Space Design Assisted by Artificial Intelligence in Early Childhood Education Classrooms

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Abstract

This chapter analyzes space setting in early childhood education, considering its influence on the teaching-learning processes. School space is a factor that promotes academic, life and attitudinal learning, and it favors the cultural exchange of rules and values, due to its non-neutrality and to the fact that it educates us continuously, with teachers learning new meanings within it, exerting great influence on the movements, behaviors and learning of the students, in particular, and all the members of the educational community, in general. At the same time, Artificial Intelligence has appeared in our daily living as an effective learning tool to unburden teachers, facilitating the co-creation and co-design of spaces in early childhood education. Artificial Intelligence is becoming a valuable instrument to analyze the organizational designs, equipment and fluid relationship of said work spaces in educational centers and their environment.

14.1. Introduction

Educational centers must be considered centers for learning and co-existence, and the way in which spaces are organized within them will determine the working and social relationships. Due to the influence of educational organization on our lives, we must analyze it from the curricular and pedagogical perspective, as well as from the psychological and sociological perspective. The term space admits different definitions and, therefore, different conceptualizations, taking into account that it generally means "indefinite expanse", i.e., area without limits that contains all finite extensions.

According to Madrid and Mayorga (2012) and Camacho (2017), the school space is the container and content of the structured teaching-learning situations, understood as a material reality that influences the educational action.

In the current context, González-Zamar and Abad Segura (2020) considered physical space as a learning factor and proposed that the planning, design and organization of space exerts great influence on the movements, behaviors and learning of students. Moreover, the design and organization of space allows favoring the cultural exchange of rules and values, as well as life and attitudinal learning (Shernoff et al., 2017).

In the studies conducted by Barret et al. (2017), Daniels et al. (2007) and Tse et al. (2015), a positive relationship has been reported between the properties of physical space, the methodology used and the influence of both on the teaching-learning process of students. According to Maxwell (2016), the adaptation of spaces favors the development of positive emotions, greater integration and better values among the students. Similarly, an adequate space promotes the social connection of the students, as well as collaboration, reflection and the exchange of ideas (Oblinger, 2005); fosters cognitive development (Fraser, 2018; Lin-Siegler et al., 2016); favors early literacy (Fraser, 2018); and promotes more active methodologies (Acaso & Megías, 2013). Physical space also influences the planning

of curricular elements: objectives, content selection and timing, classroom organization and monitoring, and evaluation and motivation of students and teachers (González-Calvo et al., 2018).

In space planning, it is important to consider not only children but also adults (teachers, parents, educators and assistants), to ensure that they all have spaces to comfortably carry out their tasks, duties and relations.

Thus, space can transform and directly influence learning and the development of people and organizations.

School space understood as a learning environment

Upon entering an educational center, the walls, the furniture and its distribution, the dead spaces, the people and the decoration show the types of activities that are carried out in it, the communication among students, the interests of the students and teachers, the relationships with the outside world, etc. As was stated by Iglesias (2008), the term "space" refers to physical space, that is, the buildings for activities, characterized by the objects, didactic material, furniture and decoration. On the other hand, the term "environment" refers to the set of physical space and the relationships that are established in it (affections, interindividual relationships among children, between children and adults, between children and society as a whole, etc.). Chacón and Triana (2020, p. 11) stated that "...for the design of school environments, it is fundamental to consider the heterogeneity of spaces, where each space has relevant characteristics and furniture for the programmed activity, two or more access points, free-leisure areas and common zones". Likewise, Urda and Leal Laredo (2017) claimed that the following aspects should be considered when designing a space that promotes education and the construction of knowledge: the identity of the building with respect to its immediate context; flexibility and permeability; transition space; and the heterogeneity of classroom spaces.

14.2. Dimensions of the Space/Environment in Early Childhood Education Centers

According to Iglesias (2008), we can analyze three dimensions in the spaces of educational centers: physical, functional and temporal.

Physical dimension

Which refers to the physical space (center, classroom, annex spaces...) and its structural conditions (floor, windows...). It also comprises the objects of the space (materials, furniture and decorative elements) and their decoration (ways of distributing the furniture and the materials within the space).

Decree 149/2009, of May 12th, which regulates the centers that teach the first cycle of early childhood education, by the Government of Andalusia (Spain), version in force 1/1/2024, gathers the minimum criteria of every early childhood education center in Chapter II, Article 11, which states that centers with the first cycle of early childhood education must be in buildings of educational use and with independent access, with architectural conditions that enable access for people with disabilities.

