

# DESIGN FOR CHILDREN: TOWARDS THE DESIGN OF LEARNING ENVIRONMENTS AND OBJECTS FOR CHILDREN


## DESIGN FOR CHILDREN: VERSO LA PROGETTAZIONE DI AMBIENTI DI APPRENDIMENTO E OGGETTI PER BAMBINI

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### ABSTRACT

The paper focuses on the design of environments and objects for children, starting from ONU, Italian ministerial guidelines and from the research paradigms of *Universal Design for Learning* and *Design for Children*. Declining those guidelines into different environments - digital, analogical, indoor, outdoor - the paper emphasises the idea of a design that, to enhance children's emotional, motor and cognitive development and their learning process, should *start from* and *be for* children.

Il paper si sofferma sulla progettazione di ambienti e di oggetti per bambini a partire dalle linee guida ministeriali e dei paradigmi di ricerca *Universal Design for Learning* e *Design for Children*.

Declinando tali teorie nelle varie tipologie di ambienti - digitali e analogici, indoor e outdoor - si enfatizza l'idea di una progettazione che, per favorire lo sviluppo cognitivo, motorio ed emozionale del bambino e il suo processo apprenditivo, deve essere sviluppata *a partire da* e *per* il bambino.

### KEYWORDS

Design, Children, Toys, Analogical Environment, Digital Environment  
Progettazione, Bambini, Gioco, Ambiente Analogico, Ambiente Digitale

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## 1. Introduction<sup>1</sup>

Learning is that cognitive process responsible for the changes generated by experience that enables the individual to acquire new knowledge, strategies and behavioural skills that are essential for the development of the person, involving adaptation to the environment.

It is through the ability to adapt to the environment that the individual finds her own way of functioning, building the personal identity that is the result of her life experiences.

Underlying the learning processes is brain neuroplasticity, i.e. the brain's ability to change its structure in response to experience (Siegel, 2014) allowing it to retain and process new information. In addition to neuroplasticity, other cognitive functions such as attention, memory, perception, emotions and motivation are also directly involved in learning processes, and the role of the body as a mediator for learning processes is crucial. In fact, several studies support the idea that movement influences the neuroplasticity of brain structures, improving cognitive functions, and consequently the quality of learning (De Bruijn, 2019).

The ways in which one learns are not the same in every individual; there are different theories supporting learning, but they all recognise the centrality of the environment as the educational context in which one learns. It is defined as the *third educator* (Malaguzzi, 2010) whereby the structure and organisation of the space is identified as having significant potential to guarantee and/or improve the quality of learning.

The *Learning Environment* represents that physical or virtual space of action in which, through experience and encounter with the other, one goes to stimulate in an educational and formative perspective, the construction of knowledge.

In the light of these considerations, a key role is played by the care of the educational environments, which must be welcoming and stimulating (Steiner, 2010) and whose constitutive elements - such as colours, sounds, lighting, didactic materials - offer the child the possibility of expressing his potential, experimenting and exploring actively, with curiosity and not slavishly, so as to reinforce his skills.

In the educational landscape numerous learning spaces, tools and processes have been developed: In fact, not only we can speak of learning both in analogical indoor and outdoor environments, but for several years now the evolution of digital has paved the way for a digitisation of learning environments that offer the opportunity

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<sup>1</sup> Arianna Cittadini author of Introduction; Elèna Cipollone author of paragraph 2; Claudia Chierichetti author of paragraph 3; Elisabetta Tombolini author of paragraph 4; Aurora Biancalani author of paragraph 5; Luna Lembo author of paragraph 6; Maria Vittoria Battaglia author of Conclusion; Stefania Morsanuto research supervisor.

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to experience increasingly innovative learning processes supported by the use of technology.

With regard to the role that the object takes on as a learning tool, the child manipulates and explores the object full of stimuli and through it discovers his skills, acquires knowledge and learns to attribute meaning to the surrounding world.

The object introduced in a playful context brings positive benefits to the learning processes: Through the play the child structures his personality, consolidates cognitive, emotional and relational skills (Vygotskij, 1966).

