The Inner Courtyards as a Wayfinding Landmark in the Intelligibility of the Mental Image Case Study: university colleges buildings

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Abstract:
The concept of Intelligibility of the mental image in many scientific fields such as psychology and geography, in addition to architectural design because of its importance and wide-ranging impact, where This concept is used to solve the difficulties of the wayfinding for new and frequent users to reach the desired spatial space. However, but studies did not address the importance of courtyards as inner reference landmark in formation of the physical aspect of the mental image of each building to its users (students, professors and administrators), and at the same time it is considered as their means to navigate to the various public and private spaces in the college building.

In an attempt to find the type of the relation between changing the design characteristics of the inner courtyards and the Intelligibility of the mental image of the recipient for their importance in determining the positions of the elements in the building, and based on the hypotheses of the research and to achieve its objectives The "Space Syntax" calculation method for determining numerical weights of the building's spatial structure, where these weights express the relative strength of the structure parts, and using comparative analysis between the university colleges' buildings, a set of conclusions and recommendations were reached to help the designer to achieve the mental image Intelligibility of the user by repositioning the inner courtyards in the university colleges’ buildings.

Keywords: Mental Image - Space Syntax - Inner Courtyards-University Colleges

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1. Introduction
Many studies have addressed the concept of mental image in the built environment, where intelligibility of the mental image is linked to the ability of individuals to form a cognitivemental map almost similar to reality, so that man is able to wayfinding through the ability to determine its location in the building, and choose the shortest way to get from its current location to the destination, Brösamle argues that the spatial cognition affects the exploratory movement directly between the starting point and destination in clear environments, whereas the Ambiguous environments tend to be more winding and diffused, (Brösamle, Hölscher, 2007).

The inner courtyards as distinctive internal reference landmarks play an important role in strengthening the mental image. “To give a place a sense of being imaginable, the designer must add new elements that either reinforce the old or contradict it” (Richard, Dober, 1969), as reflected in this concept, On the Intelligibility of the university collegesbuildings through its influence on the design characteristics of the inner courtyards positions.

2. Material and methods
2.1. characteristics of Intelligibility of the mental image in the built environment
Spatial characteristics affect the Intelligibility of the mental image through the Morphological and Syntactical Characteristics of the physical elements, which express metric and topological relations in cognitive mental maps as follows:

2.1.1. Morphological Characteristics: The discrete or independent Characteristics represent metric relations of the architectural elements, which indicate the direction and distance between spaces, by:
- Colour: Can be realized from the characteristics of the space itself.
- Scale: The elements of the built environment that are not important, and not known, or less use for the user, on a scale smaller than the reality in the cognitive mental map, and sometimes not shown in the map, and vice versa leads to the opposite.
- Metric Distance: People generally lack accuracy in the metric estimation of distances while they have greater ability to compare distances to each other, in the form of non-numeric terms, but these estimates, whether directly as per cognitive maps, or indirectly from By referring to specific places in the built environment, they differ from the actual distances depending on the degree of user attachment to a place (compatibility), and the number of different spaces that the path is estimated to be measured (Passini, R., 1984)

2.1.2. Syntactical Characteristics: Represent relational characteristics and embody the topological relations of architectural elements, where the topological relations are defined as the hierarchy (arrangement) of the positions of the spaces, and their connection with each other, and the possibility of access from one space to another, and how many spaces must be passed to reach from a specific space to the distant space within the building configuration, in addition to the number of turns in the estimation of the length of the path between different positions, where the long path with the least number of turns is shorter than the short path with multiple turns, i.e. can be perceived by the movement between the spaces, so it includes the relation of each space with all other spaces, these characteristics are important components in form cognitive mental maps, and was classified to: (Hillier, 1999)

1. Locally relational characteristics: Include the relation of space with the spaces immediately adjacent to it.
2. Globally relational characteristics: Include the relation of space with all other spaces.
2.2. The design characteristics of the inner courtyards as a Significant Positions

The inner courtyards are architectural elements that strengthen the physical aspect of the mental image of each building, and at the same time constitute wayfinding landmark to the various spaces, where an indoor reference landmark is being a visually distinctive point of interest, and spatially controlled to maintain the road, Or a decision point that helps individuals to navigate and explore the building, or to help reach the desired space, (Gangaputra, 2017).

