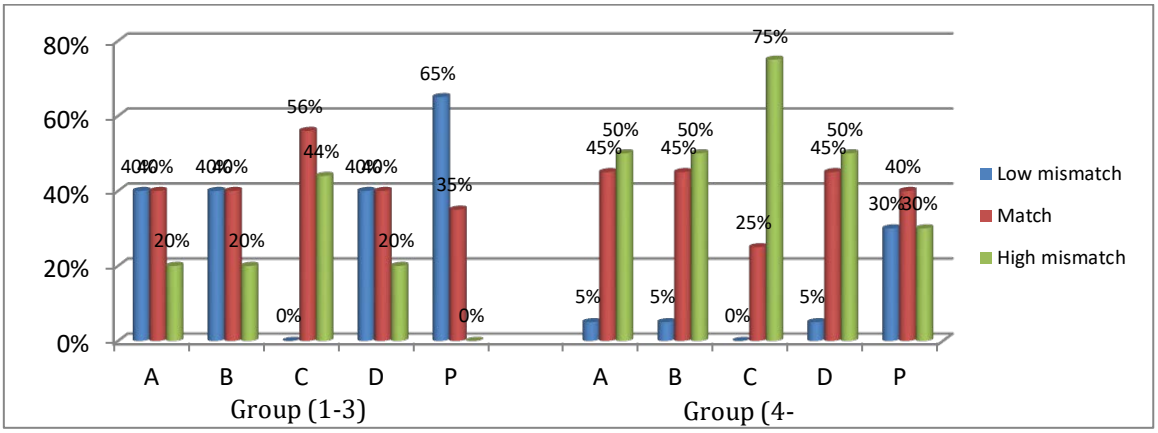

Figure 9: Pupils Percentage of Group 1-3 and 4-6 by match/mismatch level for HB against SW.

5.5.4 SEAT-TO-DESK HEIGHT (SDH)

From the correlation in Figure10, for Group 1-3 pupils, Pr schools A and C have the same low mismatch 90% but D100% while 65% match indicated B school whereas 70% in Pb. Whereas in Group 4-6, 45% match for both A and C schools but in schools B and Pbs have a low mismatch 70%

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and 55% respectively except school D has a 60% low mismatch. The result showed that a desk which has the high mismatch cause pupils to work with shoulder flexion and abduction or scapular elevation, which might cause increased muscular workload, discomfort, and pain in the shoulder region. If its high mismatch, which could cause pupils to bend forwards to work on the desk. This also has the potential to cause shoulder and back problems [20].

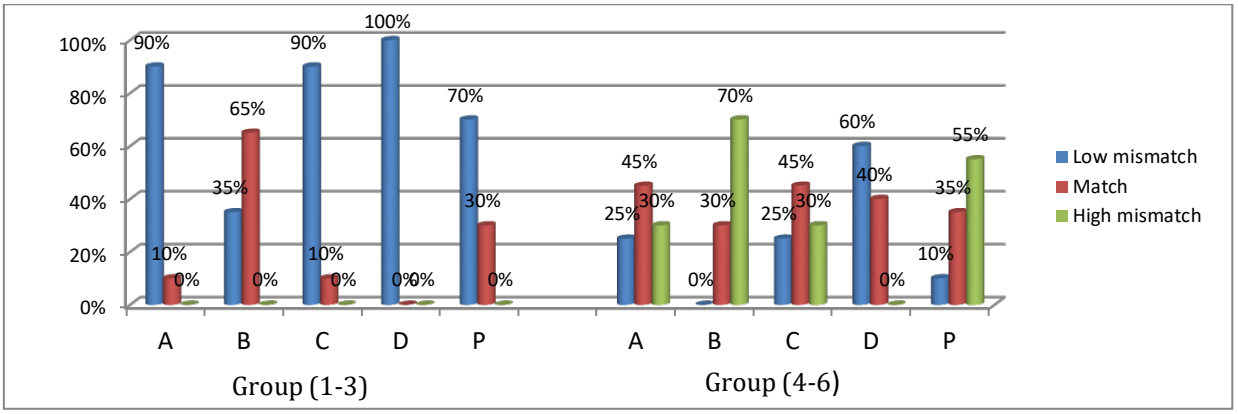

Figure 10: Pupils Percentage of Group 1-3 and 4-6 by match/mismatch level for SEH against SDH.