Article 13 gathers the facilities and material conditions of centers of the first cycle of early childhood education, including the following:

- One room per unit with a minimum of two square meters per school placement, with a total minimum of thirty-six square meters. The rooms for children under two years of age will have different areas for resting and hygiene.
- A space adapted for cooking.
- A multipurpose room of a minimum of thirty-six square meters that may be used as a cafeteria.
- A play yard of a minimum of sixty-five square meters.
- One restroom per room for children aged 2-3 years, which must be visible and accessible from the room and will have two sinks and two toilets.
- One restroom for the staff, separated from the units and services of the children, with one sink, one toilet and one shower.

- A differentiated space for the administration and coordination activities. (p. 5)

On its part, Royal Decree 132/2010, of February 12th, establishes the minimum requirements of centers that teach the second cycle of early childhood, primary and secondary education in Spain. These centers must meet, at least, the following requirements about the facilities that are common to all centers (Article 3, point 2, p. 5-6): being in independent buildings, meeting the safety and energy-saving conditions, and having ventilation, natural lighting and conditions of accessibility for people with reduced mobility. The centers that teach the second cycle of early childhood education must have a minimum of three units. Article 6 gathers the facilities and material conditions of these centers:

- One classroom per unit, with an area that suits the number of authorized school placements, and a minimum of 2 square meters per school placement.
- A multipurpose room of thirty square meters.
- A play yard that can only be used by the center, with an area of at least 150 square meters for every six units or fraction, and a differentiated schedule of use if the center has students of other educational stages. (p. 6)

In general, in order for school spaces to be adequate, they must meet three types of conditions:

- Pedagogical conditions, such as: adaptability, which implies the possibility that a building may admit changes; flexibility, to modify spaces and make them convertible and moldable; and communicability among spaces.
- Physical conditions: location, far from dangerous areas; orientation; classroom structure, which can be linear or nucleated; sufficient rooms (rest rooms, toilets, multipurpose rooms...); favorable acoustic conditions; lighting, enough natural light; natural ventilation; and adequate heating.
- Compliance with the general conditions according to the regulations in force.

There are different classifications about physical spaces in educational centers. Next, we present the classification of Domènech and Viñas (2007): teaching, leisure, services, management, and movement. Each of them is briefly explained below.

Teaching space: In these spaces, an educational activity is carried out, which has been programmed and ordered according to the curricular needs of each class or stage.

The equipment of each classroom must respond to the fundamental activity that is carried out in it, whether it is specific of the area (audiovisuals, library...) or general, and it will be adapted to each educational level or stage.

The teachers must have sufficient technological equipment: slide projectors, computers, speakers, printers...

The furniture and distribution of the classroom must favor three important aspects: easy and direct access to the materials; the presence of spaces for the permanent presentation of the classroom activity; and the free expression and participation of the students.

The classroom design must be taken care of considering characteristics like size, aesthetics, luminosity, distribution, shapes, color, decoration... adapting them to their age, with the aim of favoring creativity, communication and participation. It is important for the students to participate in the adaptation of the spaces of the center.

Regarding the materials of early childhood education classrooms, these can be grouped into assembly materials (cork board, children's books, audio material...), material for working stands (each stand must have a large recipient to store the necessary materials), material for workshops and learning environments (material classified by groups and colors, such as pencils, crayons, markers, scissors...) and other types of materials (poster board, clay, tissue paper, cellophane...).

Leisure space: In these spaces, the students express themselves and act freely and spontaneously, although they must meet an educational end. These spaces are: play yards, games rooms, etc.

Due to the minimum budgets, centers must potentiate their imagination and make good use of the materials to enrich the leisure experiences of the students. Thus, the following aspects are considered:

- The yards can be livened up with slides, tunnels made of different materials, large-diameter tubes, unleveled terrain, swings, bicycles, etc.
- Floors with geometric shapes: squares, triangles, chess boards, games such as hopscotch...
- The yard can be used for handicrafts, painting and modelling; the installation of benches of different heights for multiple uses would be enough, which can also be employed for resting.
- A high platform can be used as stage, etc.
- Parts of the yards can be used for relaxation and individual concentration, gardening, crops, small ponds, etc.
- Walls for panels, which can be decorative and employed for advertising, announcements, etc.

Service spaces: mainly formed by sanitary spaces and the cafeteria. The cleanliness and order of these places is fundamental for their correct use.