In order for objects to have an educational function, from an aesthetic point of view, they must be adapted to the age and abilities of the children using them: soft surface, size suitable for manipulation, etc. (Antonacci, 2019). In addition, it is necessary for educational purposes to understand what the child's interests and needs are so that, by interacting with the object, they can establish confidence in their own abilities and achieve specific goals. For example, if one takes hearing into account, through the creation of an object with sound stimuli, the child can develop the ability to listen and cognitive processes such as attention and auditory memory, and will have positive consequences in affective and motor development.

In light of this, it is important to enhance not only the environment but also the objects within it, that must be realised to assume an educational function and thus guarantee the children the possibility of promoting their personality and exercising cognitive, emotional and social skills, through autonomous, and thus active, exploration and experimentation that involves the use and stimulation of the senses and that adheres to appropriate safety standards.

## **2. Universal Design for Learning (UDL)**

*Universal Design for Learning* (UDL) is an approach that stems from the principles of computer and architectural accessibility. Specifically, the first time the expression «Universal Design» was used was in 1985, when architect Ronald L. Mace defined the design of products and environments useful for all people, but actually indispensable only for someone without the need for adaptations or special aids. This perspective then reached the pedagogical and didactic world, thanks to the American research group CAST (Center for Applied Special Technology), with the aim of making curricula more accessible and meeting the individual variability of students, using flexible methodologies and inclusive materials and evaluation processes (CAST, 2019). It becomes a psycho-pedagogical model of reference, aimed at guiding the educational practice, identifying and limiting the critical issues present in teaching materials and proposing an educational personalization, through an inclusive and flexible approach, with the ultimate goal of providing all students with equal opportunities and learning equity (Sasson et al., 2022; Dalton, 2020).

In fact, the UDL does not see disability as a gap to be filled, but rather as a strength of the system, which therefore must be valued and not limited. This is because in this perspective, disability is not a characteristic of the person, but a condition that takes shape in an unfavourable environment (Dickinson, 2020). Therefore, the fundamental principle of UDL is that there isn't an *average* student, but that each student learns differently, based on different and multiple factors, including physical, emotional, behavioural and cultural. The aim therefore becomes to improve the educational experience of each individual student, structuring a school and lessons that really adapt to the individual. In this perspective, therefore, the teacher/educator becomes on the one hand a de-structor of disciplinary meanings and on the other a co-builder of the student's ability to learn. All this is realised through the application of three well-defined principles. The first principle, entitled *Providing multiple means of involvement* underlines the scientific evidence linked to the close connection between cognitive processes and motivational systems. The neuroscientific literature, in fact, tells us how a motivated student is more interested and learns more easily, also because he understands why he is learning what he is learning (Cipollone, 2021; Botah, 2021). Clearly each individual has different needs and different stimuli that activate him, so it becomes central to diversify the means of involvement. The second principle *Providing multiple means of representation* refers to the different modes of learning that different students have. Each subject has preferences and for each student there are some didactic mediators who are more stimulating than others. In a perspective in which it is not possible to conduct the lesson with the individual, it becomes central to use flexible teaching, which undertakes to vary the source of information, such as textbooks, or video, or audio, or slides, in order to meet the different needs of the class group (Cipollone, 2021; Peluso, Cassese & Cipollone, 2022). The last point refers to the centrality of *Providing multiple means of expression*, highlighting how it is also essential to diversify the verification methods, in order to express what they have learned in the ways most congenial to them, perhaps even incorporating technologies that can facilitate communication and participation (Evmenova, 2018). The application of UDL therefore allows to favor the achievement of students' learning objectives, increasing their level of involvement and making them more aware and confident in this process, which very often turns out to be problematic and demanding (Dalton, 2020; Capp, 2017).

## 2.1 Design for Children

The creation of tools or objects aimed at children is a rather complex issue, which requires and has required extensive attention to the variables to be taken into account, in order to preserve the well-being of the child, but at the same time to

preserve the objectives of the use of the same. Children use a wide range of objects and supports in their activities: they use them to explore, to learn, for support, for play, for interest, etc., also facing the indirect effects of others who use objects that are not designed with the child's needs in mind.

Too often it happens that children are not taken into account when designing objects, and sometimes this also happens when designing for children. Childhood experiences have a great impact on children and this has long-term consequences, including on society and the future. It therefore becomes central to guarantee the needs and rights of children in the design phases. As the UN states, «the best interests of the child are a dynamic concept that require an assessment appropriate to the specific context» (UN GC no. 25). Children have the right to participate in their communities and have influence on topics that matter to them. We should design for children to be creators and contributors, not just consumers. Design decisions actively shape the culture surrounding the product or service and influence the children's life. The Designing for Children's Right (D4CR) has identified what should be the principles for designing objects and supports that are appropriate and designed for children (D4CR, 2023).