The features and characteristics of the inner courtyards are evidently inferred by the spatial properties that help define them as landmarks, namely Uniqueness, Contrast, Spatial Prominence, and Cognition. The design characteristics of the inner courtyards can be studied as Significant Positions through the following characteristics:

2.2.1. Morphological Characteristics

1) Courtyards are located within the building: Single main courtyard, or secondary courtyards, or main courtyard follow by secondary courtyards.

2) Courtyards positioning pattern: Symmetrical, asymmetrical.

3) The spatial relation between the courtyards and the spaces surrounding on each side, Can be summarize through two styles:
   a) Internal spatial flowing style: It is either a side spatial flow, that is, the connection between the space and the courtyard through one side of the space (an open window on the courtyard), or growing spatial flowing, that is, the connection between the space and the courtyard is so large that it grows in the vertical direction to elevate the space around the inner courtyard.
   b) Spatial unit style: That is, the spaces surrounding the inner courtyard merge with it into a single space unit, a more inclusive case of a space opening on the courtyard, where the space merges with the courtyard both at the horizontal level (the configuration of the building floor is a single space surrounding the inner courtyard) or at the vertical level (integration the most of the interior spaces of the building on the level of all floors with the courtyard in one space unit).

4) The spatial relation between the spaces surrounding on the inner courtyards: Through the following two cases: (Figure 1).
   a) A complete physical identification of the spaces: i.e. the completion of the space determinants (floor, ceiling, walls), where each of the spaces surrounding the courtyard has a fully spatial defined, and these spaces require audio-visual privacy.
   b) A sensory identification of the spaces: i.e. the absence of one of the space determinants, for example, the absence of walls or ceiling, through achieving the spatial integration between the spaces surrounding the courtyard, and these spaces become one large space, that is, the integration of the space unit with the principle of sensory identification of the spaces, The entire floor can be used as a one space, or it can be divided by partitions into spaces with different sensually defined spaces, some spaces are physically determined by two or three partitions, and the maximum ceiling of the floor represents the maximum ceiling of the spaces.
The spatial relation of the inner courtyard with the spaces surrounding it can be summarized by:

- **The courtyard as a sensory spatial unit**: that achieves the state of horizontal and vertical spatial integration with the spaces surrounding it and the sensory defined (the absence of one of the space determinants).
- **The courtyard as a physical spatial unit**: that achieves the state of horizontal integration with the spaces surrounding it and physically defined (The completion of the space determinants).

### 2.2.2. Syntactical characteristics:

The research adopts the methodology of the "Space Syntax" in evaluating the degree of Intelligibility of the physical aspect of the mental image. It adopts the mathematical method for analyzing the spatial patterns according to the mathematical indicators to measure the Syntactical characteristics of the inner courtyards. The Syntactical characteristics are analyzed at the global, local levels and their relation, according to the indicators, for each level and using the following programs:

**a) JASS program**: (Figure 2) The depth of system spaces is represented by representation of each space by node and each connectivity (direct permeability) between two adjacent spaces by line (edge or path), given Each space has a given number, and the base space or root node is defined (the space to which the depth of the all spaces will be measured) (considered as the main entrance space in the cases study), then all spaces are arranged at different depth levels, where determine the depth of any space according to the number of spaces that must be passed through to reach all spaces of the system from the base space, which determines the level of zero depth, and then continues the numbering of the spaces above the base space, and the space with a depth value of (2) means that there is an intermediate space between it and the base space, while the space with a depth of (3) means that there are two intermediate spaces between this space and the base space (Hillier, Hanson, 1984), Thus the depth of all spaces is determined according to the methodology mentioned.