Management spaces: these include not only the offices for secretaries, principals and caretakers and a teachers' room, but also a meeting room and rooms for individual and collective work for teachers.

Spaces for circulation and communication: mostly formed by corridors, halls, stairs... said spaces have two main functions: enable physical circulation between the facilities and favor work communication in the center.

The entrance is the first space through which children and parents get in contact with this new environment. Therefore, it could be set in the following manner:

- Objects that are familiar to the children.
- A place for families, in a peaceful and pleasant framework.
- A space for communication and information. For information, there could be panels to communicate any type of information aimed at parents, such as:
  - Menu of the day if there is a cafeteria.
  - General advice: meetings, trips...
  - Presentations of the productions of the children.

The corridors are places of communication, like the entrance, although they should have specific information about the ac-

tivities that are carried out in the different classrooms and workshops, with the possibility of exhibiting samples of the works done by the children. The type of communication we can offer are moments of everyday life, pedagogical projects, habits and routines, interactions among children and between children and educators, knowledge processes, and artistic expression in school.

Great common space: it is also important to highlight the importance of a space of common use for the entire center (students, parents, teachers...). The existence of this space may facilitate the organisation of debates, open discussion forums, conferences, extracurricular activities, cultural weeks..., etc., which may be a dynamizing element that would favor the development of the educational project of the center.

Table 14.1. Classification of spaces of Doménech and Viñas (2007)

Teachers	Classroom; library; specific-use rooms; audiovisual rooms
Leisure	Play yards; game rooms
Services	Cafeteria; restrooms
Management	Secretary; meeting rooms
Circulation	Corridors; stairs; halls
Common multipurpose room	Multipurpose rooms

Note. Developed by author.

Functional dimension

This is related to the way in which the spaces are used, their multi-usage, and the type of activity they serve. Thus, spaces can be used by children autonomously or under the direction of the teacher. Multi-usage refers to the different functions that a single physical space can assume (e.g., the rug is the meeting place for communication during assemblies, and later on it is the place for construction). Lastly, with regard to the types of activities that the children can carry out in a certain physical space, the latter acquires a certain functional dimension, e.g., construction place, symbolic game, music, library, etc.

Temporal dimension

This dimension is linked to time management and, consequently, to moments when the spaces will be used. The time of the different activities is necessarily bound to the space in which they are carried out: time for playing in the areas, communicating with others in the assembly, storytelling, cafeteria, recess, individual or small-group work, etc., as well as the time for free and autonomous activities, and planned and guided activities. However, in addition, the temporal dimension also refers to the pace (quick or moderate) at which the class develops, i.e., the *tempo*.

14.3. Artificial Intelligence and Educational Spaces in Early Childhood Education

Artificial Intelligence (AI) is a reality that is present in the lives of people, facilitating many tasks (Estupiñán et al., 2021), and, due to its appearance in our daily living and its proliferation and development in many aspects of our lives, it seems necessary to learn to use it and know its advantages and disadvantages in the scope of education. Although it is a relatively new technology, it is increasingly evident that it will have a great repercussion in the future (Navarro, 2018). As was stated by Marqués Cobeta (2023, p. 28), it must be implemented "as a fundamental tool for the improvement of the educational experience that is beneficial for both teachers and students in all educational stages".

The use of AI can be understood as an effective learning instrument that unburdens the teacher and offers efficient learning experiences for the students (EDUCAUSE, 2023). We highlight some of the ways in which AI may influence the design of spaces in the classrooms of early childhood education.

With the use of AI-based software and tools, teachers can obtain precise data that allow them to predict facts and search for better solutions and classroom designs to adapt to the needs of their students.

AI tools generate images from text, which allows applying collaborative and multidisciplinary approaches, such as the co-

creation and co-design of educational spaces of early childhood education (Cobeta, et al., 2023; López-Forniés & Asión-Suñer, 2023), with the need to design differentiated and fluid spaces according to the educational activity that is carried out in them (Durá-Gúrpide, 2016). AI systems allow gathering data of performance, needs, learning styles and preferences to design classroom spaces and, thus, create personalized activities (Hutchins, 2017; Pimienta & Mosquera-Martínez, 2022). Through this technological tool, it is possible to organize personalized learning environments, by analyzing the learning style of each student, and create different environments, maximizing their use and efficiency, in addition to providing real-time information about the performance of the students, with the possibility of adjusting the space and methodology (Montiel-Ruiz & López-Ruiz, 2023; Prendes-Espinosa, 2023). For example, an AI system may suggest the teacher which resources she/he may offer to her/his students, based on the study of the space in which they work most motivated and relaxed (Peñaherrera-Acurio et al., 2022).

