



ISSN: 1687-1006 p
ISSN: 2682-3640 e

The Egyptian International Journal of Engineering Sciences and Technology

Vol. 39 (2022) 60–68

<https://ejest.journals.ekb.eg/>



Evidence-Based Design as an Approach for Assessing Children Performance in Kindergartens through Seating Arrangements

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ARTICLE INFO

Keywords:

Evidence-based Design
Kindergarten
Physical Learning
Environment
Enhancing Performance
and Productivity

ABSTRACT

According to the Egyptian Government, the educational process is a very significant process which has the power to support the progress in the whole country. But it considers that the learning process consists of educational lessons given by teachers inside closed rooms where a number of students receive their lessons. Consequently, many Egyptian educational institutions are paying efforts to improve only this process and its quality without paying attention to the impact of physical environment elements. This is a problem in designing educational facilities especially in kindergartens due to its effect on performance and productivity. The aim of this research is to show teachers' perception on the effect of children performance in case of changing some factors of the physical environment by using evidence-based design as a basic tool which is a process of taking decisions according to researches to reach the best outcomes through questionnaires and quasi experiment. The research objectives are (a) Identify the impact of designing a suitable physical environment on children's performance b) Relation between evidence-based design and its use in the physical environment for learning facilities. The findings of this research will provide criteria for assessing kindergartens according to children's reactions to some changings in order to get the optimum performance of children.

1. Introduction

A kindergarten is considered the most building type that has a major effect on people's life. Children keep in their minds through their whole life all memories of their learning environment. The learning environments play a vital role in enhancing the experience and quality of learning due to their role in collecting knowledge, culture, skills and practices. Undoubtedly, if those spaces are comfortable and designed to fit their functions, they will react positively on children behavior, attitude, performance and productivity. On the other hand, if the classroom is ugly with unsuitable physical environment, this will hinder creativity and all educational purposes. Therefore, they have influences on two important sides that can form the whole personality of each child. Egypt considers education as the largest national project and puts it on the top of priorities. It has a strategic plan about education during the period from 2014 to 2030 says that "Together We Can".

Egypt pays efforts to promote education quality especially for children because of their role in the future leadership. Then, there is a gap in Egypt's plan, it depends only on developing the process with the functional places regardless creating interesting spaces with a suitable physical environment.

Based on the previous facts, the aim of this paper is to provide guidelines for kindergartens' physical environment by using Evidence based design as a tool for assessing the most effective learning environment. This tool depends on collecting quantitative and qualitative data such as studies, resources, clients need and recommendations to produce the best outcome.

2. Evidence based design

2.1. Defination

Evidence-based design in architecture could be defined as a sequence of quantitative and qualitative researches,

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analysis and examinations for any individual project to take the best decisions of design that enables achieving the best outcome which meets human and environmental needs.