**b) Depth map program**: (Figure 3) shows the graphical user interface, which consists of the main window on the right, and the sub-windows on the left, where the upper-left sub-window contains the plan layer to be analyzed, and the layers that express the results of the convex map analysis. And the lower left sub-window contains convex space analysis tools (Al_Sayed, Turner, Hillier, Iida, Penn, 2014). The convex map which is represented by two-dimensional extensions, includes the smallest and largest spaces, that include the entire spatial configuration of the floor plan, and forms the largest units that can be fully perceived by design (Hillier, Hanson, 1984), and representation These values through colour are rainbow gradients from lowest to highest, where very low values are represented in dark blue and light, and very high values in red and orange, although the numeric values of colour grades vary from one plan to another, Through this method we can analyze and discussion result without being forced to understand or perform accurate mathematical equations and calculations that lead to the resulting graphs.
The courtyards positions are analyzed in the case study using these two programs according to three levels, and using the following indicators:

**The global level:** Includes the following indicators:

a) **Space Depth Indicator:** Depth represents the number of visibility-permeability steps separating two spaces from the base space, through the number of depth levels from the main entrance (table 1).

| Table (1) Shows evaluation of space depth according to number of depth levels (Author) |
|-----------------------------------|----------------|----------------|
| Shallow depth                     | 0-2            |               |
| Medium depth                      | 3-4            |               |
| Deep depth                        | 5 and above    |               |

b) **Integration indicator:** Is a global synthetic measure of accessibility, studies indicate the role of integration property in achieving the ease of wayfinding, through integration the all spaces in the floor plan, and represents the relative depth of the space or shallow relative to the spaces, and the space is integrated When other spaces have a relatively shallow relation with it, and are isolated when other spaces have a relative depth in relation to it, i.e., integrated spaces are on average close to all other spaces in the system, the value of integration measures the relative position of any space, according to the floor plan configuration in general.

c) **Integration Core Indicator:** It represents 10-12% of the high values of highly integrated spaces, and represents the locations of the permeability oriented spaces at the global level.

**The Local level:** Includes the following indicators:

a) **Local Control Indicator:** It refers to the degree of local choice provided by the space to the adjacent spaces, and reflects the spread of the local movement of the occupants (students and teachers).

b) **Local Control Core Indicator:** It constitutes (50%) of the distribution of the control values of the convex spaces, i.e. the distribution of the most control spaces to the local movement.

**The relation between global and local levels:** through the following indicator:

a) **Global Control strong Core indicator:** It Expresses the characteristics of the spatial syntactic of the courtyards positions through the intersection of the synthetic cores, that is, the intersection of the integration and control cores in the spatial system, this indicator refers to a structure of the public spaces, that representing the positions of the visibility and permeability oriented spaces at the local and global level.

2.3. Evaluate the degree of the mental image Intelligibility

Through evaluate the following characteristics:

**2.3.1. The spatial orientation characteristic of the inner courtyards position**

By evaluating the corresponding relation between the global control strong core indicator and the courtyards positions as away finding landmark within this core, (Table 2).
Table (2): Shows evaluating the degree of the mental image intelligibility through the spatial orientation characteristic of the courtyards positions (Author)

<table>
<thead>
<tr>
<th>Degree of the intelligibility</th>
<th>Global control strong core of the courtyards positions</th>
<th>Type of the correspond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Global integration core</td>
<td>Local control core</td>
</tr>
<tr>
<td>High intelligibility</td>
<td>High integration core</td>
<td>High control core</td>
</tr>
<tr>
<td>Medium intelligibility</td>
<td>High integration core</td>
<td>Medium control core</td>
</tr>
<tr>
<td>Low intelligibility</td>
<td>Low integration core</td>
<td>Low control core</td>
</tr>
</tbody>
</table>

2.3.2. The spatial Prominence characteristic of the positions of the inner courtyards:
By evaluating the relation between the space depth and the global integration indicators of the courtyards positions,(Table 3).

