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Dimension analysis and architectural model of BAPNE classroom for pre-school and primary education

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Abstract

The aim of this article is to determine the relationship between architecture and teaching, providing functional architecture models that are capable of absorbing the teaching load for movement and, fundamentally, for the development of kinesthetic intelligence (Howard Gardner). For this, we will establish a metric range of spatial proportions, m²/student ratio, in accordance with the activities performed on the BAPNE method.

This study will focus on students of Pre-school and Primary Education, providing specific standing architectural models and the minimum requirements for a classroom, as well as determining whether a space is suitable or not for the proposed activities.

The method includes analyzing architecture of the basic teaching room, approaching other education systems (Dalcroze, Montessori) and determining the differences between those systems and BAPNE. This study is carried out by architects and engineers, directly noting the architectural needs that current teaching requires for user stimulation.

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1. Introduction

The existing relationship between humans, the space they inhabit and the transformation of their habitat make for a starting point that directly connects architecture and its user.

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Nevertheless, although we will avoid debating on when and how the search for an adequate spatial proportion for human needs started, it is true that the study of specific needs in the adequate sizing of spaces leads us to finding the optimization and proportion of said spaces for their intended uses. We need to assume, then, that space is an item to be rationalized in the disposition of our habitat.

The need for a (architectural) space where to stimulate our brain builds a clear link between two fields that have been inherently related (architecture – intellectual stimulation). At the same time, the theory of Multiple Intelligences (Howard Gardner, 1987) meant a switch around knowledge and stimulation of human intelligence, changing our understanding of our intelligence and its possibilities for stimulation. In the development of this concept of intelligence we understand that kinesthetic, interpersonal, intrapersonal, visual-spatial and musical intelligences are closely linked to the environment around them, since they need a “space” or place where to be developed. This leads us to ask: What stimulation capability is in the space around them? What type of space do we need? What characteristics does that space need to have?

Far from attempting to tackle all possible interpretations to those questions, we will focus on the direct correlation between spatial proportion and the human as its user, for the development and stimulation of kinesthetic intelligence in first place and, secondly, for the rest of intelligences cited above (interpersonal, intrapersonal, visual-spatial and musical intelligences).

Given the existing relationship between Architecture and Anatomy, the latter even being part of the BAPNE acronym (Biomechanics, Anatomy, Psychology, Neuroscience, Ethnomusicology) we deem it essential to establish parameters to indicate the characteristics that must be present in the spaces we use.

The aim of this paper is to determine the metric guidelines that need to be fulfilled in order to apply BAPNE methodology in an architectural space. We will leave aside the rest of issues not related with spatial proportion and its use.

In this present study we will emphasize three parameters: Ratio m²/student; minimum dimensions (length – width – height and minimum usable space); and spatial proportion (length – width – height relation). The secondary aim of this research is to conclude resulting measurements and justify them in a specific classroom perimeter and in a specific shape.

1.1. State of the issue, literature review

In order to approach the issue of this research we need to know the technical and spatial requirements that might exist and are current to the pedagogy of movement.

The relationship between kinesthesia, pedagogy of movement and projection of body within space with the design and the environment in which they take place are cited in studies by authors such as Beacham R.C. (1985), Goodkin D. (2001), Wolff, S. J. (2003), Toranzo V. (2007), Morris, R. V. (2008), Marín Acosta, F. I. (2011), Beilock, S. L., & Gray, R. (2012), Ingham, P. (2012), Ingham, E. (2012), Widmer M. (2013), Bond V.L. (2013), Miller, S. C., Lindt, S. F., & McIntyre, C. J. (2014). Many of these studies are linked to, and strongly reinforced by, education methodologies that believe motion in the classroom is key. They are studies made by people who approached their works on education taking kinesthesia and body movement into account. Such is the case of Montessori, Laban, Dalcroze, Orff, Kodaly, Waldoff. All of them reinforce the importance of the infrastructure that surrounds these activities, thus focusing on the design characteristics of a classroom that optimizes learning at cognitive level and attitude. Their studies on movement have yielded examples on reference environments, created in order to implement said education models, such as:

María Montessori schools; institutions that stress the connections between mind and body, movement and cognitive aspects. In the book “El niño: el secreto de la infancia” (1981), Montessori lays out crucial pedagogical aspects in order to understand the importance of contact and inter-relation between student and spaces. “Movement, or physical activity is, then, an essential factor for the intellectual growth, which depends on impressions received from the outside. It is through movement that we get in touch with external reality and it is through these contacts that, over time, we acquire thoughts, even abstract ones”. An example of Montessori school is Hertzberger in Delft, laid out in separate environments, prioritizing children’s freedom of choice, made up of “L” shaped classrooms, with room corners prepared for students’ concentration and energy focalization. Montessori builds on the idea that furniture and equipment need to be easy to move and operate by the children to free up those very spaces. All being calculated for

stimulation in a way that, should anyone stumble with a chair or table or if the student dropped them, the noise would be an indicator of “error control” which would allow them for rectification.

Laban Schools. Rudolf von Laban’s pedagogy of movement and his methodology were based on satisfying new expression needs by linking space, movement and also rhythm to an action by a dancer. This actor would need to concentrate completely as, according to this conception, “all exterior movement is a consequence of an interior movement”. According to Laban, the body establishes its own rules for movement in space in accordance with directions, crossing through and cutting space, turning around, in meandering ways, spiraling. His method is based on the icosahedron figure, formed by 20 equilateral triangles, in order to circumscribe body movement in the kinesphere. He divides the study of harmony of space in 2 sections: Choreutics is the exploration of the shape of a movement that ends up in a dance; Eukinetics is the style of movement that the individual dancer performs. Control of the kinesphere helps mark the dynamic, rhythm, agogics and phrasing, favoring gestural control in void strike and, sometimes, being activated by dissociated use of arms and hands (one side to mark beat and the other to mark dynamics, for example). Currently, Laban centers built in different locations around the world give preference to the concept of luminosity, wide spaces and well-distributed classrooms in square or rectangular shapes. They use materials that allow for exterior understanding of interior life and silhouettes dancing in the structure, with a great array of colors to convey the positive energy that inhabits them and that inspires movement.

The institute of Rhythm in Hellerau (1911) by Jaques Dalcroze. It is a music school that works on eurhythmics as a method for musicians and dancers. Dalcroze followed up on studies by Delsarte, who is considered the precursor of modern dancing, which explain that rhythm and dynamic of music depend completely on physical movement and the muscular system. He had an ultimate goal of providing total freedom on both thought and expression to his students. In his Hellerau institution, floors at different heights were combined in environments where lighting in an unobstructed space would be part of the experience accompanying movement.

Orff Schulwerk Institute. This institute was founded in Salzburg by composer Carl Orff as headquarters and seminar for his scholarly tasks for elementary level music. Currently, didactics of movement at the Orff Institute are renowned by its innovative music and dance teaching. Its indications about spaces and classrooms are limited to favoring open spaces for teaching, without chairs or desks and where students use the floor for seating during the rest of the activities proposed by the method.

Goetheanum house by Rudolph Steiner. This author studied anthroposophy; the sensations of the individual with light, the environment, angles and material state and designed a reference space such as Goetheanum. This is where Waldorf methodology stems from, for which there are schools all over the world and where maximum environmental comfort is paramount for the children who inhabit them. These are soft spaces, with rounded walls and edges creating tranquil surrounding spaces to achieve maximum development of learning, together with dim colors such as rosewood or peach for concentration. Wide spaces with no excess light and fabrics to dim this excessive light; fabrics are also used to cover beams and they are let hang towards the floor as a haima in order to reduce height to the level of those who inhabit the building because high ceilings generate less inviting spaces.

1.2. Aim of research

In this report we address social density and spatial density approaches to allow practicing any methodological works by the authors cited above, as well as those dynamics pertaining to the BAPNE method, which are central to this study.

When sizing, it is mandatory to consider the case with the greatest spatial requirements among those cited above, which is the kinesphere, given that it encompasses the possibilities of body movement of every individual in a dodecahedron within a sphere.

The activities that are developed in the BAPNE methodology set out concrete spatial needs, both because of differences in positioning in different exercises or in the very activity.