2.2. Origin and History

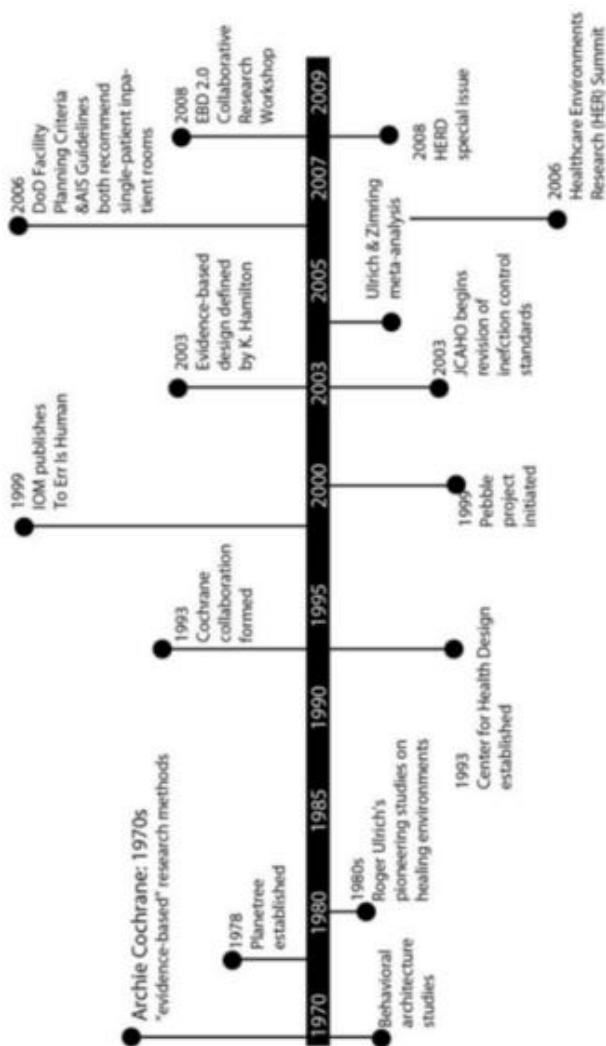


Figure 1: Timeline of Evidence-Based Design

2.3. Importance and purpose

There are three main points on the importance of Evidence based design.

2.3.1. Time saving

It decreases the spent time in meeting and discussions so, stakeholders and users move faster and keep the schedule of any project on time. Combining this with decision making process will increase efficiency of the sequence by streamlining and rearranging the options' set based on analysis and researches.

2.3.2. Improvement of the design process

It helps to define criteria and goals clearly and improve coordination for teams.

2.3.3. Risk avoidance

Decreases the risk of taking bad decisions through understanding the method of applying the best practice in designs.

2.3.4. Decrease cost

According to of the previous points, this will reduce cost of the process.

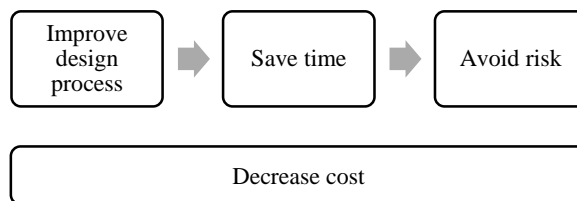


Figure 2: How Evidence-based design reduces cost (Author, 2019)

2.4. Process

The following presents the steps and activities during evidence-based design process:

- Define the goals of the client
- Define the goals of the firm
- Define the top issue of design
- Convert the issue of design into research questions
- Collect information
- Critical evidence clarification
- Create concept of evidence-based design
- Form hypothesis
- Choose measures

2.5. Applications

The following figure presents the steps and activities during evidence-based design process.

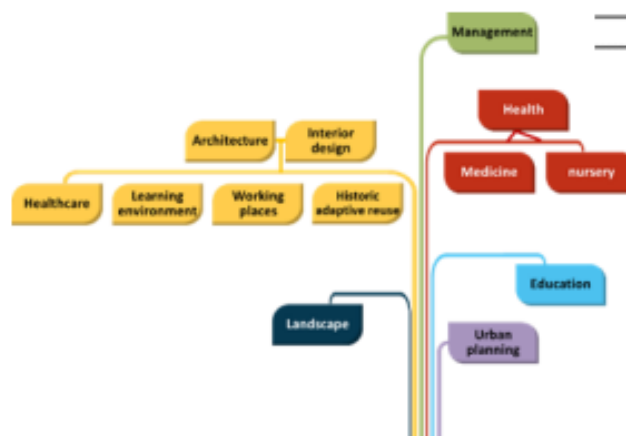


Figure 3: Evidence-Based Design applications

3. Kindergartens as a learning environment

3.1. Learning environment definition

It is a place or space in which teachers and learners interact and use plenty of different tools and resources for information in their activities during learning.

3.2. Types of learning environment

Learning environment has four types; each type has different elements and unique effect on students and their level of performance and concentration.