Table (3): Shows Evaluating the degree of the mental image intelligibility through the spatial prominence characteristic of the courtyards positions (Author)

<table>
<thead>
<tr>
<th>Degree of the intelligibility</th>
<th>Space depth of the courtyard position</th>
<th>Global integration of the courtyard position</th>
</tr>
</thead>
<tbody>
<tr>
<td>High intelligibility</td>
<td>Shallow depth</td>
<td>High integration</td>
</tr>
<tr>
<td></td>
<td>Medium depth</td>
<td>High integration</td>
</tr>
<tr>
<td>Medium intelligibility</td>
<td>Shallow depth</td>
<td>Low integration</td>
</tr>
<tr>
<td></td>
<td>Medium depth</td>
<td>Medium integration</td>
</tr>
<tr>
<td>Low intelligibility</td>
<td>Deep depth</td>
<td>High integration</td>
</tr>
<tr>
<td></td>
<td>Deep depth</td>
<td>Low integration</td>
</tr>
</tbody>
</table>

2.4. The study cases
In order to test the research hypothesis, the Faculty of Education at Al-Baath University / Syria and the Faculty of Dentistry at Assiut University in Egypt were analyzed, where achieved diversity in the design characteristics of the inner courtyards as significant positions, in terms of the number of courtyards, their dimensions and their geometrical relation (symmetrical / asymmetrical),The distinction is made between the different courtyards position through numbered it in each case study.

2.4.1. Faculty of Education at Al-Baath University / Syria:
(Fig. 4) shows the ground floor plan of the Faculty, the pattern of the multi-space configuration pattern, a node and path pattern in the formation of the transitional and movement spaces, and the diversity of the inner courtyards (main and secondary).
2.4.2. Faculty of Dentistry at Assiut University / Egypt:
(Fig. 5) shows the ground floor plan of the Faculty, the pattern of the network spatial configuration, a node and path pattern in the formation of the transitional and movement spaces, and the diversity of the inner courtyards (main and secondary).

![Figure (5) Ground floor plan of the faculty of dentistry at Assiut University / Egypt](image)

3. Results and discussion
By analyzing the morphological and syntactical characteristics of the inner courtyards, using convex space map by Depth map, and the space depth graph by JASS program for the cases study buildings, taking into account the position of the main entrance as a base space, was found the following results

3.1. Results related to the morphological characteristics of the inner courtyards.
Table (4) shows the results of the morphological characteristics of the inner courtyards, as follows:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public lobby</td>
<td>Students' foyer</td>
<td>administrators' foyer</td>
<td>Patients' Lobby</td>
<td>Patients' waiting Lobby (free)</td>
<td>Patients' waiting Lobby (paid)</td>
<td>Classroom foyer</td>
<td>theaters foyer</td>
</tr>
</tbody>
</table>

3.1.1. Faculty of Education at Al-Baath University / Syria: It includes six courtyards, as follows:
1) Main courtyards: Including two pattern of courtyards:
   a) The main central courtyard (1): It forms a sensory spatial unit with the public lobby (A), a physical spatial unit with the theater foyer (H), and distributed corridor into learning spaces.
   b) The main non-central courtyards, including three main asymmetrical courtyards, as follows:
      • The main courtyard (2): It forms a physical spatial unit with each the student foyer (B), the classroom foyer (G), and the theater foyer (H).
      • The main courtyard (3): It forms a physical spatial unit with the distributed corridor into administrative spaces.
• The main courtyard (4): It forms a physical spatial unit with educational, service and administrative spaces.

2) Secondary courtyards: including two secondary symmetrical courtyards, as follows:
  • The secondary courtyard (5): It forms a physical spatial unit with the distributed corridor into the administrative spaces.
  • The secondary courtyard (6): It forms a physical spatial unit with the distributed corridor into the administrative spaces, and a physical spatial unit with the administrative spaces.

3.1.2. Faculty of Dentistry at Assiut University / Egypt: It includes eight courtyards, as follows:

1) Main courtyards: Including two pattern of courtyards:
  a) The main central courtyards (1), (2), (3) and (4): It forms a physical spatial unit with the public lobby and the classroom foyer.
  b) The main non-central courtyards (5) and (6): It forms a physical spatial unit with the students’ foyer.

2) Secondary courtyards: It includes two secondary symmetrical courtyards, as follows:
  a) The secondary courtyard (7): It forms a physical spatial unit with the clinics.
  b) The secondary courtyard (8): It forms a physical spatial unit with the corridor distributed to the clinics.

