

# Towards Developing Criteria to Evaluate the Functional Performance Efficiency of Learning Spaces

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## ABSTRACT

The spatial and geometric design of learning spaces plays an important role in transmitting the dynamics of learning. Recently, there has been a major milestone in effective teaching and learning methods (modern pedagogical approaches) that aim to shift students away from the traditional learning process towards collaborative, problem-oriented and independent learning. These changes required a new generation of learning spaces with different strategies and methods to adapt to these changes. This research problem lies in the huge gap between modern pedagogical methods and the spatial and geometric configuration of different learning spaces that do not meet the requirements of these methods. This article examines the impact of designing different learning spaces on learner-centred teaching and learning by understanding the interrelationships between research in architecture, learning sciences, and environmental psychology in order to achieve effective learning. As a result of the research, a set of criteria for evaluating the functional effectiveness of the research areas under consideration was developed.

## 1. Introduction

Many challenges face the rapid development of modern pedagogical methods, including teaching and learning methods and the spatial environment in which they arise. Recently, there has been a lot of research on the differences between teaching and learning methods and the factors that influence them. The most important of these factors is the physical or virtual space in which teaching and learning take place; because physical space influences people's conscious and subconscious behaviour and also shapes the learning experience of students. Recently, higher education institutions have rethought the formal and informal spaces in which learning takes place, based on research on best practices for educational methods such as collaborative, problem-based and team learning strategies. As a result, a new generation of learning spaces have been designed with different strategies and techniques, such as technology-infested classrooms, flexible spaces, mobile furniture, and the lack of a "classroom-front" teacher area. Studies of these study spaces have shown more opportunities for student interaction and more discussions between students and teachers compared to similar spaces found in traditional study spaces.

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These changes accompany the shift of the paradigm from lecture-based to collaborative and active learning. This article describes the development of classroom design principles based on best practice in teaching and learning, as well as proposed criteria for assessing classroom functional performance.

Initially, this article presents theoretical research that covers some definitions and terminology of environmental psychology, teaching and learning approaches, types of learning spaces and principles for their design, as well as spatial considerations to be considered when designing a learning space. We then move on to discussing the relationship between these terms in this article to develop a set of criteria for evaluating the functional performance of the classes.

### 1.1. Theoretical Background

This part discusses the various theoretical concepts in environmental psychology, teaching and learning methods, and different types of learning spaces, and spatial determinants that affect the efficiency of user performance.

#### 1.1.1. Environmental Psychology

Environmental psychology tends to "study human behaviour in the physical environment" by studying the relationship between a person and the physical environment and the interaction between them (Dane, 2019). Consequently, this science studies people's experiences (behaviours) in different places (Mosharraf & Tabaeian, 2014).

Based on the purpose of this research, such relations can be translated as illustrated in Figure 1. Consequently, it is clarified that the teaching and learning process is affected by the physical space and the elements that make up the space in which the learning process is carried out.

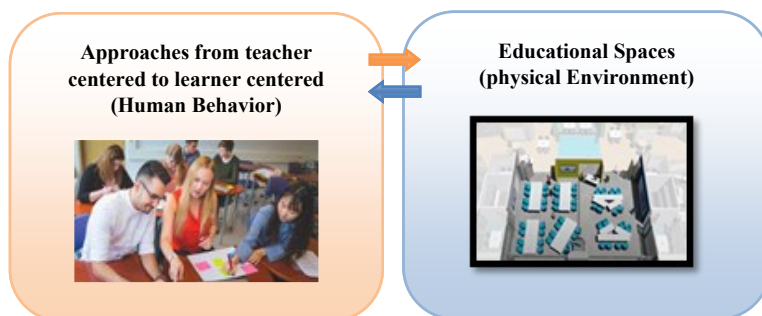


Figure 1. *The relation between human behaviour & physical environment*

Source: Processed by the researchers from: (Council of Europe development bank, 2019)

#### 1.1.2. Learning & Teaching Approaches

The "teaching process" is defined as the transfer of knowledge without interaction or participation. It contrasts with the "learning process" which is defined as; "an activity or process of acquiring knowledge or skills through the study, practice, teaching or experience of something" (Sharkey & Weimer, 2003).