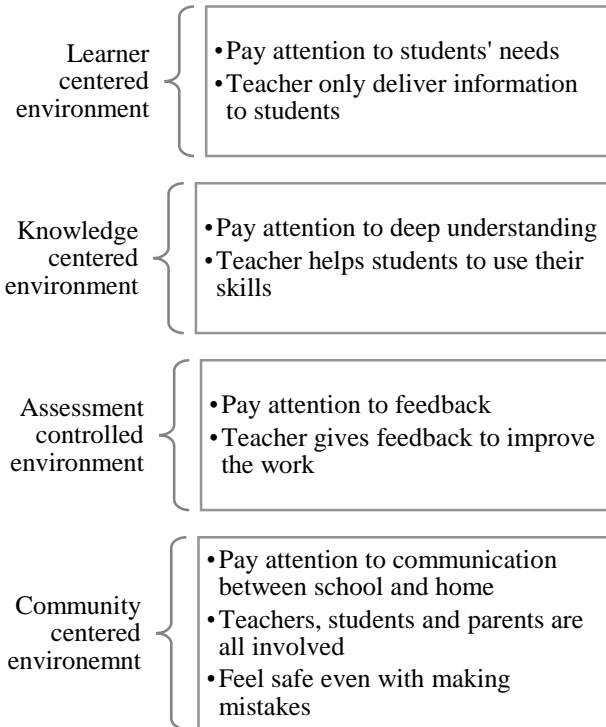


Figure 4: Types of learning environment (Author, 2019)

3.3. History of kindergarten

The national academic press published the timeline of kindergartens and developments in 2015.

There was a belief that children could learn best by playing under supervision. Consequently, Friedrich Froebel created the idea of different educational institution for children called Kindergarten in the early 1800s.

Nowadays, the requirements for teachers increased and included several courses and teaching degrees. Also, license from state is needed.

3.4. Importance of learning during preschool's period

According to [1]:

- Rates of graduates from high school increases
- Doing better in tests
- Reduction of grade repetition

- Reduction of children who attend in special education institutions
- Reduction of crimes and law-breaking
- Reduction of rates of pregnancy through teen age
- Increasing of high-quality employment with high wages of adults
- Contributes in the stability of families
- Improving efficiency of classroom
- Big savings

3.5. Factors affecting quality of physical learning environment

3.5.1. Light

Undoubtedly that light quality and quantity affects the comfort perception in every space [2]. The good quality depends on the accurate balance between natural and artificial light because long exposure to artificial light could increase the nervous system excitation [3]. The artificial light quality depends on its type whether it is cool, warm or full-spectrum fluorescent [2] and the quantity depends on the amount of lux, the good average for classrooms lies between 300 and 500 lux.



Figure 5: A naturally lit corridor with blinds installed to reduce glare



Figure 6: Internal glazing can support a good mix of natural and artificial light

3.5.2. Noise

Learning has a complex relationship with sound because it is related to some factors such as sound property, noise type and listener characteristics [4]. In 2010, Klatte noted that

sound characteristics affects greatly on student's achievement and understanding after doing a study for acoustic conditions in classrooms.

There are no international recognized regulations for the maximum level of noise inside classrooms, but in Brazil's norms the allowable level in classrooms should not exceed 40dB [5]



Figure 7: Glazed, acoustically-controlled meeting rooms may contain noisy and quite actions

3.5.3. Air Quality

It has been known for several years that classrooms air quality has an effect on students. Specialists mentioned many reasons for bad air quality such as high level of dander, germs, microbes and dust. But the main reason is high level of CO² which reduces oxygen amount in the brain causing drowsiness with poor performance. According to American Society of Heating, Refrigerating and Air-Conditioning Engineers, the recommended level of CO² should not be more than 1100 ppm for closed areas [6]

3.5.4. Temperature

In 1995, Anderson et al. showed that temperature effects on students' learning. High temperature affects negatively on performance and social relationships while low temperature causes other changes that increase nerve activity levels [7] According to the UNESCO's international institute for educational planning, the suitable temperature range for better learning lies between 20°C and 23 °C.