Similarly, AI can define spaces that encourage collaboration and cooperative work, by designing flexible groups, and allowing for temperature, lighting and sound adjustment, in order to maximize concentration among the students. A very novel aspect of AI is that it improves safety in educational centers, due to smart surveillance systems that can detect risk situations. With AI, it is possible to design classrooms that can be accessed by students with disabilities, which allows compensating opportunities. Lastly, AI improves energy efficiency and reduces the costs in classrooms and educational centers, which reduces the environmental impact. To sum up, AI enables the design of sustainable classrooms for early childhood education to preserve the space in which children live. Using AI tools and the Floorplanner application, we present the design of the following propositions of spatiograms for classrooms of early childhood education for children aged 0-3 years (see images 14.1 to 14.6)[1]

1. Note: Spatiograms designed with AI by Jesús Martín Pérez (4th year student of the Degree of Pedagogy, University of Seville).
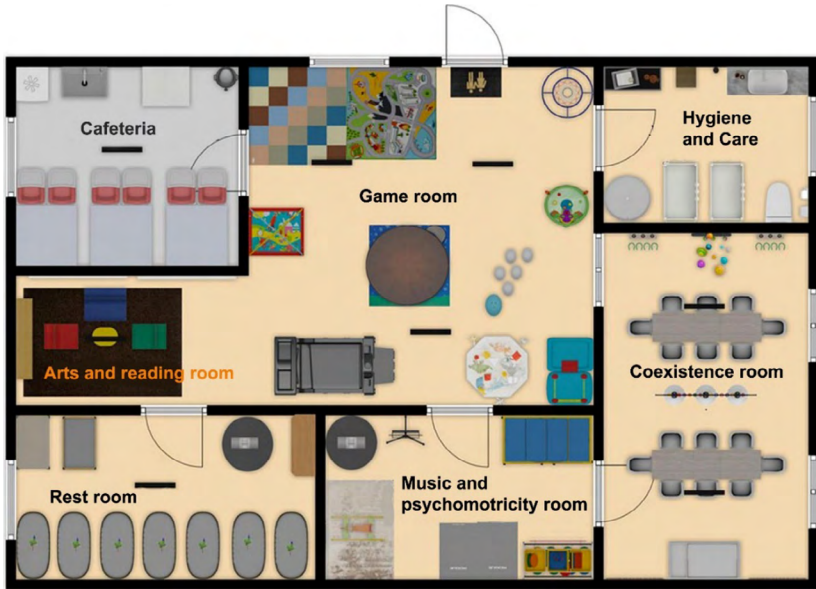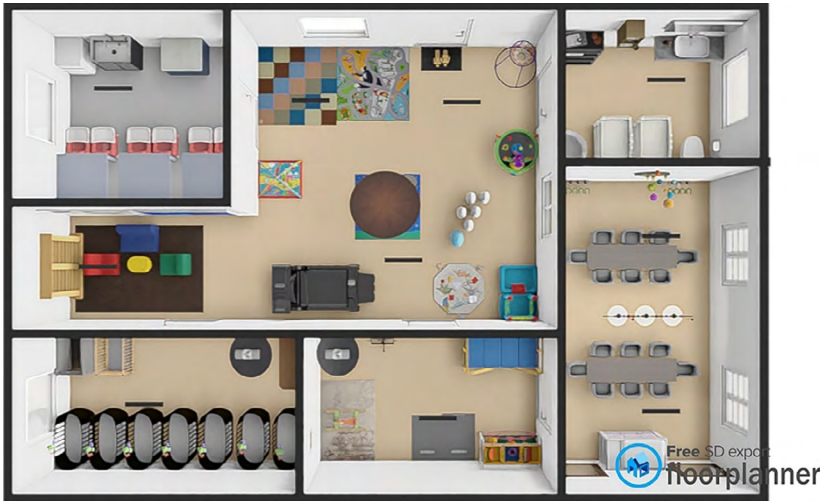
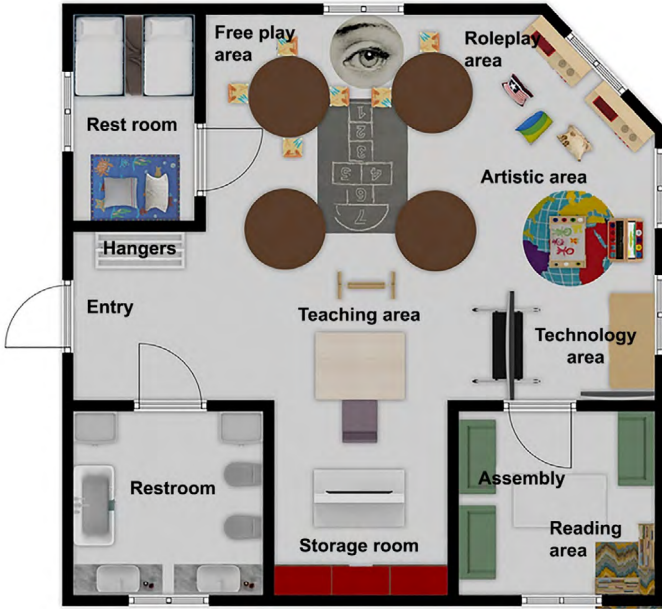**Image 14.1.** Spatiogram (2D).