It is a qualitative change in a person's views, understandings, and concepts based on one's own experience. It should be noted that there is a fundamental difference between the two processes that affect student learning outcomes, whether it is the student's surface learning that ends at the end of the exam, or the deep learning.

## 2. Metaphors Describe Basic Ways of Understanding the Area of Learning

Sfard (1998) explained the complex phenomenon of the teaching and learning process using three metaphors, which can be expressed as "acquisition", "participation", and "knowledge creation". These three learning metaphors may be related (Xu, 2015). Figure 2 shows the

relationship between them. These metaphors can help you specify forms and types of learning sites suitable for each metaphor.

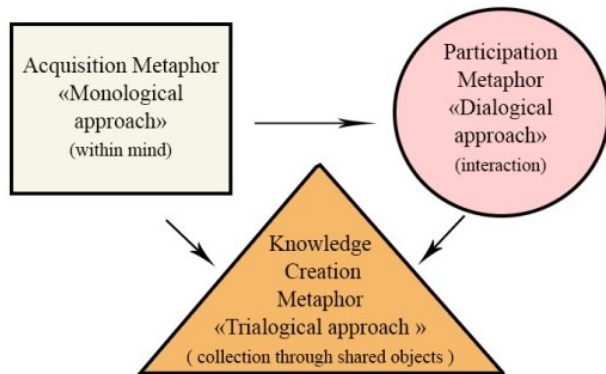


Figure 2. *Three metaphors of learning*



Source: Modified by researchers from: Paralič, J. (2010)

### 2.1. The Different Approaches from Teacher-Centred to Learner-Centred

The differences between teacher-centred and student-centred approaches can be explained in Table 1 (Beckers, 2016; Fayez & Al-zu, 2013; Sailer, 2015). From an architectural point of view, to take full advantage of the learner-centered approach, the physical learning space must support and reinforce the pedagogical methods used in the Active Learning classroom.

Table 1.

#### *The difference between Teacher-Centered & Learning-Centered*

Teacher-Centred	Learner-Centred
Students carry out their work on their own, following the teacher's instructions. Students are passive because they only receive information.	Students work together in groups according to the purpose of the activity. Teachers and students are active participants.
The teacher's mission is to impart only knowledge.	The role of the student is to discover and process material, and the role of the teacher transforms into guidance that helps him understand better.
	
Teacher is the sole leader. Discipline comes from the teacher. Some students are teachers' assistants. The teaching method is established for all students. Students may perform limited duties. The learning process is separate from the evaluation process.	Leadership is shared. Discipline comes from within each person. All students have the opportunity to be an integral part of classroom management. The teaching method reflects individual differences. Students share in classroom responsibilities. Training and assessment are conducted together.

Source: developed by researcher

### 2.2. Factors that Influence on Effective Learning

According to Radcliffe (2009), there are three elements (physical space, technology, and pedagogy) that influence each other (Ellis & Goodyear, 2016); as shown in Figure 3.

The physical space is one of them; since it must provide the necessary conditions that support the technological and educational aspect to support different approaches to learning and teaching:

- ✓ Social learning by designing spaces where students can communicate and collaborate easily.
- ✓ Peer-to-peer learning.
- ✓ Personal learning.
- ✓ Supports quick reconfiguration between multiple modes: from lecture to project work to discussion (Active Learning Spaces).

