



## Method of Improving Designs of Built Local Schools According to Iraqi and International Criteria

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### Abstract

Local schools in Iraq suffer from low functional performance caused by several reasons, including; increasing the number of students, changing curriculum, and the developing methods of learning, as well as high economic consequences of demolition for these schools, which cast a shadow on the functional performance of these schools. Therefore, their design needs to be improved to match these changing factors. This paper tries to study this problem by following two steps; Firstly, delineation of built types of local schools, delineation of functional components with the area, then comparing these functional components and their areas with that in Iraqi and International standards, to discover the shortage quantitatively and, to satisfy the needed necessities, secondly, the step of preparation (design alternatives) for each type, by using mechanisms as addition, subtraction, and substitution. The research was able to put forward possible alternatives to built types of local schools, the adoption of design solutions to address the shortage for each type and try to come up with multiple alternatives, then choose the best alternative of them, and by using evaluation criteria qualitatively, the best alternative selected. Hence, the Double Courts alternative in primary schools seems to be the best one, depending on five criteria; a ratio of satisfying necessities, orientation as an environmental request, financial economy, ratio of modification, and design flexibility.

**Disciplinary:** Architecture, Education

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## 1 Introduction

The development of teaching methods and the change of educational curricula in the world and Iraq have made school buildings unable to meet this development. The old type of schools in Iraq and especially in Mosul city hurt the educational achievement of students and the staff

performance. Further in, the economic consequences of replacing the existing school buildings (which represent a large number of school buildings as a repetitive model all over Iraq) with others, was a motive for this research. Previous studies did not state design strategies to develop the buildings of the local school, another motive, is to satisfy the needed necessities quantitatively and qualitatively, and to achieve the client goals from an economic, functional, and environmental point of view. Our objective is to identify design strategies to meet the existing shortage in local schools and meet future needs and requirements, to provide a flexible school building that encounters the rapid developments in teaching methods and curriculum (Al-Masoudi., 2019; Valkiria, 2008). Initially, the shortage in the local schools was determined through comparisons between the functional components of those existing schools, on the one hand, and international and Iraqi standards on the other, to determine the scale of the problem, and then give accurate strategies to solve these problems.

To achieve this objective, by following the next methodology:

- Define the international and Iraqi area standards for the primary school buildings and define their different types and sizes to determine the local reality of primary school buildings and diagnose defects in them.
- make a comparison between the functional components in local schools and that within the international and local standards and determine the nature of the shortage.
- Giving design alternatives and then choosing the best one according to several criteria.

## 2 Literature Review

Nasser and Shaayi (2018) exhibited the capacity of the class are 30 students for primary schools, and 25 students for secondary schools, with the provision of a cafe', waiting for space for students and parents, and sports spaces (basket, flying, and ping pong), also stated 2.5m<sup>2</sup> per student as the minimum area for primary schools, 10m<sup>2</sup> per student for secondary schools.

Al-Etabi (2011) focused on local schools by making the outer spaces more sustainable, by proposing design solutions for them, such as changing their forms and their furniture, because of their role in education and social interaction.

Moore (2013) addressed the relationship between educational outputs and the architectural design of educational social and support spaces, and the impact of a physical characteristic of primary schools upon educational performance, such as class size, school size, and the number of students. Also, they pointed out that small schools offer an opportunity for student gathering and this enhances interactive education, also indicated the importance of the small classes and the relatively low density in enhancing interactive education and educational results outputs.

Al-Masoudi (2019) provided a set of solutions to address the reality of technological development and changing teaching methods in school buildings, by correcting disadvantages in the functional program and space organization and giving solutions to the complementary educational spaces. Moreover, the study identified indicators for the design of attractive and flexible spaces that correspond to the changing in educational curriculum, as well as responding to

rapid developments in information technologies, through minor modifications to the old spaces, as the design of multi-use spaces to meet the functional requirements of the educational process (Heritor, Jose, 2008, Zhang, 2015; Mohammed, 2020).