Table (4): Shows results of the morphological characteristics of the inner courtyards of the case study buildings (Author)

<table>
<thead>
<tr>
<th>The faculty</th>
<th>Number of the main courtyards</th>
<th>Number of the secondary courtyards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Central</td>
<td>Non-central</td>
</tr>
<tr>
<td></td>
<td>symmetrical</td>
<td>asymmetrical</td>
</tr>
<tr>
<td>Faculty of education</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Faculty of dentistry</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

3.2. Results related to the degree of the mental image Intelligibility

The degree of the mental image Intelligibility of the courtyards positions is evaluate by both of the characteristics of spatial orientation and prominence, as mention in the Tables 2 and 3.

3.2.1. Faculty of Education at Al-Baath University / Syria:

Table (5) shows the results of the mental image intelligibility of the courtyards positions, as follows:

a) Results related to the characteristic of spatial orientation of the courtyards positions

Figure (6) shows the indicator of the global integration core, and Figure (7) shows the indicator of the local control core in the convex map, where the gradient colours show the values of the two indicators.
b) Results related to the characteristic of spatial Prominence of the courtyards positions
(Figure 8) shows the graph of direct permeability relations between adjacent spaces of the ground floor plan, Figure (9) shows the graph of space depth of the courtyard positions from the main entrance, and Figure (10) shows the values of the global integration indicator (through the colour gradients) in the convex space map of the courtyards positions.

Figure (8) Graph of direct permeability relations between adjacent spaces of the ground floor plan of the faculty of education (Author)

Figure (9) space depth graph of the courtyards positions from the main entrance of the faculty of education (Author)

Figure (10) global integration indicator in the convex map of the faculty of education (Author)
Table (5): Shows results of the mental image intelligibility of the courtyards positions in the faculty of education

<table>
<thead>
<tr>
<th>The courtyard type</th>
<th>Num. of the court</th>
<th>Morphological characteristics</th>
<th>spatial orientation (Global Control strong Core)</th>
<th>intelligibility through spatial orientation</th>
<th>Spatial prominence</th>
<th>intelligibility through spatial prominence</th>
</tr>
</thead>
<tbody>
<tr>
<td>main central</td>
<td>1</td>
<td>a sensory spatial unit for the public lobby</td>
<td>High degree (redcolour)</td>
<td>High intelligibility (whole correspond)</td>
<td>(2) Shallow depth</td>
<td>High degree (redcolour)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Local control (Fig.7)</td>
<td></td>
<td></td>
<td>High intelligibility</td>
</tr>
<tr>
<td>secondary non-central</td>
<td>2</td>
<td>a physical spatial unit for the theater and classroom' foyer</td>
<td>High degree (redcolour)</td>
<td>medium intelligibility (partial correspond)</td>
<td>(4) medium depth</td>
<td>Medium degree (green colour)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium degree (green colour)</td>
<td></td>
<td></td>
<td>low intelligibility</td>
</tr>
<tr>
<td>non-central</td>
<td>3</td>
<td>a physical spatial unit for corridors distributed to offices</td>
<td>Medium degree (green colour)</td>
<td>low intelligibility (No-correspond)</td>
<td>(5-6-7) deep depth</td>
<td>Low degree (blue colour)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>low degree (blue colour)</td>
<td></td>
<td></td>
<td>low intelligibility</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>a physical spatial unit for the functional spaces</td>
<td>Low degree (blue colour)</td>
<td>Low intelligibility (No-correspond)</td>
<td>(4) medium depth</td>
<td>Medium degree (green colour)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low degree (blue colour)</td>
<td></td>
<td></td>
<td>low intelligibility</td>
</tr>
<tr>
<td>secondary non-central</td>
<td>5</td>
<td>a physical spatial unit for corridors associated to the public lobby</td>
<td>Low degree (blue colour)</td>
<td>Low intelligibility (No-correspond)</td>
<td>(5-6) deep depth</td>
<td>Low degree (blue colour)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low degree (blue colour)</td>
<td></td>
<td></td>
<td>low intelligibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low degree (blue colour)</td>
<td></td>
<td></td>
<td>low intelligibility</td>
</tr>
</tbody>
</table>
Table (5) shows the following results:

- **The main central courtyard (1):** through the orientation and spatial prominence of the courtyard position, as characteristics of the mental image intelligibility, it achieves two different degrees, a high degree of intelligibility for the public lobby, and a medium degree of intelligibility for the distributed corridor to the classrooms, and the foyer of the theater.