Specifically, these guidelines take into consideration 3 focal points in design, that correspond to three macro-areas: *Design for Inclusion, Design for Play and Learning, Design for Safety and Sustainability*, for a total of 10 points that lead us to understand how to design the ideal object, able to respond to the needs and peculiarities of children.

The first point is titled *Gather and respect children's views* and highlights how fundamental it is to take into account the point of view of children when designing objects that they will have to use: it therefore suggests implementing children's input in design and also to get input from experts in children's well-being, need and age specific development, in order to have a 360-degree framing. The second principle, titled *Everyone can Use*, highlights how objects should in no way discriminate against children for different characteristics, including gender, sex, age, ability, language, ethnicity, nationality or socio-economic background. Every game or object created must be designed to be suitable for each child, also bearing in mind that children may not use it for what has been intended. The third and last point of the macro-area of *Design for inclusion* is titled *Use communication children can understand*. This point opens a reflection on a much discussed issue about the methods of communication that are used with children (Cameron-Faulkner, 2018). It is common to think that children are not always able to understand and therefore it is preferred to avoid talking and explaining some information. What literature says, however, and what this principle supports, is that children are able to understand what they are told, if this is done in a language that

they are able to understand and from a point of view that they are able to understand. To simplify this step, you can consider the use of different types of forms of communication, such as pictures, video, text and sound, always keeping in mind the characteristics of the child we are addressing. The fourth principle, that falls within the macro-area of *Design for Play and Learning*, is titled *Allow and Support Exploration*. This point suggests the importance of leaving the child free to explore and experiment. «Let's help them do it themselves», as Maria Montessori said (Isaacs, 2018). We must therefore allow children to explore and make mistakes, helping them to fix them, either by themselves or with an adult. Curiosity must also be encouraged and children must be continually offered new opportunities to acquire new skills. The fifth point, *Encourage Children to Play with Others*, supports the importance of collaboration with peers, because this can contribute to the development of good social and relational skills. To make this possible, it is essential that the educator creates a healthy social environment, not highlighting differences with a discriminatory purpose, but making them resources for the group. The last point of the second macro-area is called *Create a Balanced Environment*. In designing an object or tool it is essential that there is a balance in ways, times and spaces in order to make it healthy and stimulating. With this in mind, it is essential to create a balance between moments of pause and moments of activity and it is important to set limits that regulate the timing and mode of play. The third macro-area is called *Design for Safety and Sustainability*. Point seven (the first of this macro-area) is titled *Keep Children Safe and Protected*. This point explains the centrality of creating objects and tools that are adequate and that do not harm the safety of children. It becomes central, in this perspective, to help the child understand why and how something may not be safe, so as to warn them. Point eight, entitled *Do not Misuse Children's Data*, shows how fundamental it is, in the research phase for the creation of an object and in the design phase, to protect children's data, without in any way monetizing, sharing or selling personal data to other parties. Principle nine is *Help Children Recognise and Understand Commercial Activities* and affirm to label marketing clearly so children cannot confuse it with information and clearly state when actions in your product or service commit children to download content, or commit to exclusive use of your product. Finally, the last point of the guide, *Design for Future*, underlines the importance of reflecting on children's rights and the role they have in the new world and the new future. Children must be made to participate and be informed of the critical issues that our world is experiencing, in order to sensitise them and stimulate reflections on the present and the future. In conclusion, these guidelines have been designed to provide the basis for the design of objects, tools and spaces designed and adequate for children and in order to stimulate reflections on crucial aspects for the realisation of supports aimed at

supporting the adequate stimulation and development of the child. The ultimate goal, when designing environments and objects for children, must be to educate educators to understand children and educate children to understand their world and their part in the world.

### **3. Learning through the body**

«Education must involve body and soul and results from active and vital participation through the intervention of all the organs of the body» (Dewey, 1961: 83).

The learning process, which is complex and articulated, is linked to the analysis of information thanks to the simultaneous stimulation of several senses.