Exercises performed in this methodology stimulate firstly the kinesthetic intelligence, as well as the totality of activities also stimulates the development of interpersonal and intrapersonal intelligence. In other type of BAPNE methodology activities visual-spatial and musical intelligence are also put into play.

BAPNE uses group dynamics performed in circles or ellipses, as in the initial activities or the canon, in which students intervene establishing visual contact while interacting and developing the exercise of interacting among peers and doing body percussion.

Another variation established in BAPNE is interacting on opposite lines in which one side interacts with the other. This is one of the spatial needs with higher area requirements, because of the obligation of setting all students in two sides with an approximate space between them of 4.5 m. This activity is easiest seen in the exercise (Campanero 1-2-3-4-5).

On the other hand, those activities with the highest degree of kinesthetic intelligence stimulation can be set on those in which position change are regular, including exercises in which several planes, sagittal, transversal and longitudinal, take part (Ta-ki + U, 4, 3).

Another exercise that means a substantial difference in the development of the activity and use of the room is the one performed without a specific position (free disposition) and with constant changes to it; although just as it happens with the exercise (walk + percussion + speak), this type of exercise activates interpersonal, intrapersonal and spatial intelligence while a sequence of percussion or music is performed, which means musical intelligence stimulation at the same time.

All these activities just as they are described and detailed in the cited references, have specific spatial needs to which we must refer in order to determine if the space where we want to perform it in is valid.

2. Method

2.1. Aim

In order to define a BAPNE classroom (or a classroom suitable for teaching BAPNE) it is basic to first take into account the group of people who will enjoy and benefit from it. Therefore, as an essential step in this research, we must define and know the classroom's usable anatomic characteristics, aiming at quantifying necessary space for the performance of BAPNE activities, as well as knowing the basic learning positions used in the methodology. Spanish directive in architecture of nursery rooms, kindergartens, primary and secondary education establishes (Royal Decree 132/2010 Feb. 2nd) 1.5 m² per person for classroom spaces, 2 m² for kindergarten and 5 m² per person for other spaces (gym, labs, library). The m²/student ratio for BAPNE activities is estimated at 3.5 m²/person, taking into account both static activities (fixed positioning) and those requiring movement. The rest of standardized frameworks enforced by law and which we will take into consideration in this research refer to distances and heights that should be met in order to safeguard health of users. They are as follow:

- Minimum height = 3,00m
- Free length in shorter side \geq 6,00 m
- Maximum distance between open wall (light) and opposite wall $d < 7,2$ lineal meters (should this not be met, a choice will be made of opening a second wall).

When writing about space, it is necessary to specify how many users will enjoy this space. This study will consider a maximum of 30 people, including teachers.

2.2. Method

Positions performed in the BAPNE methodology, most of them defined in the State of the Issue, can be summed up in seven basic types, be them standing or sitting positions: two opposing lines, circle, two concentric circles, small circles, classic mirror stance (teacher / students), semicircle and free disposition. Through space and activity analysis (fulfilling the complete set of positioning) we have come to establish a minimum standard space of 3.5 square meters per person.

The first analyzed configuration, which is also the most common, is the rectangular room with a short / long side ratio of 1 / 1.7. The fact that it is the most common setting in the education field is, undoubtedly, due to its possibility to adopt different teaching methods and therefore make it a versatile space (which is not to say it makes it a flexible space). The rectangular BAPNE classroom will have a minimum size of 8x13.75 m. yielding a total area of 110 square meters. This area responds well to the different needs related to the basic positions of the methodology, which

guarantees a very high efficiency given its special characteristics: other user visualization during activities is good due to distances; long and short side guarantee optimal orientation of person in space; spatial performance of action in relation to the activities done in small groups is optimal due to blocking of verbally transmitted information (activities require use of voice); light quality is quite high, since in this spatial configuration distance between the 2 main walls is shortest; acoustic studies of rectangular rooms are not unfavorable.

The second type of room we have analyzed is the square shape, understood as a classroom that presents same length for all four sides.

This area responds well to BAPNE needs, although we need to mention that it needs to take up a bigger area in order to include all necessary exercises and their positioning, making the total needed area 151 square meters, while leaving some parts of the space unused during certain exercises. Visualization in this type of room can be classified as good; distances are short, although not as efficient as in the quadrangular type. Quadrangular disposition requires reference points in the classroom so as to help students orientate and refer themselves in the space. Performance in this type of room is favorable when working in separate groups, as it means more separation from others and therefore lower noise pollution. Just as in the rectangular type of room, specialized study and materials are needed to control reverb and oral transmission of messages.