Heritor & Jose (2009) concerned with developing the plans of existing schools in Portugal by the change in the educational curriculum and laws, also classified the school spaces functionally; the educational spaces used during official hours; social spaces such as a library, meeting rooms, theatres that can be used out of official working hours; and support spaces such as service spaces, administration spaces, and others.

Finn and Achilles (2016) referred to the educational environment, its appropriate scale, and its role in enhancing the educational outdoor education, by dividing it into parts proportionated to the human dimension of children, also indicated the importance of social spaces to increase social interaction, which improves the educational process.

These studies stated the different kinds of spaces in the school, which are devoted to many purposes, and addressed some affecting characteristics, such as school and class sizes according to student number (Finn, 2016).

## 3 Method

### 3.1 Investigation Steps

- 1- Selection of samples from (built types of local schools) in Mosul city, the sample was tested based on the most prevalent sample after holding a questionnaire at the Nineveh Education Directorate. (Figure 1)
- 2- Analysis of this sample (primary schools) to determine the functional shortage in the school's components quantitatively and qualitatively. The space allocated to each student in each classroom was calculated according to the number of students occupying the educational space and social spaces, and according to the function allocated to each space, it was also clear that there is no space allocated for cultural Spaces in schools that are executed. Calculating the total area of administrative spaces and percentages of the total area of movement spaces, storerooms, and construction structures, showing the extent of the problem by comparing to the school buildings around the world according to local and international standards. (See Table 1)
- 3- Analysis of international examples of schools, which meet the modern trends in International learning methods, to identify its components quantitatively and qualitatively.
- 4- Classify local and international standards specialized in schools. Where Table (2) clarifies the quantitative deficiency by comparing the spaces allocated to each student with what is being implemented in international schools to keep pace with the development in educational methods and advanced education curricula and finding the qualitative shortages at local schools and calculating the spaces allocated to them. The sum represents a quantitative deficiency in building spaces. (See Table 2)
- 5- Make a comparison to determine the shortage in local schools in terms of functional components (quantity and quality). Table (3) represents a comparison of the spaces and functions available in local schools with the average of the International and local standards ((quantitatively and qualitatively)) to diagnose the real deficiency in those schools, which in turn affects the educational process. The areas allocated to each student in educational spaces or recreational Spaces or other supportive activities in comparison to a minimum international and local standards .as shown in Table 3.



**Figure 1:** Chosen sample plan for the most prevalent pattern for primary schools in the city.

### 3.2 Treatment Step

Identify the design strategies to fulfill the shortage of built types of local schools, using the “addition, subtraction, and substitution” mechanisms to generate several design alternatives. Figures 2, 3, 4, and 5 show the design alternatives.

## 4 Result and Discussion

### 4.1 Analyzing a Sample

Analyzing a sample of the built type of local school (quantitatively and qualitatively), and calculating the area allocated to each student, the total area of the chosen samples is equal to 1650 m. (see Table 1).

**Table 1:** Analyzing a sample of a local school to determine functional components quantitatively and qualitatively.

Type of spaces	Sub- Type of spaces	Area (m <sup>2</sup> )/ Student
Educational spaces	Classrooms	1.6
	Scientific Laboratories	1.6
	Art Studio	1.4
Social spaces	Courtyards	1.1
	Open spaces	4.1
Cultural spaces		0.0
Sport spaces	Open sport spaces	20
Supportive spaces	Circulation spaces	15%
	Structure	15%
	Stores	0.5 %
Administration spaces	Administer room	15
	Assistant room	15
	Teachers’ rooms	20

### 4.2 Mechanisms to Treat the Shortage

The architects used many mechanisms to produce many new solutions (alternatives), that differ from their original forms, these mechanisms are Addition, Subtraction and Addition, Repetition, Division, Rotation, Displacement, and Internal modification. Applying treatment mechanisms to the (built types of local schools), to produce four alternatives according to probable orientation.