Therefore it is fundamental to recognize the active role acted by the individual who, immersed in a multisensory learning space, feel the activation of all sensory receptors, from those at a distance such as eyes, ears and nose to those that come into direct contact with stimuli such as the skin, membranes and muscles.

These assumptions can find their ground in the theory of *Embodied Cognition*, based on the premise that the brain is strongly linked to the body in cognitive processes, taking an active and direct role in cognition, so the individual learns through it and not only through the activation of neural networks (Ale et al., 2022). Indeed, the concepts stored in long-term memory, which constitute the meanings of objects, events and abstract ideas, are linked to the reiteration of perceptual experiences and their introspection, as much as to bodily actions enacted in the acquisition phase (Kiefer et al., 2023).

From the earliest childhood, the individual is strongly involved in feeling part of the world and experiencing it as a complex system of skills, learning strategies and ways of organising relationships; the body acquires a fundamental role in the cognitive process (Lozada & Carro, 2016).

So the production of dynamic movements in space, experiencing social, family and school changes, produces culture, values and rights.

The special feature of children is precisely that they explore and understand the world by means of the body. Thus, the acquisition of knowledge proceeds in the analysis from the surrounding reality in which spatial cognition is supported by the spontaneous and natural acting out of the child who, actively exploring, continuously enacts mental operations of verification, confirmation or refutation of prior ideas (Oudgenoeg-Paz & Mulder, 2021).

A type of learning that is based on direct experience allows the individual to do a deeper information processing, which is linked to a better quality of cross-skill acquisition. The use of the body as a means allows the subject to know, to recognize, to discover, to deeper, to reflect and to create new patterns; enriching or refuting previous ones.

Pleasant sensory impressions improve our state of mind and increase the body's rhythmic activity (Maggi, 2020), it follows how the learning process is directly related to the way our bodies perceive and process environmental stimulation.

Studies have shown how a learning space that simultaneously activates the senses and, consequently, make the child able to play an active and participatory role in the process of acquiring information, leads to a better quality in acquisition, in comparison with classically educational-didactic methodologies commonly used in which children are placed as receivers of external knowledge (Chierichetti & Tombolini, 2023).

The body is recognized as the function of a didactic mediator, through which the subject comes into contact with a specific dimension of sensoriality and acquires knowledge about the world, elaborating its own and peculiar analysis of it (Piccinno, 2019).

The adoption of an active pedagogy makes the child as the first protagonist, he or she can build his or her own knowledge, the process of experiential learning can be linked to a given context or, at the same time, to generalizable and different living spaces. Indeed, it is precisely through personal participation in the activity that learning is most profound and lasting, finding in the body an ally, a means, a tool, a mediator, a facilitator.

The body has always served as a mediator of knowledge, realising this role through movement, relationship and action. (Maggi,2021).

The body and the movement thus assume an essential relevance in the different plans for the formation of the person (Munafò,2017), it should then assume greater significance in educational-didactic practices applicable since kindergarten where the subject is an agent in the formative process in its entirety.

Body, mind and environment interact inseparably and dynamically, a design based on design research that takes these assumptions into account could therefore be functional and supportive of the natural process of information development and acquisition. Theories of embodied cognition and specific co-design for child-focused educational spaces are becoming increasingly important in *Interaction Design for Children*, showing their potential and benefit (Schaper et al., 2023).

Such design lays its foundation on concepts related to *Design Thinking*, a process of embodied experience, which sees knowledge and meaning in the world as a construction given by experiences directly lived by the body in action (Diethelm, 2019).

Furthermore, it is fundamental to take into account basic concepts in embodied design techniques such as: supporting children to connect to lived experience and bodily sensations in a specific environment or context, considering dynamics that enable children to reflect on their lived experience, considering design thinking as a process embodied in experience, supporting children in translating intangible knowledge based on their bodily experience into visual, tactile, and somato-sensory

outcomes, and understanding the impact of the social and physical environment on children's sensorimotor experiences and bodily actions, to enrich children's sensorimotor experiences through appropriate technological solutions (Schaper et al. , 2023).