The third type of room we have analyzed is the “L” shape. Although its total area is slightly higher than in the rectangular case, that difference allows us to strengthen certain room characteristics. When working activities with students we see no great differences with the rectangular shape. Visualization is the only aspect we could qualify as low or very low, since there is a potential blind angle. Equally, there is a difference with the quadrangular shape, as the aggregated space’s contiguous edge creates a wave rupture point, which does not favor the clear transmission of messages. This type of classroom offers a number of mixed uses options to which we will refer in future articles.

The fourth type of room studied is the curved shape, be it ameba shape, convex or concave shapes. The fact of having a curve means a greater consumption of space, raising total area to 160 m².

We need to mention that a room like this can present an infinite number of shape variations that might optimize that figure. Although this shape can bring about lack of orientation and thus a need for using objects to develop it, it is true that it is the most adequate to ease fluidity of exercises. Visualization is very favorable as these spaces lead to finding radial points from which to centralize space, which means easy visualization of other components of the exercise. Nevertheless, the point where we do find problems is in the free group disposition, given that the room’s sheer size promotes excessive segregation of said groups. Another negative point of this type of room comes from the acoustics. Although curved spaces help clear message transmission, the fact of doing singing exercises and not having collision planes for sound waves will mean their overlapping.

3. Proposal:

Established data and minimal requirement for each space notwithstanding, the ideal solution for a classroom for movement will depend on the joint school project. That is to say, if we take up remodeling of facilities, the logical idea will be adapting to it. If we generate a new project, we will be able to choose any of the mentioned types. In order to correctly teach BAPNE methodology, in area and volume parameters, we must obey optimization of space in use, which is to say: not because we have more room we will be in a situation of comfort (in parameters of proportion). Being space optimization an essential parameter we should therefore conclude a spatial model. At this said, though, the most efficient room as per factors of area and total cost, consumption of square meters developed and space exploitation is the Quadrangular Room. Not having this type of room for BAPNE activities does not mean we need to reject the teaching of this methodology. We can work with a different series of activities or else proceed to division in two or more student groups, therefore performing and coordinating different activities simultaneously.

For example, while 15 students perform the opposing lines activity called “Campanero 1, 2 and 3”, the other 15 can be divided in 3, 5 person micro-groups performing short movement sequences, such as those considered position-number “Cuadrado + 5”. A different variation to be mentioned, which will be taken up in fore coming articles, is the “L” shaped room, given the fact that it only adds 10 m² net and, at the same time, it brings a key in order to create a versatile and flexible classroom for the practicing of kinesthetic intelligence over areas and corners of the BAPNE classroom.

4. Conclusion

Just as it was mentioned in the introduction, parameters are established for the architectural environment in terms of space and proportions:

1. The metric ratio established in this article leads us to formulate a range-based simplification, establishing all necessary parameters.

Therefore, spaces deemed suitable will be those having a minimum free area in relation to their users and without gradient variations (be them imperfections or level changes). All previous dispositions fulfilled, we establish:

Table 1. Students-area-size ratios

Number of students	Minimum area (m2)*	Minimum rectangle**
5 to 10	30	4,5 x 6
11 to 15	40,62	6,25 x 6
16 to 20	52	8 x 6
21 to 25	63,37	9,75 x 6
26 to 30	74,5	11,5 x 6

* Minimum area counted with room for furniture, entry points, etc.

** Minimum rectangle guarantees that a proportion is available that is suitable for BAPNE methodology teaching.

2. Mathematic criteria formulation for this case must be comprised by the variables of number of users; at the same time, multiplying factors are fixed (2 and 6,5), which are equivalent to the summation of required space plus max space of use. It is then reflected as follows:

$$\text{Ideal area} = \frac{(\text{Number of users} \times 1,1) + 2}{2} * 6,5$$

$$\text{Minimum area} = \frac{(\text{Number of users} \times 0,7) + 2}{2} * 6,5$$

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