**Table 2:** 'Identifying components in international schools quantitatively and qualitatively

Type of spaces	Sub-Type spaces	Mohammad Al-durra school	Mean according to international standards (m <sup>2</sup> )	Number of students	Shortage within standards (m <sup>2</sup> )	Total Shortage (m <sup>2</sup> )
Educational spaces	Classrooms	1.6	2.4	360 students	0.8	288
	Scientific Lab.	1.6	2.5	60 to two classes	0.9	54
	Laboratories	0.0	2.3	60 to two classes	2.3	138
	Open classrooms	0.0	2.4	60 to two classes	2.4	144
	Art Studio	1.4	3.2	60 to two classes	1.8	108
Social spaces	Courtyards	1.1	3	90 students	1.9	171
	Open spaces	4.1	4.2	360 students	0.1	36
	Café & Restaurant	0.0	1.7	360 students	1.7	612
	Waiting Halls	0.0	0.3	180 students	0.3	54
	Interior Halls	0.0	2.3	90 students	2.3	207
Cultural spaces	Library	0.0	2.4	60 students	2.4	144
	Poetry Club	0.0	2.5	30 to one class	2.5	75
	Painting Studio	0.0	3.8	30 to one class	3.8	144
	Music Studio	0.0	0.95	30 to one class	0.95	144
	Acting Studio	0.0	0.95	30 to one class	0.95	144
	Dancing Studio	0.0	0.95	30 to one class	0.95	144
Sport spaces	Open sport spaces	20	24	60 students	4.0	240
	Close sport spaces	0.0	13.9	60 students	13.9	834
	Open swim. Pool	0.0	0.0	0	0.0	0.0
	Close swim. Pool	0.0	0.0	0	0.0	0.0
Supportive spaces	Multi-purpose hall	0.0	2.35	220 persons	2.35	517
	Theater	0.0	2.2	220 persons	2.20	484
	Bathroom	1.2	1.3	20 persons	0.1	2
	Circulation	15%	25 %	-----	10%	10%
	Structure	15 %	22.5%	-----	7.5%	7.5%
	Parking	0 %	12.5%	-----	12.5%	12.5%
	Stores	0.5 %	8.5%	-----	8%	8%
Administration Spaces	Manager room	15	28	1 person	13	13
	Assistant room	15	23	2 room	8	16
	Teachers rooms	40	50	3 room	10	110
	Advisor rooms	0.0	15	2 room	15	30
	Offices	0.0	20	2 room	20	40
Total area Shortage						<b>6752 m<sup>2</sup></b>

**Criteria for evaluation of alternatives:**

Functional: Ratio of achieved area, the achieved area / the required area.

Functional: The future expansion, in means of horizontal one only, where vertical expansion has excluded since it is equal in all alternatives.

Economic: Ratio of subtracted areas to add other spaces / total areas.

Economic: Ratio of added areas / total areas.

Environmental: Orientation, a ratio of classrooms at good orientation, a ratio of classrooms at acceptable orientation, a ratio of classrooms at non-acceptable orientation.

To state the relative priorities between previous criteria, a questionnaire was held for the Architects at (the office of Education in the governorate of Nineveh) and discovered that the sequence (Economic criteria, then Functional, then Environmental) represents the Office's priorities according to many reasons (see Table 4). The ratio of achieving the area, The ratio of classrooms in good orientation, Accessibility in terms of movement, The ratio of added areas (minimum costs), The ratio of subtracted areas to add other spaces, and the future expansion.

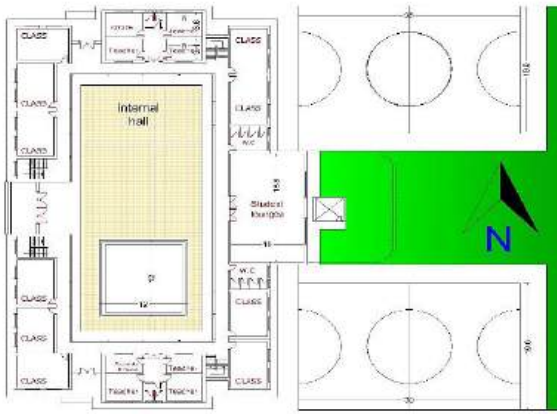
**Table 3: Finding quantitative and qualitative shortages compared to international standards of schools**