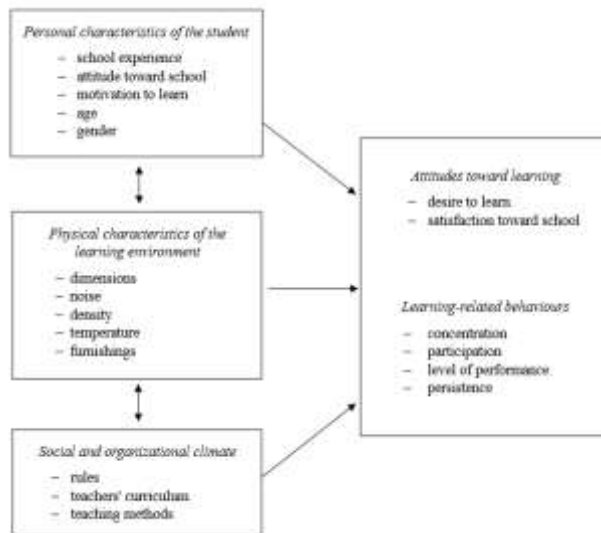
#### **4. Environment as a *third teacher***

The environment assumes the role of co-protagonist within the formative and educational process of the individual who inhabits and uses it, as it transmits messages and communicates information, being functional to the different developmental goals.

Malaguzzi (2010), founder of the *Reggio Emilia Approach*, defines the surrounding environment as a *third teacher* for the child, important for enhancing the quality of learning in the same way as reference adults, such as parents, educators and teachers, and peers. The space is thus conceived as a pedagogical device, as a resource, within which the arrangement of the environments, furnishings and materials mirrors the educational approach adopted; for this reason it must be congruent with the used teaching method and consistent with the educational and didactic activities that will be shaped and take life within it (Galletti & Weyland, 2022).

A worthy predecessor of such a vision was the approach of Maria Montessori, who emphasised the value of the physical environment within pre-schools, in which furniture and materials must be 'child-friendly', i.e. accessible to the little ones, in order to guide the development of autonomy and enhance their process of discovery and learning (Montessori, 1970).

In the light of this, the contribution offered by architectural psychology (Amicone, Petruccelli & Bonaiuto, 2017), which aims to identify the factors and environmental conditions that can favour or hinder the learning process, is fundamental. The effects on the well-being of students and their behaviour are uneven, depending on different lighting, sounds, temperatures, spatial organisation, presence of furniture, wall colours or types of outdoor spaces. This interaction between the environment and the individual in learning contexts is well outlined by Gifford (2014) and his model (figure 1 below), in which it can be seen how the physical characteristics of the school environment, the personal characteristics of the student and the social and organisational climate influence attitudes and behaviours related to learning, including psychophysical, motivational and cognitive aspects of the individual.



**Figure 1.** Schematic summary of the environmental psychology model for places of education and learning (Gifford, 2014)

Every element or material in the environment influences the behaviour and actions performed by the student. A physical environment rich in stimuli gives the child the opportunity to acquire new knowledge, exercise skills, express creativity, stimulate the imagination, formulate hypotheses, make discoveries, experiment, draw conclusions, i.e. improve their skills. The wealth of materials also provides the opportunity to satisfy different interests, allowing children to freely choose from the activities that the environment offers (Močinić & Moscarda, 2019).

Thus, the organisation of spaces and environments constitutes an essential aspect to be taken into account within educational planning, so that it constitutes a factor in the development of perceptual, cognitive and motor skills. The choices of certain furnishings, objects and materials strongly influence the way children feel and experience space. Spatial characteristics can favour or, on the contrary, inhibit attitudes of exploration and discovery, communication and relationship, autonomy and socialisation (Benati, Cristoni & D'Alfonso, 2014).

In order to propose an inclusive learning environment, capable of guaranteeing each child and student participation and well-being, it is fundamental to structure it based on three basic concepts, such as *readability*, *affordance* and *semantotopics*. *Readability* makes it possible to understand with immediacy the purpose of a given space and predict what activities take place within it thanks to the presence of objects and information. *Affordance* implies that spaces and objects implicitly suggest certain actions to the perceiving observer. Finally, *semantotopics* concerns the design and arrangement of spaces in such a way that

they convey an unambiguous reading of the meaning of use (Sandri & Marcarini, 2019).

The language of space is perceived and interpreted by individuals from an early age and, like any language, constitutes an element that contributes to the formation of thought. This reading, which allows us to analyse and distinguish reality, is multisensory and involves both sensory receptors, such as sight, hearing and smell, and immediate receptors for the environment, such as the skin, membranes and muscles.