Image 14.2. Spatiogram (3D).

Image 14.3. Spatiogram (2D).
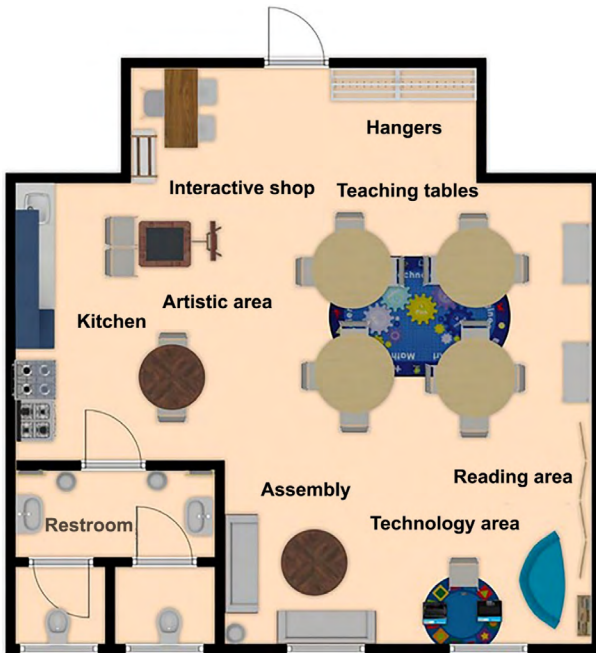

Image 14.4. Spatiogram (3D).

Image 14.5. Spatiogram (2D).

Image 14.6. Spatiogram (3D).

The process followed for the design of the classrooms consisted in the steps described below:

1. Signing in the website of "Floorplanner" to start using its established functions.
2. Starting the spatiogram. In the homepage of "Flooplanner", the user accesses the "Projects" option, and then selects the option "Create new project".
3. Main data of the project: after clicking the "Create new project" option, the user adds those data that characterize the project (name, country, labels...).
4. Room assistant: although the tool offers a total of 3 options (room assistant, uploading floor plan and empty plan) after introducing the data of the project, the plans that were introduced in this case were created from the ideas provided by the assistant.
5. Room shapes: the shape of the spatiogram is selected based on the ideas and structures conceived by the user.
6. Dimensions: the dimensions are introduced, which will take into account the total area, height of the ceiling, Dimension A and Dimension B.
7. Room style: here begins one of the most remarkable aspects of the tool, since a large number of decoration styles are provided.
8. Educational plan: in this step, most of the work of this project is conducted. Through the control panel, the user can access different options, such as "Build", "Information", "Objects", "Finishing", etc.
9. Export image: once the educational plan is complete, the user selects the option that appears at the top right of the screen in orange ("Export Image"). Then, the user decides whether to export the image with a certain quality, i.e., in 2D or 3D, as well as the format of the image.
10. Download file (spatiogram): after exporting the image, it is necessary to go back to the control panel, as is mentioned in step 8, which includes the "Export" option. This section includes all the exports that have been made and the downloaded files.

Lastly, it is important to highlight some of the AI tools that can be used in the scope of education to create and edit images:

Midjourney, Bing, LeiaPix, Dreamstudio, Leap AI, Magician Design, PicWish, Getimg ai, StockimgAI, Removebg, and Florplanner. To create and edit videos: Boomy, Voicemod, Lovo AI, Eleven labs, Songburst AI, Adobe Podcast, and Buzz AI. With Machine Learning (automatic learning), it is possible to analyze a large amount of data and suggest adjustments in the design of classrooms in real time.

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