- **The main side courtyard (2):** It achieves two degrees of the mental image intelligibility, medium intelligibility for the foyer of the theater (associated with the student foyer), a low degree for the student foyer, and the classroom foyer, and a low intelligibility through the spatial prominence to its position.

- **The main side courtyard (3):** Through the orientation and spatial prominence of the courtyard, it achieves a low degree of the mental image intelligibility in relation to the corridors distributed to administrative offices.

- **The main side courtyard (4):** It forms a physical spatial unit with administrative offices, laboratories, and service spaces, and does not achieve any degree of the mental image intelligibility with the transition and movement spaces.

- **The secondary side courtyard (5):** Through the spatial orientation, it achieves two different degrees, a low degree of intelligibility for the corridor associated with the public lobby, and the corridors distributed to the administrative offices, and a medium degree of intelligibility for the corridor associated with the lobby of the administrators, and achieved through the spatial prominence of its position also two different degrees, a medium degree of intelligibility for the corridor associated with the public lobby, and a low degree of intelligibility for the corridor distributed to the administrative offices and the corridor associated with the lobby of administrators.

- **The secondary side courtyard (6):** It achieves two different degrees of the mental image intelligibility, with a low degree of intelligibility for the corridor distributed to administrative offices, and a medium degree of intelligibility for the corridor associated with the students' foyer.

### 3.2.2. Faculty of Dentistry, Assiut University, Egypt

Table (6) shows the results of the mental image intelligibility of the courtyards positions, as follows:

<table>
<thead>
<tr>
<th>Courtyard Type</th>
<th>Transition Spaces</th>
<th>Corridor Distributed to Offices</th>
<th>Students Foyer</th>
<th>Administrative Offices</th>
<th>Public Lobby</th>
<th>Deep Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Degree</td>
<td>Low Degree</td>
<td>Low Degree</td>
<td>Low Degree</td>
<td>Low Degree</td>
<td>Medium Degree</td>
<td>13-14-15</td>
</tr>
<tr>
<td>High Degree</td>
<td>High Degree</td>
<td>High Degree</td>
<td>High Degree</td>
<td>High Degree</td>
<td>Low Degree</td>
<td>Low Degree</td>
</tr>
</tbody>
</table>

| Table (5) shows the following results: |

- **The main central courtyard (1):** through the orientation and spatial prominence of the courtyard position, as characteristics of the mental image intelligibility, it achieves two different degrees, a high degree of intelligibility for the public lobby, and a medium degree of intelligibility for the distributed corridor to the classrooms, and the foyer of the theater.

- **The main side courtyard (2):** It achieves two degrees of the mental image intelligibility, medium intelligibility for the foyer of the theater (associated with the student foyer), a low degree for the student foyer, and the classroom foyer, and a low intelligibility through the spatial prominence to its position.

- **The main side courtyard (3):** Through the orientation and spatial prominence of the courtyard, it achieves a low degree of the mental image intelligibility in relation to the corridors distributed to administrative offices.

- **The main side courtyard (4):** It forms a physical spatial unit with administrative offices, laboratories, and service spaces, and does not achieve any degree of the mental image intelligibility with the transition and movement spaces.

- **The secondary side courtyard (5):** Through the spatial orientation, it achieves two different degrees, a low degree of intelligibility for the corridor associated with the public lobby, and the corridors distributed to the administrative offices, and a medium degree of intelligibility for the corridor associated with the lobby of the administrators, and achieved through the spatial prominence of its position also two different degrees, a medium degree of intelligibility for the corridor associated with the public lobby, and a low degree of intelligibility for the corridor distributed to the administrative offices and the corridor associated with the lobby of administrators.