Children, in fact, possess an innate perceptive competence and sensitivity that is enhanced in this phase of life with respect to others; for these reasons, it is important to take light, colour, olfactory, sound and tactile elements into great consideration when designing, as they play a salient role in the sensorial definition of spaces (Bobbio, 2020).

In light of this, it is pivotal for pedagogy and architecture to dialogue for the effective realisation of educational environments that are functional to the child's development and learning.

In the next sections different types of educational environments are taken into account.

## **5. Analogical Environment. Designing Indoor and Outdoor spaces to enhance children's learning experience.**

The place where the learning process takes place plays a key role in learning; this place must possess specific characteristics so that it is appropriate, welcoming and inclusive. The new pedagogical vision is linked to the architectural aspect by seeking to reinforce the active learning of the child by involving him or her responsibly in the school environment. Indeed, not only it is essential to take into account the safety of children, so that play equipment should be designed and built in accordance with appropriate safety standards for the age and abilities of children (Antonacci, et. al. 2019): it is also pivotal to adopt an educational point of view, so that school architectural structures can help improve learning and teaching. The Ministry of Education has stipulated Guidelines entitled *Designing, building and inhabiting the school* in order to design and propose innovative teaching paths and environments to make students active protagonists of their learning pathways (Alvisi et. al., 2022). One of the main aspects discussed is that schools should be both *inside* and *outside*, in which outdoor spaces, such as courtyards, terraces, roof gardens, become, like the classrooms, primary learning environments. Such environments should enhance effective learning processes that enable the children to come up with new and creative solutions and to exercise divergent thinking instead of the convergent thinking stimulated by traditional didactics. The child must be at the centre of all learning processes: useful in this direction is

acknowledging the importance of leading the child towards intuition and creativity, as proposed in Camillo Bortolato's *Analogical Method*. It is based on the use of images, metaphors and analogies that are considered fundamental for learning new concepts. In fact, *analogical languages* are *image languages* that implement correspondences with reality and support the process of abstraction and understanding of it (Antonietti, 1999). This method finds its roots by approaching other important methods of educational innovation such as the Montessori approach and socio-constructivism. Since analogical languages are linked to the imagination it is essential to design an environment capable of soliciting children's creativity and to indulge each child's desire to learn by respecting their learning stages, skills and comprehension capacity, which differs for each subject. This is why the teacher accommodates the respective individual needs of the children by guiding them through the learning process without imposing specific stages; in fact, the effort to learn is seen as a value and not as an obstacle. The analogical method lets intuition, analogy, the intelligence of error and the desire to discover guide children's learning; in fact, direct action is the basis of experiential learning, allowing the student to learn through experience. As stated by the above mentioned ministerial guidelines, outdoor environments are as crucial as indoor spaces. This means that, when designing tools and spaces for children, Outdoor Education has to be taken into account too. *Outdoor Education* is an educational practice that uses outdoor spaces as places for education and training. The child in the midst of nature has the opportunity to play, have fun and explore the environment in search of new things to discover. This type of pedagogical approach aims to immerse children in sensory experiences that allow them to develop their motor skills, enhance their relational skills and creativity, and educate them to respect the environment. The practice of outdoor education is essential for children to become autonomous and responsible. Therefore, it can be asserted that being outdoors educates the body, mind and social sense, contributing to increased knowledge and respect for the natural environment (Crudeli, et. all., 2012). The kindergarten is the first educational setting, outside the family environment, in which children spend most of their time during the day; therefore, it is necessary to offer them the opportunity to play and learn outdoors. The most commonly used outdoor games in education can include a wide range of activities, such as:

- Climbing games and slides: these allow children to develop agility and strength in their arm, leg and trunk muscles and balance as they climb and slide along structures.
- Swings and seesaws: excellent for developing coordination and balance.

- Sand arenas and water games: promote creativity and sensory development by allowing children to explore by manipulating materials such as sand and water.
- Cycle tracks and tricycles: allow motor skills to be developed while improving balance.