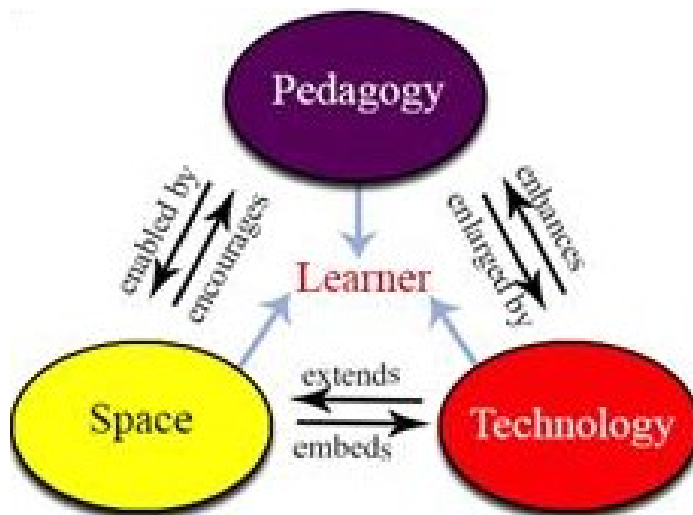


Figure 3. *The interrelationships between space, pedagogy and technology*

Source: Modified by researchers

#### 2.2.1. Traditional Types of Learning Spaces

Classrooms, lecture halls, and other formal classrooms are the most visible parts of campus life. Most people focus on these spaces, thinking about how the environment influences learning, but most learning takes place outside formal spaces (informal learning spaces) where students spend most of their time outside the classroom with their peers. When discussing academic work or other topics (Diana G. Oblinger, 2006).

- **Formal learning spaces:** Formal learning spaces, such as classrooms and lecture halls, are the most obvious on-campus learning spaces and support large groups of students in enjoying presentations and lectures (Beckers, 2016).
- **Informal learning spaces:** Informal learning spaces are defined as spaces that are designed to encourage students to interact with their peers when discussing academic work or other subjects outside the classroom. These spaces help motivate social interactions, meetings and conversations that foster personal and professional development. These spaces can appear in empty classrooms, libraries, group offices, offices, furnished corridors, public spaces, open spaces, and other socially oriented spaces (Diana G. Oblinger, 2006; McDaniel, 2014).

#### 2.2.2. New Generation of Learning Spaces

Several studies have demonstrated the failure of traditional lecture-oriented learning spaces as elements of the physical environment work to suppress social activity and effective responses. New trends have emerged that learning can be improved, deepened and more rewarding if the curriculum makes students active participants (Diana G. Oblinger, 2006).

Continuous research has resulted in new designs to reinforce these learning trends.

- **Active Learning Classrooms (ALCs)**

There is a huge gulf between what can be learned by listening or reading and what can be learned through practice. Active learning plays a role here. In 1991, Bonwell and Eison described active learning as "anything that requires students to do something and think about what they are doing." (Nureva, 2017). Basically, Active Learning Classes (ALC) is defined as learner-centered and technology-rich activities that focus on constructive innovation and collaboration (Center for Educational Innovation, 2021; Nureva, 2017), as shown in Figure 4.



Figure 4. *Student-Instructor Communications*  
Source: *Active Learning Classrooms (Queen's University)*

- **Flexible Learning Spaces (FLSs)**

The term refers to the provision of multi-functional spaces that can respond to different user needs and individual goals that change over time, providing the right mix of open spaces with split or grid configurations that allow teachers to create layouts consistent with the educational goals of an institution's curriculum (Hoodless et al.). The design of these spaces is directly related to the learning behaviour that students are expected to exhibit in each area. Thus, the shape of this space should allow you to create different work areas and perform more than one activity at a time (Duthilleul, Y., Carro, R.; and Tapaninen, R. and Maslauskaitė, 2019). This is shown in Figure 5.

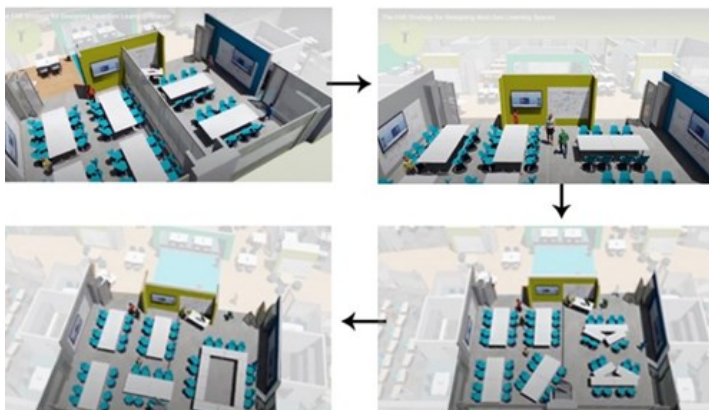


Figure 5. *The Cross model allows different functions simultaneously*  
Source: *(Council of Europe development bank, 2019)*



### • Innovative Learning Environments (ILEs)

ILE defines itself as a product of innovative space design, teaching practice and innovative learning that can evolve and adapt in the future. Its aim is to provide physical education institutions designed to combine flexible use of space, technology and furniture with excellent collaboration and flexibility in teaching and curriculum (Earp, 2019).