5.5.5 SEAT-TO-DESK CLEARANCE (SDC)

Figure11 displayed that SDC of pupils in all Pr and Pb schools in both groups (1-3) and (4-6) have the high matched 100 %. This means that all pupils have their thighs not contact with the desk; thus, there is no problem for legs movement [20].

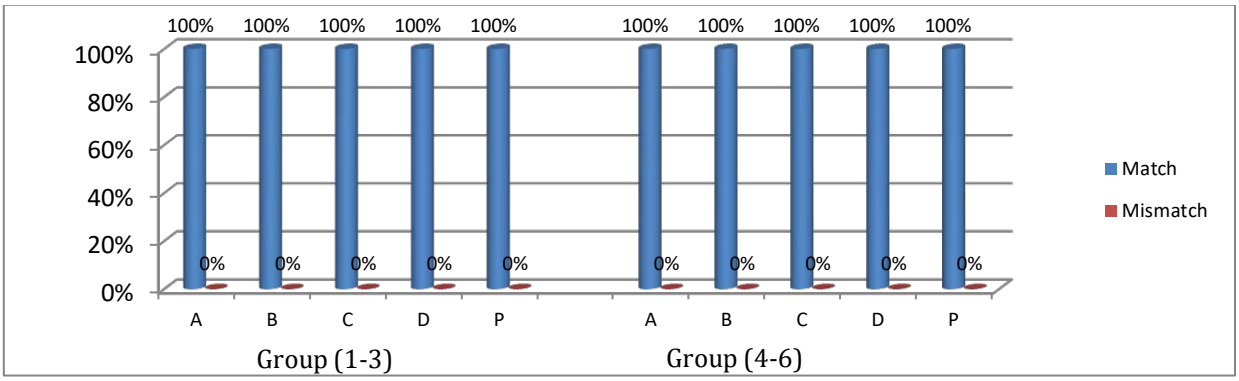

Figure 11: Pupils Percentage of Group 1-3 and 4-6 by match/mismatch level for TT against SDC.

6. CONCLUSION

This paper indicated that there is a potent association between the furniture dimension and anthropometric measurement in the classroom to enhance their learning attention and increase the comfortable seating of pupils. From the analysis of this study, which included the existence of the abnormality of furniture dimension with anthropometric measurement of pupils in several private and public primary schools in Erbil city. It was concluded that the most studying parameters of chairs and desks for Group 1-3, pupils are unsuitable in both schools just in the seat to desk height parameter that is convenient for pupils to move legs freely and fell relax seating in the classroom. While the desks and seats for Group 4-6 pupils in private school samples are appropriately convenient, but for public schools, there is uncomfortably just in the seat depth parameter. Although the a match or mismatch is significant for evaluating furniture that indicated from the combination of the existing furniture with anthropometric data with those equation which indicated them, all schools for pupils Group 1-3 have mismatched between classroom furniture dimensions and pupils anthropometry those mismatches

cause several types of pain and unwanted permanent poor sitting posture habits that create lack of comfort. Whereas for Group 4-6 for most private schools, the high match occurred than public schools. The research suggests designing two different sizes of classroom chairs and desks for each grade Groups pupils 1-3 and 4-6 should be made based on anthropometric measurements of the pupils to avoid discomfort, pain, decrease the occurrence of musculoskeletal disorder, in addition to ensuring comfort for pupils. This lessening is attributed to the fact that the new seat and desk designs conform to the requirements of pupils anthropometry.

7. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

8. REFERENCES

[1] Hira, D.S. (1980). An ergonomic appraisal of educational desks. Ergonomics. 23: 213-221.

[2] Al Saleh K. and Ramadan M. (2011). Are the criteria for health and safety available in adjustable Saudi school furniture? iBusiness. 3: 205-212.

[3] Murphy S., Buckle P. and Stubbs D., (2007). A cross sectional study of self -reported back and neck pain among English school children and associated physical and psychological risk factors. Applied Ergonomics.

[4] Smith-Zuzovsky N. and Exner C. E., (2004)"The effect of seated positioningqualityontypical6-and 7-year-oldchildren'sobject manipulation skills," American Journal of Occupational Therapy , 58(4), 380-388.