3.5.5. Colors

The effects of colors on human moods that is called as color psychology. The researchers showed that some colors of classrooms are more favorable than others. [8] presented a study about colors and emotions. They clarified that light colors are related to positive relations and neutral or colors such as grey and black are related to negative emotions. Therefore, it is preferable to use bright colors and avoid dark colors.

3.5.6. Materials and texture

The UNESCO's international institute added that environmentally friendly and locally available material is

preferable without decreasing the structural durability and strength durability of the buildings.

3.5.7. Shapes

Several shapes are used for classroom design such as circle, square, rectangle, triangle and hexagon. Most of studies concentrates on talking about the crucial role of circle classrooms on students and especially children. The

circular shape has six main advantages in the learning environment which make it more desirable. [2]

3.5.8. Furniture arrangement

According to [2], the selection and design of furniture may affect teachers' and students' engagement. Furniture style and items may control the students' numbers, their distribution and opportunities for participation in class' activities. Each type has a specific purpose and may require adjustments to classroom control and teaching method. Each instructor decides which type is the best for his classroom activities.

3.5.9. Scale

Studies have proved that learning environment and scale may affect the way teachers and students are socially organized, in addition to opportunities for adopting a diversity of learning techniques and modalities [2]. Every classroom should be designed that each student has a minimum area of 1.2 m² and this may reach to 1.4 m² in slightly larger classrooms.

3.5.10. Ergonomic

The international institute of UNESCO showed the conditions for appropriate furniture in classrooms, it should be with the correct dimensions for students according to their ages. It also advised with mobile furniture pieces for more flexibility.




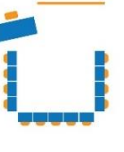
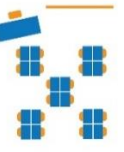


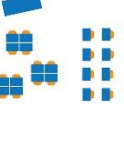

Figure 8: Children ergonomic, wrong and correct sitting pose of a kind near the table

4. Output of literature review

The previous section defined the process of evidence-based design and all the factors that affects the physical learning environment. Below

Table 1 is a comparison between all types of seating arrangement according to the following criteria: type, shape, definition and the pros and cons of each.

Table 1: Comparison between seating arrangement types [9]

Seating Arrangement				
Type	Shape	Definition	Pros	Cons
Rows/ Columns		<ul style="list-style-type: none"> • Teacher-centered instruction • Independent learning format • Suitable for all class sizes 	<ul style="list-style-type: none"> • Encourage individual work & productivity • Minimizes distribution & cheating • Easier to supervise 	<ul style="list-style-type: none"> • Discourage student centered discussion & group work • Lose focus • Uneven distribution of interaction amongst class • Difficult for teacher movement
Horseshoe/ U-shape		<ul style="list-style-type: none"> • Teacher & learner-centered instruction • Large group format • Best for small & medium class 	<ul style="list-style-type: none"> • Easy interaction • Encourage discussion & participation • Enhances connection between students & educators • Large area for presentation & demonstration 	<ul style="list-style-type: none"> • Not suitable for small groups • Difficult to make discussion in larger groups • May overwhelm shy students • Difficult to control behavior
Clusters		<ul style="list-style-type: none"> • Predominantly learner-centered instruction • Small group format • Suitable for all class sizes 	<ul style="list-style-type: none"> • Encourage interaction of all students • Create a more personal and safer environment for students to convey their ideas • Develop problem solving and communication skills • Flexibility to strategically form groups • Suitable for small groups 	<ul style="list-style-type: none"> • Increases noise level, distraction and off-task behavior • Decreases productivity • Less individual accountability • Harder to assess students' abilities & understanding level
Runway		<ul style="list-style-type: none"> • Teacher-centered instruction • Best for smaller classes 	<ul style="list-style-type: none"> • Suitable for lecture and discussion-based class 	<ul style="list-style-type: none"> • Makes partner and group work tricky
Stadium		<ul style="list-style-type: none"> • Best-suited teacher centric classes • Focuses on the attention of students to the room front 	<ul style="list-style-type: none"> • Ability of well sight through teacher and students • Angling rows helps to leave space for AV cart or podium 	<ul style="list-style-type: none"> • Less suitable for group work • May place some students far away from the room front
Combination		<ul style="list-style-type: none"> • Suitable for class with students of different learning levels, behavioral issues and learning method 	<ul style="list-style-type: none"> • Flexible design for workshop and movement • It does not require a specific desk 	<ul style="list-style-type: none"> • Un Uniformity in the class • It does not give all students the same view
Group/ Pods		<ul style="list-style-type: none"> • Learners' groups-centered instruction • Suitable for small and large groups 	<ul style="list-style-type: none"> • Allows for collaboration between students within their group • Allows teachers to interact with students on an individual or small-group basis • Easy to set up and reconfigure for different situations as needed 	<ul style="list-style-type: none"> • Not suitable for smaller classrooms • May not be ideal for students who have difficulty remaining focused • Easier for students to cheat during assignments