#### A. Characteristics of New Generation of Learning Spaces

- The spaces include moveable furniture that can be easily reconfigured.
- The rooms have an "eccentric" or "polycentric" design because the front of the room is undefined. Instead, the instructor moves from one place to another to encourage students to work together.
- Spaces provide easy access to digital learning tools.
- Spaces are modifiable because it is a spatial feature that indicates the possibility of changing the layout of the site based on different actions (Talbert & Mor-Avi, 2019).

#### B. The Benefits of implementing New Generation of Learning Spaces

Research shows that Active Learning improves content behaviour better than traditional lectures. The new generation of learning spaces aims to increase student participation, encouraging them to motivate, discover, share and discuss information with peers, which improves understanding and remembering. It also promotes decision making and accountability. In addition, it contributes to the development of students' self-confidence. These spaces also allow students to easily adapt to different situations and challenges. Figure (6) compares student performance in traditional and active learning spaces ( Monahan, 2000; Nureva, 2017).

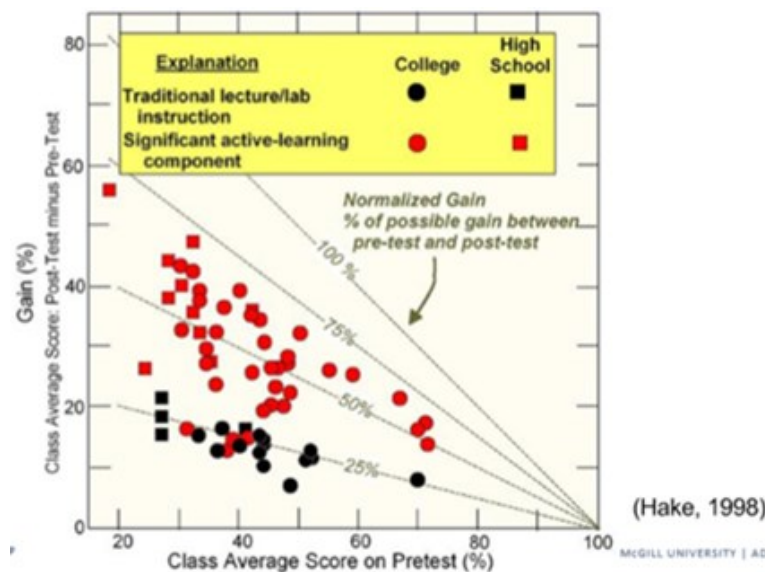
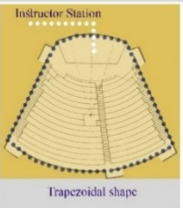
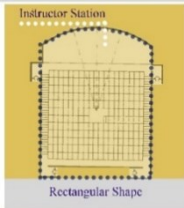




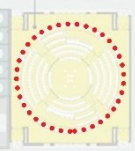


Figure 6. *The comparison between results of students in traditional spaces and Active learning spaces*  
Source: (Centre for teaching and learning, Northern Michigan University)

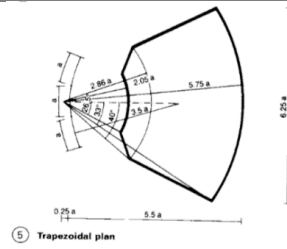
### 3. Comparative Study between Traditional & New Generation of Learning Spaces

The following Table 2 provides a comparison that explains the differences between the basic elements of traditional learning spaces and new generation learning spaces (Chen-Wishart, 2014; Chiara & Callender, 1997; Dane, 2019; Imms, W., Mahat, M., Byers, T. & Murphy, 2017; Smith, 2017). The researcher makes such a comparison.