- **The secondary side courtyard (6):** It achieves two different degrees of the mental image intelligibility, with a low degree of intelligibility for the corridor distributed to administrative offices, and a medium degree of intelligibility for the corridor associated with the students' foyer.
Figure (11) shows the indicator of the global integration core, and Figure (12) shows the indicator of the local control core in the convex map, where the gradient colours show the values of the two indicators.

b) Results related to the characteristic of spatial Prominence of the courtyards positions
(Figure 13) shows the graph of direct permeability relations between adjacent spaces of the ground floor plan, and Figure (14) shows the graph of space depth of the courtyard positions from the main entrance Figure (15) shows the values of the global integration indicator (through the colour gradients) in the convex space map of the courtyards positions.
Table (6): Shows results of the mental image intelligibility of the courtyards positions in the faculty of dentistry (Author)

<table>
<thead>
<tr>
<th>The courtyard type</th>
<th>Number of the court.</th>
<th>Morphologic al characteristic s</th>
<th>spatial orientation (Global Control strong Core)</th>
<th>intelligibility through spatial orientation</th>
<th>Spatial prominence</th>
<th>intelligibility through spatial prominence</th>
</tr>
</thead>
<tbody>
<tr>
<td>main</td>
<td>1-2-3-4</td>
<td>a physical spatial unit for the public lobby</td>
<td>High degree (redcolour)</td>
<td>High intelligibility (wholecorre spond)</td>
<td>(1) Shallow depth</td>
<td>High degree (redcolour)</td>
</tr>
<tr>
<td></td>
<td>5-6</td>
<td>a physical spatial unit for the student's foyer</td>
<td>High degree (redcolour)</td>
<td>High intelligibility (wholecorre spond)</td>
<td>(3) medium depth</td>
<td>Medium degree (greenco lour)</td>
</tr>
<tr>
<td>Second ary</td>
<td>7</td>
<td>a physical spatial unit for functional spaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>non-central</td>
<td>8</td>
<td>a physical spatial unit for the corridor distributed to clinics</td>
<td>low degree (blue colour)</td>
<td>low intelligibility (No-correspond)</td>
<td>(6) deep depth</td>
<td>low degree (bluecolour)</td>
</tr>
</tbody>
</table>

Figure (13) Graph of direct permeability relations between adjacent spaces of the ground floor plan of the faculty of dentistry (Author)

Figure (15) global integration indicator in the convex map of the faculty of dentistry (Author)

Figure (14) Space depth graph of the courtyard positions from the main entrance of the faculty of dentistry (Author)
Table (6) shows the following results:

- **The four main central courtyards (1, 2, 3, and 4):** Through the spatial orientation and prominence characteristics, it achieve a high degree of the mental image intelligibility for the public lobby.

- **The two main side courtyards (5 and 6):** Through the spatial orientation characteristic, it achieve a high degree of the mental image intelligibility, and a medium degree through the spatial prominence characteristic for the student's foyer.

- **The secondary side courtyard (7):** It forms a physical spatial unit with clinics, and service spaces, and does not achieve any degree of the mental image intelligibility with the transition and movement spaces.

- **The secondary side courtyard (8):** Through the spatial orientation and prominence characteristics, it achieve a low degree of the mental image intelligibility for the corridor distributed to the clinics spaces.

4. **Conclusions and recommendations**

4.1. **Conclusions related to the morphological characteristics of the inner courtyards.**

The morphological properties of the inner courtyards that achieve the mental image intelligibility in the study cases are classified as follows:

1) **The pattern of central main courtyard position,** in a sideways of the public lobby formation, and using a sensory spatial unit, as in the faculty of education at Al-Baath University, or by using the pattern of numerousmaincentral courtyards positions, in a symmetrical way to the public lobby, and using a physical spatial unit, as in the faculty of dentistry at Assiut University, have achieved a high degree of the mental image intelligibility of the courtyards positions.

2) **The pattern of non-central main courtyards positions,** in a symmetrical way, using the(node & path)style in the formation of the transition and movement spaces, and the grid pattern of the building configuration, as in the faculty of dentistry at Assiut University, have achieved a high degree of the mental image intelligibility, as local and global spatially oriented spaces, and have an medium degree for the spatial prominence of the courtyards positions.