Type of spaces	Sub- Type spaces	Mohammad Al-durra school	Minimum built area	Mean of the area according to standards	Minimum area
Educational spaces	Classrooms	1.6 m <sup>2</sup>	35 m <sup>2</sup>	2.0 m <sup>2</sup>	60 m <sup>2</sup>
	Scientific Lab.	1.6 m <sup>2</sup>	51 m <sup>2</sup>	2.2 m <sup>2</sup>	75-80 m <sup>2</sup>
	Laboratories	0.0	0.0	2.3 m <sup>2</sup>	70-80 m <sup>2</sup>
	Open classrooms	0.0	0.0	2.0 m <sup>2</sup>	60-70 m <sup>2</sup>
	Art Studio	1.4 m <sup>2</sup>	35 m <sup>2</sup>	3.5 m <sup>2</sup>	90-100 m <sup>2</sup>
Social spaces	Courtyards	1.1 m <sup>2</sup>	350 m <sup>2</sup>	2.1 m <sup>2</sup>	600-700 m <sup>2</sup>
	Open spaces	4.1 m <sup>2</sup>	Not designed	4.2 m <sup>2</sup>	designed
	Café & Restaurant	.....	.....	1.2 m <sup>2</sup>	150 -200 m <sup>2</sup>
	Waiting Halls	.....	.....	0.5 m <sup>2</sup>	150 m <sup>2</sup>
Cultural spaces	Interior Halls	.....	.....	2.0 m <sup>2</sup>	200 m <sup>2</sup>
	Library	.....	.....	2.4 m <sup>2</sup>	200 m <sup>2</sup>
	Poetry Club	.....	.....	2.5 m <sup>2</sup>	50 m <sup>2</sup>
	Painting Studio	.....	.....	3.8 m <sup>2</sup>	70 m <sup>2</sup>
	Music Studio	.....	.....	3.8 m <sup>2</sup>	70 m <sup>2</sup>
	Acting Studio	.....	.....	3.8 m <sup>2</sup>	70 m <sup>2</sup>
Sport spaces	Dancing Studio	.....	.....	3.8 m <sup>2</sup>	70 m <sup>2</sup>
	Open sport spaces	20 m <sup>2</sup>	600 m <sup>2</sup>	24 m <sup>2</sup>	700 m <sup>2</sup>
	Close sport spaces	.....	.....	13.9 m <sup>2</sup>	400 m <sup>2</sup>
	Open swim. pool	.....	.....	.....	.....
Supportive spaces	Close swim. pool	.....	.....	.....	.....
	Multi-purpose hall	.....	.....	2.35 with a size of 225 person	517 m <sup>2</sup>
	Theater	.....	.....	.....	.....
	Bathroom	Each25 student=1 w.c	Number 15	Each 20 students=1 w.c	Number 18=25
	Circulation	15%	.....	22 %	12.5%
	Structure	15%	.....	12.5%	22 %
	Parking	.....	.....	Number 23	460 m <sup>2</sup>
Administration Spaces	Stores	0.5 %	.....	1.6 %	1.6%
	Manager room	15 m <sup>2</sup>	15 m <sup>2</sup>	Number 1=28	28 m <sup>2</sup>
	Assistant room	15 m <sup>2</sup>	15 m <sup>2</sup>	Number 2=23	46 m <sup>2</sup>
	Teachers rooms	40 m <sup>2</sup>	40 m <sup>2</sup>	Number 5=30	150 m <sup>2</sup>
	Advisor rooms	.....	.....	Number 2=15	30 m <sup>2</sup>
Offices	.....	.....	Number 2=20	40 m <sup>2</sup>	

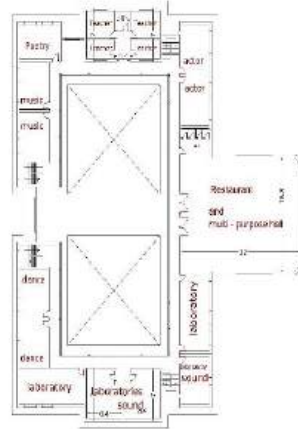
It turned out that the economic factor is one of the most important criteria for evaluating alternatives because of the deterioration of our country in the economic situation. The sample chosen represents a large number of schools implemented in the city.