Table 2.  
*The Differences between the Traditional Learning Spaces & New Generation of Learning Spaces*

Formal Learning Spaces	Traditional Learning Spaces	New Generation of Learning Spaces
<i>Lecture Hall</i>		
Geometrical Configuration	<p>The idea of the shape design is based on the teacher having a front platform, and good viewing angles for students.</p> <div></div>	<p>There are non-traditional shapes that can be used in the lecture hall, such as the circular shape.</p> <div></div>
Spatial Arrangement	<div></div> <p>The space spatial arrangement depend on the presence of a front platform for the teacher , with a clear division of places for students to sit facing instructor.</p>	<div></div> <p>Hall furnishings transform from a large lecture hall, into small groups, to support collaborative teamwork, without the need to rearrange furniture or students.</p> <div></div> <p>The configuration of seats in a circular shape around the instructor reduces the distance that usually separates a teacher from a student.</p>

## Size of the Lecture Hall



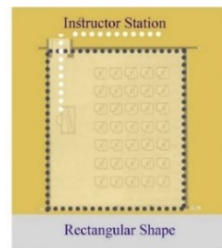
- The distance of the last row, it can exceed 20 meters from the teacher.
- The dimension of the last row is calculated on the basis of the display screen dimensions; as seats should be located at a distance not less than twice the width of the screen and not more than six times its width.

The distance between teacher and student isn't more than eight rows or 9 m distance. As the maximum interactive distance between teacher and student is 9m.

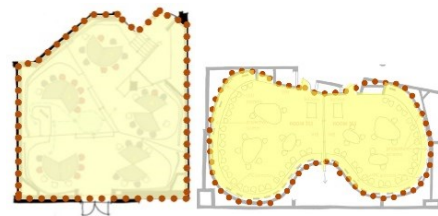
## Classrooms

### Geometrical Configuration

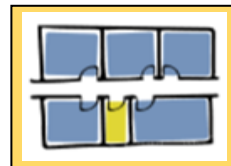
Traditionally, Only rectangular shapes are used.



New trends have tended to use irregular shapes such as trapezoid and circular shapes.



### The types of learning spaces



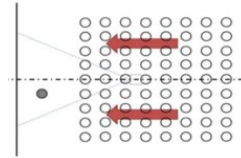
Closed Classroom



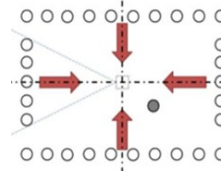
- Classrooms with flexible walls and breakout space.
- Open plan with the ability for separate classrooms.
- Open plan with some adjoining spaces.



## Spatial Arrangement

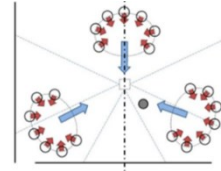


The space spatial arrangement depends on the presence of a front platform for the teacher, with a clear division of places for students to sit facing instructor.



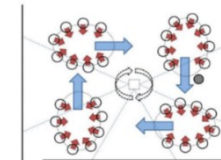
### • Alternative 1

This alternative is characterized by supporting discussion across the cohort.



### • Alternative 2

This alternative contains multiple directions of spatial orientation; students are clustered into groups to facilitate group, or peer-to-peer interaction.



### • Alternative 3

In alternative 3, student groups are formed and directed toward each other, and the teacher is positioned outside the students' circle, as Design Studio, unlike alternative 1 and 2.

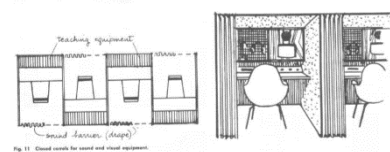
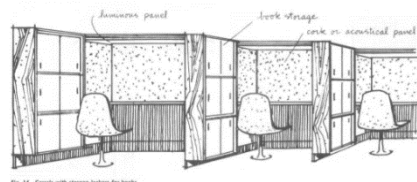
## Size of the Classrooms

- The preferred shape of a classroom is square. If the room has to be rectangular then the preferred dimensions should be a 2:3 or 3:4 ratios (width to length). Long, narrow rooms are not acceptable.
- The area for student in Tutorial rooms = 1.85 m<sup>2</sup>/student.
- The area for student in Drawing offices = 4.6 m<sup>2</sup>/student.
- The area for student = 3-4 m<sup>2</sup>/student

## Informal Learning Spaces

### Geometrical Configuration

#### • Individual Study

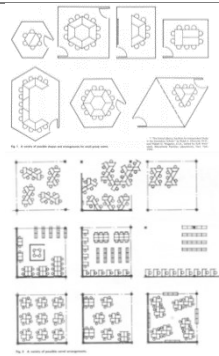


#### • Small-Group work

#### • Individual Study



#### • Small-Group Work



- Furnished rooms in corridors (peer- to- peer discussion)

Source: data developed by researcher

## 4. Spatial Configurations Determinants

The following explains the determinants of spatial configuration that should be taken into account in learning spaces to improve work efficiency and meet human needs (Torres, 2014).