The following Table 2 is the factors that affect the physical learning environment as: naturalness and psychological comfort, stimulation and physical comfort and individualization and social comfort.

Table 2: Factors affect physical learning environment

Naturalness & psychological comfort				Stimulation & physical comfort				Individualization & social comfort																	
Light		Noise		Air		Temp		Color	Material & Texture		Shape	Seating arrangement	Scale	Furniture											
Dark	Good	Glare	Very good	Good	Bad	Very good	Good	Bad	Good	Intermedia	Bad														
< 300 lux	300:500 lux	>500 lux	<35 dB	35:40 dB	> 40 dB	<1100 ppm of CO ²	1100 ppm of CO ²	>1100 ppm of CO ²	<18 C	18:21 C	>21 C	Bright	Warm	Dark											
									Non-slip	Non-toxic	Low VOC	Safe	Circle	Square	Rectangle	Hexagon	Triangle	Cluster	Row & columns	U-shaped	Small	Medium	Large	Ergonomic	Non-ergonomic

5. Applicable study

This research includes applicable study in form of a quasi-experiment and survey questionnaire to check if the seating arrangement (one of the factors which affect physical learning environment) inside kindergarten classrooms affects children’s performance or not. This experiment focuses on applying of EBD process to reach the aim which is it is a process of taking decisions for the built environment depending on several research to accomplish the best outcomes.

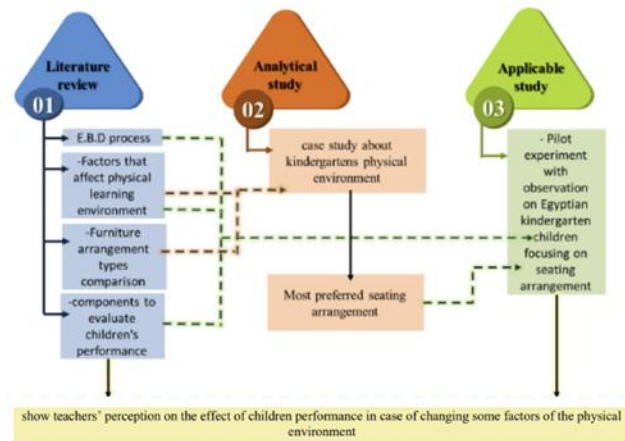


Figure 9: Chart about the used method

5.1. Method

Behavior observation with a survey questionnaire.

5.1.1. Choosing case studies

The case studies depended on experiment with survey to define the difference of students’ performance after changing seating arrangement and this helped to reach the steps and criteria used in the survey.