**Table 4: ‘‘The result: evaluation of alternatives according to the priorities of criteria’’**

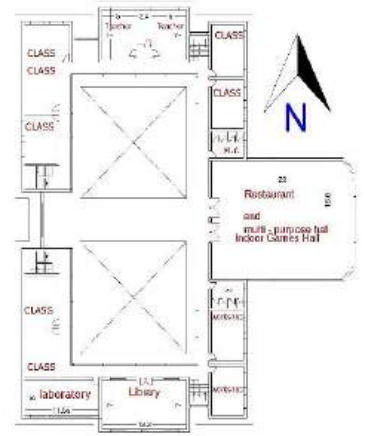
Criteria	Criteria 1 The ratio of the achieved area	Criteria 2 The ratio of classrooms in good orientation	Criteria 3 The future expansion	Criteria 4 Accessibility in terms of movement	Criteria 5 The ratio of subtracted areas to add other spaces	Criteria 6 The ratio of added areas (minimum costs)	Average Ratios	Treating Mechanisms
Alternative	18%	17%	13%	5%	22%	25%	100%	Credit
Alternative1	16	9	3	4	14	13	59	Addition
Alternative2	19	11	10	4	21	20	<b>85</b>	Subtract And Addition
Alternative3	17	14	3	4	16	15	69	Mirror
Alternative4	17	14	7	4	16	15	73	Addition And Rotation