### 4.1. Psychological Determinants

- **Visual privacy:** People tend to be in places with some degree of restraint and visual privacy. This can be achieved with furniture, partitions and walls.
- **Acoustic privacy:** It is an effective treatment of the acoustic environment in rooms that are affected by connecting elements: ceiling, walls, floor and furniture.
- **Aesthetic appreciation:** It is influenced by the environment. It depends on the time, place, purpose and context. Aesthetics can be achieved not only functionally, structurally and physically, but also through the experience that the design itself gives to the human senses.

### 4.2. Physiological Determinants

Factors to consider at the design stage that relate to physiological responses include:

#### 4.2.1. Functional Efficiency

This includes the extent to which the physiological needs of the inner space are met in order to achieve comfort and performance.

- **Vision:** The ability to perform the tasks by providing good & clear vision.
- **Hearing:** The critical variables in human hearing are intelligibility, audibility, signal-to-noise ratio, and noise disturbance.
- **Stability and mobility:** Stability refers to the elements that support people in performing their functional tasks. Some elements to consider from a mobility perspective are the slope of the ceilings, the width of the corridors, the depth of the stairs, the position of the handrails, etc...

#### 4.2.2. Ergonomic Design

Ergonomics integrates human measurement data, physiology and psychology in response to the user's environmental needs. This data is used by the designer to create interiors tailored to the human body. Figure (7) illustrates the use of ergonomics to create flexibility in various aspects of the traditional studio / work environment.



Figure 7. The use of ergonomics to create flex and flexibility within the various aspects of the traditional studio/work environment

source: Wendy R. McClure, T. J. B. (2007). *The Built Environment: A Collaborative Inquiry into Design and Planning*

#### 4.3. Sociological Determinants

As far as social needs are concerned, when designing, factors related to sociological responses should be taken into account:

- The distance of interaction between people and tasks should be taken into account in the physical arrangement of interior spaces.
- The scale of the room in relation to its inhabitants also affects the distance of the conversation. When the room size decreases, people tend to sit together.

The following Figure (8) Summarize the considerations when designing a learning space to meet the needs of users and improve the functional efficiency of these spaces:

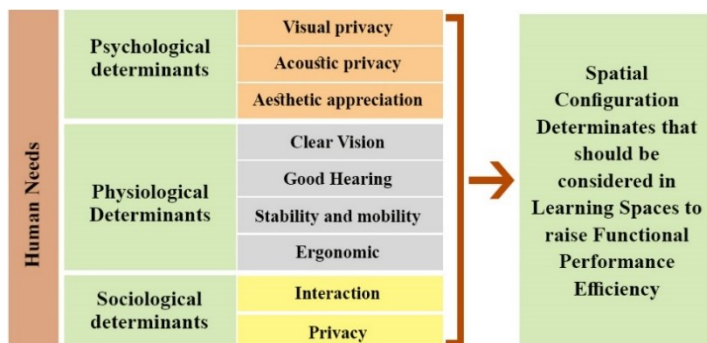


Figure 8. Functional performance efficiency standards

Source: data developed by researcher

## 5. Discussions

After analysing theoretical studies, it was found that there is a relationship between the form of educational space, its components and its possibilities, and the behaviour of students and teachers, because each of them creates one another.

New generations of learning spaces (ACL / FLS / ILE) respond to user needs based on pedagogical theories, making it easier for learners and teachers to reform their environment based on their needs and desired behaviours (co-educational learning, individual lecture, etc.) and provide different techniques as technologies. In this way, these spaces support the process of interaction, brainstorming, discussion, information exchange, problem solving and decision making, etc.