<p>Study in Malaysia 2013</p> <ul style="list-style-type: none"> Survey for teachers and students for the best lay arrangement Result: Different seating enhanced learning process 	<p>Study through class of pre-calculus 2014</p> <ul style="list-style-type: none"> Survey, experiment and interview to define best arrangement from 3 styles Result: Group arrangement reached highest percentage from students 	<p>New York at ten different schools</p> <ul style="list-style-type: none"> Survey and experiment Result: Group arrangement is the most effective for performance, activities and doing tasks
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Figure 10: Case studies

5.1.2. Choosing sample

LOOP kindergarten, Tianjin, China

The case study was chosen to be evaluated as an existing kindergarten according to its physical environment.



Figure 11: LOOP kindergarten, Tianjin, China

5.1.3. *Choosing survey*

It contains questions about activities, communication and movement of children before and after the new arrangement.

5.1.4. *Place*

A public kindergarten at St. Mary and St. George church, Madinaty, Cairo, Egypt.

5.1.5. *Steps*

- Following the process of E.B.D for the quasi experiment
- Measure the performance of students in case of existed column seating arrangement
- Rearrange the furniture for 3 different shapes
- According to children’s opinions, one of the new shapes is more preferable which is U-shaped
- Re- measure the performance by observation and survey questionnaire done by the teachers

5.1.6. *The main activity during the experiment: listening and answering questions*

The first trial was using small groups; each one was a small circle:

Table 3: First trial results (Author, 2019)

Good effects	Bad effects
Separating the children into groups facilitated the movement through the class.	Each group of children felt that they were separate from the rest of their class and need to sit beside each other sharing everything.
Encourage interaction between each group’s children.	Some students could not have a clear sight to the board due to the closed circle. Some children were looking at the opposite side of the board.
	Some children had a less communication with the teachers than others.
	Each group’s children were talking to each other neglecting the teacher instructions and this led to less concentration of some children.

The second trial was small open groups consisted of three chairs:

Table 4: Second trail results (Author, 2019)

Good effects	Bad effects
Facilitating the movement inside the class.	Some chairs’ angles not suitable for a good full sight to the board.
Good sight to the board and teacher for most of students.	Uneven distribution of interaction amongst the class.
Encourage interaction.	Some children did not like the angles of furniture and wanted them to be on 90 degree

The third trial was Horseshoe/U-shaped:

Table 5: Third trial results (Author, 2019)

Good effects	Bad effects
Easy interaction with even distribution	Sometimes difficult to control behavior
Encourage participation and discussion	Not suitable for small groups
Full good sight to the board and teacher for all students	
Enhanced communication between students and teachers	
Offered large area for presentation and demonstration	

- ❖ Each trial was done: once for twenty minutes
- ❖ No of observers: two in addition to the author
- ❖ No of teachers surveyed: two

To ensure that the results are representative of the effect of changing the searing layout only and no other factors affected student performance: the only element which was changed inside the familiar classroom is seating arrangement and also the author who observed the experiment was a familiar person to the classroom and this helped in making children interact normally without any changes.

Table 6: Observation experiment checklist (Author, 2019)

Effect of changing seating layout	Usual furniture arrangement			New furniture arrangement		
	low	medium	high	low	medium	high
Interaction						
Communication with teacher						
1. Which level do students interact by asking and answering teachers’ questions?						
2. Which level do students participate in discussion?						
3. Which level do students initiate conversation?						
Communication with others						
1. What is the level of communication between two students?						
2. What is the level of communication of a student in a group activity						
Attention						
Indoor activities						
What is the level of students’ attention in the following?						
1. reading						
2. writing						
3. listening						
4. drawing						
5. quizzes						
6. playing musical instruments						
7. physical activities						
8. mental games						
Movement						
Outdoor activities						
1. Which level of students’ movements during outdoor activities?						