These activities allow the child to enhance their physical, cognitive and social development through interactive and fun experiences during which they learn to work in a group through interaction with other children, learning to share and communicate effectively. The development of these social skills is essential for academic success and daily life activities (Montessori, 1918). *Outdoor Education* is an educational model to be considered integrative and complementary to the traditional learning and teaching method; the innovation is to offer children and teachers the opportunity to learn based on observations and experiences in real situations. Playing in natural environments plays an important role in the development of children's well-being and offers them the opportunity to explore, learn and socialise in the open air.

## **6. Digital environment**

Digital learning environments are the result of the digital innovation we are witnessing, which required changes in the didactic, educational and pedagogical landscape whereby conventional learning environments become digital by exploiting the potential of technology. The greatest functionality of digital learning environments is found in the possibility of personalisation of learning, respecting the uniqueness and individuality of each student. A digital environment is created with the support of digital tools and devices to facilitate learning processes by making them customisable and synchronous with the cultural reality of today's digital native learners (Shonfeld, 2021).

### **6.1 Digital environment, Augmented Reality and specific tools**

The most deeply rooted learning theories state that the acquisition and internalisation of content is advantaged and facilitated to the extent that such content is processed through teaching methods aligned with the learner's cultural reality (Duijzer, 2017). Starting from the aforementioned theoretical framework, we would like to draw attention to the possible learning support tools characterised by an ease of application that makes them easy protagonists in the process of building digital environments. Recent research in the university sphere (Lembo et al, 2023; Cipollone et al, 2023) has in fact shown how the use of augmented reality conveyed through qr-codes scannable by smartphones has enabled students to improve their learning processes and consequently their teaching performance.

This is because students were given the opportunity to interact with learning content that had previously been two-dimensional, now three-dimensional and superimposed on the subject's physical reality. This resulted in an *Augmented Learning* experience in which students interacted with the virtual object by manipulating it. The result was an improved performance generated by an implementation of the learning processes. Digitising learning environments also allows for a further advantage: recruiting data from the analysis of which a customisation of teaching methods and strategies is derived. In fact, the design of acoustic and visual sensors to be applied to the teaching environment makes it possible to monitor the persistence of acoustic and visual comfort for as long as the students experience the classrooms. Already from an ex-ante design, it is necessary to move towards interventions aimed at the aforementioned acoustic comfort, which includes: the reduction of external noise, a low level of internal noise, a good degree of acoustic insulation, the control of noise from internal sources and optimal reverberation (Garai, 2017). Compliance with the aforementioned conditions is aimed at achieving a more optimal verbal communication and understanding between pupils and teachers, a condition that has always been characterised as indispensable in educational contexts (Garai, 2017). The acoustic reference parameters for the various requirements and the relative optimum values can be found in legislative documents and in the technical standards of the sector, both national and international (UNI EN ISO, 9921). Equipping learning environments with appropriate technological equipment, such as PCs, tablets, etc., also makes it possible to foster the social dimension of online learning: from this perspective, educational resources take on the characteristic of a broad spectrum to which one has access anywhere and at any time. In a learning digital environment and e-learning context, video lessons, interactive simulations and virtual laboratories fit in, a set of didactic experiences through which students can experiment newer and more innovative learning processes (Penna, 2011).

## **6.2 Children design in Digital environment**

The design of products for children must respond to the ability to hold the attention of a rapidly developing child. Gibson introduced the term *affordance* as a property of objects that conveys information about how people can interact with them: it refers to the relationship between a physical object and a person or agent. The presence of *affordance* is thus determined by the quality of the object and the agent's abilities and explains how children interact with objects. Since the *affordance* is perceived by the user, it is based on previous experiences. For example, a child who has never seen a ball will not necessarily think that it can be thrown (Gibson, 1977). The contemporary landscape of children's play can include new forms of toys, called smart toys, which include both tangible objects and electronic components

that facilitate a two-way interaction between the child and the smart toy to perform tasks with a purpose (Cagiltay, 2014). Interaction in digitally enhanced physical spaces has two key components: increasing children's awareness of their activities and providing richer experiences by combining physical and virtual reality. In modern play design, interaction is facilitated by electronic sensors within toys so that children can build richer interactions, either directly or computer-mediated. The design of these toys must take into account specific components: challenge, curiosity, control and imagination. Smart toys can be used by children to acquire both behavioural and cognitive skills. Furthermore, these technologies can be regarded as cognitive tools, helping children to construct their own learning experiences (Cagiltay, 2014). Scientific research has considered three concepts for developing an educational toy: randomness, empathy and play value (Gielen, 2010).