3) **The pattern of non-central main courtyards positions,** in an asymmetrical way, using the multispace pattern of the building configuration, as in the faculty of education at Al-Baath University, have achieved a low degree of the mental image intelligibility of the courtyards positions.

4) **The pattern of non-central secondary courtyards positions,** in a symmetrical way, using a physical spatial unit with the corridors associated to the public lobby, as the courtyard (5) at the faculty of education, have achieved a medium degreeof the mental image intelligibility which related to the spatial prominence characteristic of the courtyards positions.

5) **The pattern of non-central secondary courtyards positions,** in a symmetrical way, and using a physical spatial unit with the transitional spaces, as in the secondary courtyard (5and 6) in the faculty of education at Al-Baath University, have achieved a medium degree of the mental image intelligibility which related to the spatial orientation characteristic of the courtyards positions.

6) **The pattern of non-central secondary courtyards positions,** in a symmetrical way, and using a physical spatial unit to the distributed corridors of the spaces, as in the two study cases, have achieved a low degree of the mental image intelligibility of the courtyards positions.
7) The inner courtyards that form a physical spatial unit with the different functional spaces have not achieved any wayfinding landmark of the mental image intelligibility.

4.2. Conclusions related to the degree of the mental image intelligibility
1) The results showed a measure of the courtyards positions, as a local and global oriented spaces, through the corresponding relation with the global control strong core indicator, as one of the spatial structure characteristics of the inner courtyards as wayfinding landmark of the mental image intelligibility, and the corresponding relation has appeared in the pattern of the main central courtyard position, in a side way, as in the faculty of education at AL-Baath University, and the main central courtyards pattern in a symmetrical way, as in the faculty of the dentistry at Assiut University.
2) The results also showed a proportional relation to the spatial prominence characteristic of the inner courtyards, that the more shallow courtyards are the more integrated will be, this indicates an inverse proportionate relation, as in the two cases study.

4.3. Final conclusions
The research presented determinants that help the designer in achieving a clear mental image in the design of the university colleges' buildings, through the pattern of positioning the inner courtyards as follows:
1) The main courtyards are positioned as a wayfinding landmark of the mental image intelligibility of a high degree: By using numerous main central courtyards, in a symmetrical way for the formation of the public lobby, or single main central courtyard, in a side way to the public lobby, and using a sensory spatial unit in its relation with the public lobby.
2) The main non-central courtyards are positioned as a wayfinding landmark of the mental image intelligibility of a high degree: By symmetrical positioning of the main side courtyards, using the grid pattern of the buildings' configuration, and the style of (node & path) for the transition and movement spaces.
3) The main non-central courtyards are positioned as a wayfinding landmark of the mental image intelligibility of a low degree: By asymmetrical positioning, and using of the multi-spaces formation pattern for the building configuration.
4) The secondary non-central courtyards are positioned as a wayfinding landmark of the mental image intelligibility of a medium degree: By symmetrical positioning, using a sensory spatial unit of the corridors connected to the public lobby, or forms a physical spatial unit with the transitional spaces.
5) The secondary non-central courtyards are positioned as a wayfinding landmark of the mental image intelligibility of a low degree: By symmetrical positioning, using a physical spatial unit to the distributed corridors for the spaces, and the architectural spaces.
6) The research was able to prove its hypothesis that the mental image intelligibility is affected by changing the morphological and syntactical characteristics of the inner courtyards as a wayfinding landmark in the university colleges' buildings.

4.4. Recommendations
1) The research recommends to the possibility of following the methodology in this research to analyze and study the pattern of the inner courtyards positions as a wayfinding landmark of the
mental image intelligibility for the different functional buildings (schools, hotels, hospitals, etc.), and then determine the specificity of the functional pattern of these buildings.

2) The possibility of studying the effect of visibility characteristics to the mental image intelligibility of the different functional buildings and have convergence in the number of the spaces.

5. Reference


[4] Hillier, B; (1999) the hidden geometry of deformed grids: or, why space syntax works, when it looks as though it shouldn't. Environment and Planning B: Planning and Design, 26 pp. 169-191