Figure 12: Steps of the quasi experiment

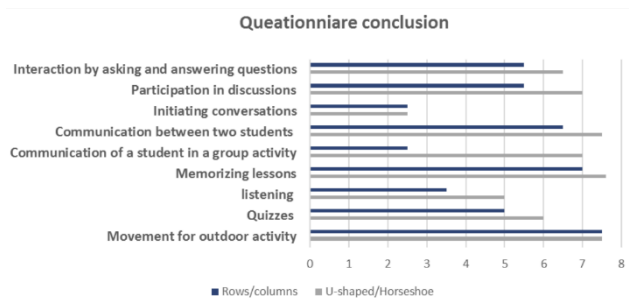


Figure 13: Survey questionnaire (Author, 2019)

5.1.7. Results

The experiment result depended on:

- Author observation
- Teachers’ observation and survey
- Children’s interaction and opinion about the different arrangements

According to the observation of the three previous trials and their consequences on students’ performance, it is obvious that U-shaped furniture arrangement is the most suitable and preferable for kindergarten children. But to make sure if this new arrangement could really enhance the children’s performance, a questionnaire was distributed to the teachers to evaluate the level of performance for the two arrangement; first one is the normal rows furniture and the second is U-shaped arrangement.

Most of the components increased after the experiment. So, enhancing learning environment by changing seating arrangement.

6. Findings and recommendations

6.1. Findings of the research

The main dissertation findings according to this research sequence which could help in generating the final guidelines are:

- Comparison between different seating arrangement such as; rows/columns, Horseshoe/U-shaped and Group

- New consideration for the seating arrangement after the performed experiment according to the children’s opinion and experiment and according to their teachers’ and the author’s opinion and observation.

As a result, for all the previous studies and researches the following table is the final guidelines for choosing seating arrangement in kindergarten in order to enhance performance and productivity.

6.1.1. Recommendations

Table 7: Output of factors (Author, 2019)

Factors	To be avoided	To be kept	To be developed
Seating arrangements	Using columns and rows furniture arrangement for most of the activities	Using Horseshoe/ U-shaped, and group arrangement most of the time	Make the classroom flexible to change the arrangement according to the activity requirements

6.2. Recommendations Regarding the Method

It is recommended for using evidence-based design as a tool for enhancing performance and productivity in learning environments. The process used in this dissertation could be used for other analysis; this research focused only on seating arrangement but it is recommended for usage on other factors due to its advantages. This method depends on previous researches and studies to take right decisions and this help in improving the design process saving time, avoiding risk and decreasing cost

6.3. Recommendations for future research

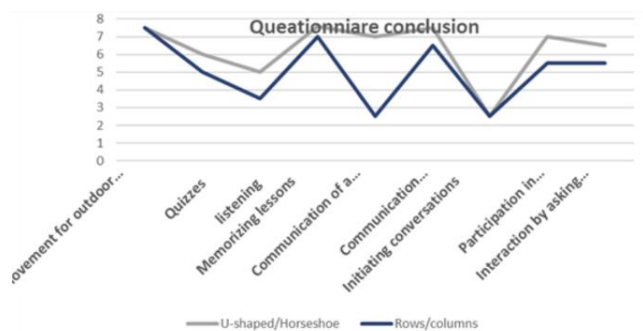


Figure 14: Results from questionnaire conducted (Author, 2019)

It is recommended that future researches focus on design factors or techniques may help children to initiate conversation inside their classes for more benefit. Also, trying more applicable experiments for more factors rather than furniture arrangement to get more accurate results according to the children opinion and interaction not only previous researches on students from different ages. Some factors could be easily and cheaply applied and used for

other experiments such as; color furniture whether it is ergonomic or non-ergonomic and temperature.

7. Concluding remarks

Finally, this research included discussion of the whole dissertation and showed the findings from different parts of the research such as; literature review, case studies and applicable study. Also, it presented recommendation for the current dissertation and for future researches to get more accurate and effective results for children could enhance the learning environment and increase their performance.

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