In contrast, traditional educational spaces offer a traditional approach based on simply giving information without any interaction, since there is a platform of teachers in front of all students to which all students go, with parallel rows of fixed furniture leading the teacher. It should be noted, however, that the new generations of learning spaces do not guarantee their success if a teacher is unable to alternate between different teaching and learning methods (collaborative

learning, individual learning master classes, etc.) depending on the purpose of content. in addition to academic content that offers contemporary learning methods to ensure deep learning, and students are motivated and willing to learn.

It should also be noted that the success of the learning process does not depend on the previous only, but there are other factors that cannot be missed, such as lighting, ventilation, sound, noise, contact with nature elements, the size of the openings, the colours of the space, etc...

The ability of a learning space to meet basic needs of the user, whether physiological needs (good vision – clear sound - corridors width...), psychological needs (visual privacy - auditory - containment - beauty elements ...), or social needs (interaction - privacy ...), can lead to a set of criteria that can be used to evaluate functional performance. It is clear from the above that there is a close relationship between the fields of architecture, learning science and environmental psychology, which should not be overlooked in order to achieve effective learning.

## **6. Conclusion**

The work is based on the study of each of the "determinants of spatial and geometric configurations" that make up the human response. A set of criteria has been developed to assess the functional efficiency of classrooms and their ability to meet the needs of the teacher and student.

These criteria are based on the capacity of learning spaces to achieve effective teaching and learning objectives. The survey identifies effective teaching and learning goals that can be achieved by meeting the requirements of teachers and students.

In conclusion, Effective Teaching & Learning Goals (ETLG) can be summarized as follows:

- The classroom enables collaborative learning, peer learning, and individual Learning.
- The classroom enables the implementation of a variety of teaching and learning approaches in order to promote interaction with content such as:
  - Lectures
  - Teacher- Led interactive
  - Student – Activities and Presentation
- The classroom allows leadership to be shared between the teacher and the student; as the role of the teacher in guiding students beyond imparting knowledge. (Student & Teacher are active participation).
- The classroom helps the teacher to respect and take into account the individual differences of students.

As for teacher requirements to fulfil Effective Teaching and Learning Goals (ETLG); they can be cited as follow:

- The teacher is able to move freely, to access all students equally, either individually, in small groups or as a whole cohort. (ETLG:1)
- The teacher is able to visually scan the classroom to monitor students, evaluate progress and identify students who may need assistance. (ETLG:2)
- The teacher is able to quick shift between multiple learning modes from lecture to project works till discussion. (ETLG:2)
- The Space has (acentric) or (polycentric) design, as there no defined front of the room. Instead, the teacher moves from one location to another to encourage student to work. (ETLG:3)
- The space provides the various technologies that able teacher & student to work, share and build their knowledge with each other. (ETLG:3)
- The flexible of the space able to provide various Learning styles, activities, technology to accommodate with students' individual differences. (ETLG:4)

Student's requirements that should be met in the classroom to achieve the effective teaching and learning goals (ETLG) can also be summarized as follow:

- Students able to rearrange mobile furniture; that serve different learning approaches, whether individually, with peers or in groups. (ETLG:1)
- Students able to move freely, to create different learning styles. (ETLG:1)
- Students able to display their product of their interactions for the other students and the teacher to see and discuss with them. (ETLG:2)
- Students able to interact with the learning content in various ways that may be individual or group-based. (ETLG:2)
- Students have sufficient spaces to do various activities. (ETLG:3)
- Students able to interact with each other & with the teacher easily based on the interaction distance. (ETLG:3)
- The space provides the various technologies that able teacher & student to work, share and build knowledge with each other. (ETLG:3)

The previous set of ETLG Criteria can serve as a tool to evaluate the functional effectiveness of classes. This criterion can be assessed on a five-point scale. This can be actual classroom teaching and learning to participate in assessment, or by displaying a series of images showing spatial features or being assessed virtually.

The assessment process outlined in this document can be widely adapted and applied to all typologies and configurations of any learning space, where each criterion is analysed and assessed in order to achieve an overall improved, harmonious (or consistent) successful and effective relationship between the learning space and users either teacher or student.

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