(a) Ground Floor

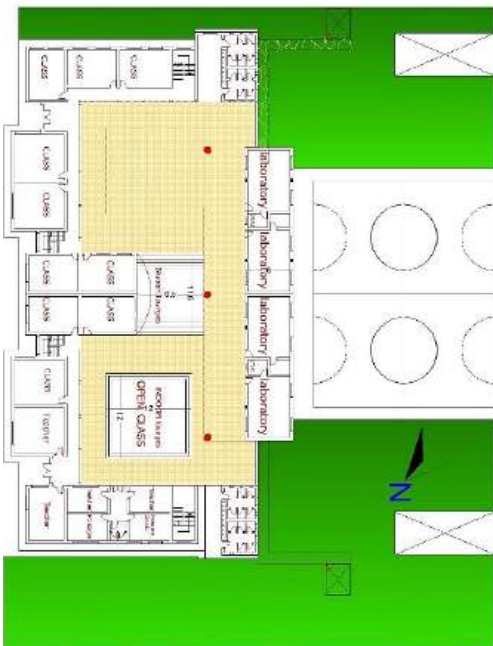


(b) First Floor

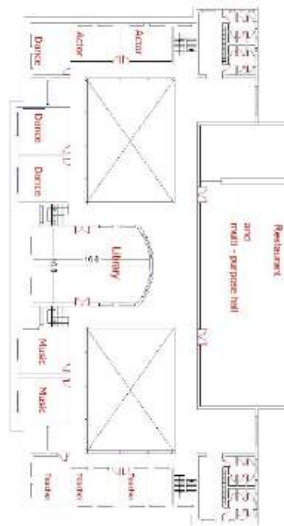


(c) Second Floor

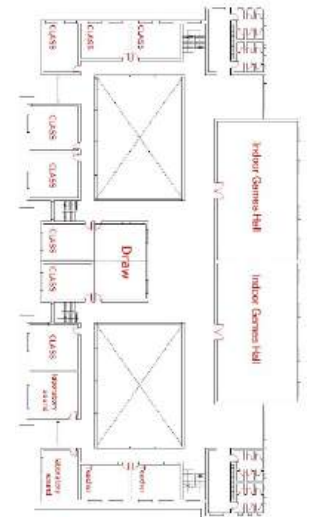
**Figure 2: Design Alternative#1.**



(a) Ground Floor

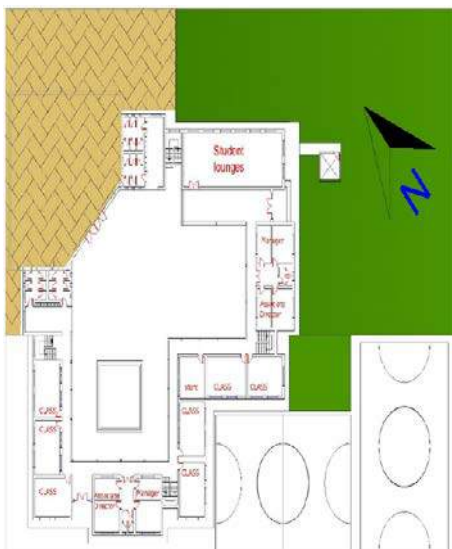


(b) First Floor



(c) Second Floor

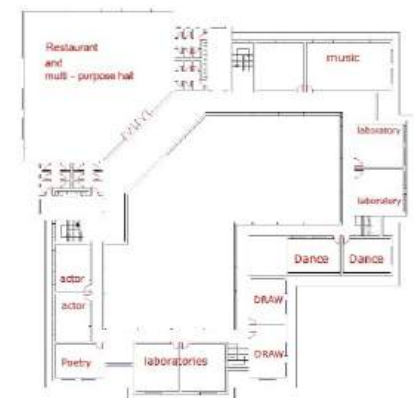
**Figure 3: Design Alternative#2.**



(a) Ground Floor



(b) First Floor



(c) Second Floor

**Figure 4: Design Alternative#3.**

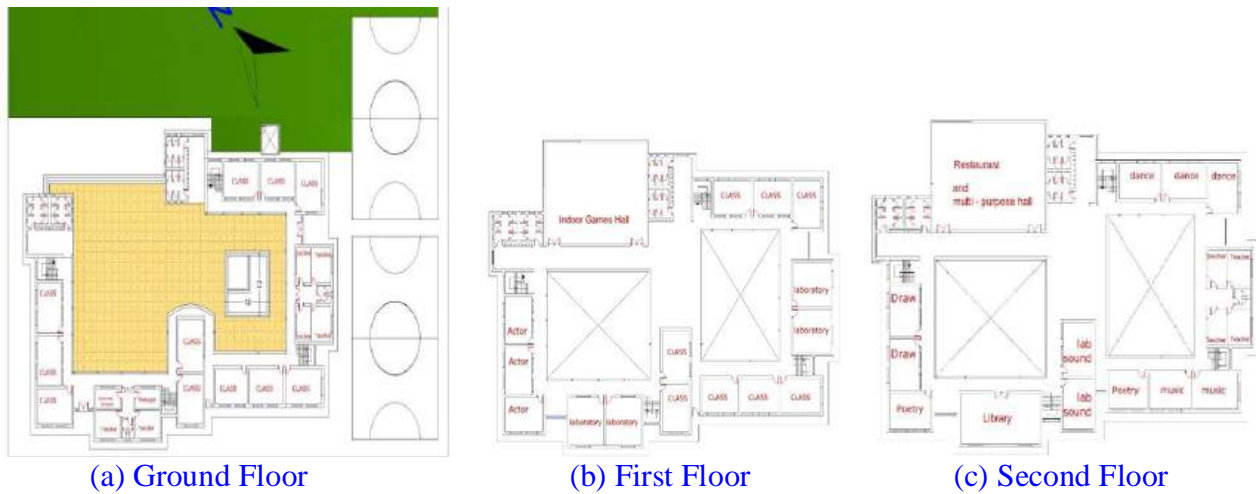


Figure 5: Design Alternative#4.

## 5 Conclusion

The research stated many strategies with its mechanisms to improve the designs of local schools, satisfy the needed necessities, and cover the shortage. The research stated many alternatives deferent in their attitudes, functionally, environmentally, and economically speaking. The client emphasizes economic then functional then environmental criteria, therefore the Architect can orient the designing process according to the initial objectives. The research offered the potential to manipulate the design according to different attitudes. The “Double Courts” alternative in “Primary schools” seems to be the best one, depending on five criteria. This methodology can help to improve other local school types, in the different attitudes.

## 6 Acknowledgment

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