[5] Castellucci H.I., Arezes M., Catal´an, P.M., and Molenbroek J.F.M., (2016). Evidence for the need to update the Chile a standard for school furniture dimension specifications," International Journal of Industrial Ergonomics, 56, 181-188.

[6] Helander M.G,(2003) "Forget about ergonomics in chair design? Focus on aesthetics and comfort!," Ergonomics, 46(13-14), 1306-1319.

[7] Rani Lauder, V. J. (2008). Ergonomics for Children: Designing products and places for toddlers to teens. Boca, Florida, US: Taylor and Francic Group.

[8] Onawumi A.S., Oyawale F.A., and Dunmade I.S.,(2016) "Ergonomic assessment of school furniture in primary schools in Nigeria," International Journal of Applied Science and Technology. 6(1), 92-101.

[9] Bennet, C. (2002). Changing Education Ergonomics. The Proceeding of the XVI Annual International Occupational Ergonomics and Safety Conference, Toronto.

[10] Nasr, A., Mahmood, K., and Ahm Sh. (2018). An Ergonomic Student Chair Design and Engineering for Classroom Environment.in Finland.

[11] Xu, J., and Zhang H. (2013). Modern office furniture design based on ergonomics. Advanced Materials Research, 628, 57-62.

[12] Prakash Salunke, et al (2015). Identifying Anthropometric Parameters Considered for the Improvement in Ergonomic Design of Classroom Furniture. International Journal of Industrial Engineering, Research, and Development. 6(1), 01-13.

[13] Pheasant S. and Haslegrave C.M. (2016). *Bodyspace: Anthropometry, ergonomics and the Design of work*. CRCPress.

*Corresponding author (Adeeb N.Ahmad) Email: adeeb.ahmed@su.edu.krd. Volume 11 No.6 ISSN2228-9860 eISSN1906-9642 CODEN: ITJEA8 Paper ID:11A06T http://TUENGR.COM/V11/11A06T.pdf DOI: 10.14456/ITJEMAST.2020.120

[14] Dianat I., Karimi M. A., Hashemi A. A., and Bahrampour S. (2013). Classroom furniture and anthropometric characteristics of Iranian high school students: proposed dimensions based on anthropometric data. *Applied Ergonomics*. 44(1), 101-108.

[15] Gouvali M.K, Boudolos K. (2006). Match between school furniture dimensions and children's anthropometry. Applied Ergonomics. 37: 765-773.

[16] Castellucci H.I, Arezes P.M, and Viviani C.A. (2010). Mismatch between classroom furniture and anthropometric measures in Chile schools. Applied Ergonomics. 41: 563-568

[17] Parcells C., Stommel M., Hubbard R.P. (1999). Mismatch of classroom furniture and student body dimensions: empirical findings and health implications. J Adolescent Health. 1999; 24: 265-273.

[18] Cranz G. (2000). The Alexander Technique in the world of design: posture and the common chair. J Body Work MovTher. 4: 90–98.

[19] Salaheddine B., Khalid A.S., Abdulsamad A.K. (2013). Ergonomic assessment of primary school furniture in UAE.

[20] Parvez M.S.; Parvin F.; Shahriar M.M.,and Kibria G. (2018). Design of Ergonomically Fit Classroom Furniture for Primary Schools of Bangladesh.in Bangladesh.

Rawaz Najmaddin Abdullah is a joint master student in the Department of Architecture, Salahaddin University and Tishik International University - Erbil. She obtained a BS in Architecture from University of Salahaddin, Erbil Iraq. She is a teaching staff at Architecture Department, College of Engineering-Tishik international. Her research interest is Ergonomic and Human Factors Design.

Dr. Adeeb Nuri Ahmed Jabari is an Assistant Professor at Department of Architecture- College of Engineering-University of Salahaddin-Erbil-Iraq. He got a Bachelor's Degree in Architectural Engineering from University of Baghdad, a Master's Degree in Architectural Engineering from Baghdad University, a PhD in Architectural Engineering from University of Technology in Baghdad. His research encompasses Urban Design, Landscape Design, Interior Design, Building Restoration, Building Technology, Architectural Environment, Architectural Building Design for Civil Engineering.