### **6.3 Digital environment for children**

With this in mind, we would like to draw attention to recent research that has evaluated the benefits of digital environments in an early childhood context. Research over the last decade has evaluated the latest generation of media within an integrated perspective that takes pedagogy into account in terms of interactive learning methodologies such as 'learning by doing'. The results show how new technologies bring benefits to learning processes due to their interaction and multisensory potential (Celentano, 2014). Specifically, an educational digital game was developed, characterised on the one hand by a multiplicity and variety of content stimuli presented, and on the other, by a high degree of interactivity and collaboration. It follows, therefore, that experiencing meaningful learning processes through an integrated approach of reality and virtuality in innovative learning settings, such as virtual and/or immersive classrooms, provides a development possibility for e-learning. These methods respond to the complexity of the individual already in early childhood, a complexity for which it is essential to think of learning devices that are also complex, which see reality and virtuality as entities that can no longer be separated but rather, integrated, to move towards a higher degree of learning (Celentano, 2014). More recent research has focused on learning processes that can benefit from the support of digital and multisensory components in learning environments. Specifically, this experiment compared traditional storytelling, proposed to a control group, with multisensory digital storytelling, proposed to the experimental group. The sample consisted of children aged between 3 and 4 years. This study represents the continuation of a previous research conducted on 5-year-old children. The aim was to investigate, with the

EMOJ digital software, the emotions aroused in the children by the oral reenactment of the story and to assess, through a recording protocol, the level of information acquisition in both groups. The results showed that the children who participated in the digital multisensory storytelling showed a higher ability to recall the salient points of the presented story orally, remembering more details, than the children who received the conventional storytelling. Furthermore, it was investigated whether these results were influenced by the gender variable and it emerged that males and females achieved similar results in both methodologies. The second objective of the research was to ascertain whether the children were emotionally activated in the retelling phase and, if so, to assess the type of emotion predominantly felt. In the control group, 62% neutrality was observed, corresponding to an emotional state intensity of 0 and a totally neutral facial expression. Where, on the other hand, emotional activation was recorded, the main emotion detected was joy. In the experimental group, a higher level of emotional activation was recorded. The predominantly experienced emotion was, again, joy. A good relationship therefore emerged between the level of information acquisition and the positive emotions experienced in the oral recall phase. In conclusion, it could be deduced that digital multisensory storytelling positively influences the child's ability to re-enact the story and from this follows a higher emotional activation in the retelling phase, demonstrating a close relationship between the storytelling methodology and information acquisition (Chierichetti et al, 2023; Tombolini et al, 2023). In light of the above, digital learning environments represent a new frontier in the educational landscape, as they offer learning opportunities within an increasingly digital and globalised world. However, it is important to emphasise that the functionality and effectiveness of such environments is only real to the extent that they are seen to support and not replace the presence and contribution of the human mind.

## **Conclusion**

The path followed so far has emphasised three key components of the individual's development and learning process, namely the body, movement and the environment - and the objects that compose it - inextricably linked to each other. In this conceptual frame knowledge is understood not as a static and passive registration of symbols, but rather an interactive and iterative process of exchange, manipulation and continuous re-elaboration in which the perceiver does not obtain the object as something given, but builds dynamically what he knows about the world, about himself and about others - also based on the environment in which this exchange takes place.

In this perspective the body is understood as a multifaceted translation pole, which connects the external and the internal worlds, the subject and the object: The reality experienced, interpreted, known and shared is, therefore, the product of mediative processes between the subject and environment whose medium is corporeity and its exploratory movement.

The individual discovers reality precisely thanks to the constant interaction with the physical environment, moving and acting within it: each object becomes a perceived object since movement allows it to be experienced and included within an interpretative system (Lo Presti, 2016; Piaget, 1937).

The individual, in fact, does not perceive the world as an external and passive observer who only stores data coming from the external world, but rather by actively and dynamically experiencing perception intended as continuous exploration (Varela, Rosch and Thompson, 1993; Gibson, 1979). Neurological data corroborate the hypothesis of a practical perception aimed at action and interaction with the surrounding world: in the anterior part of the intraparietal sulcus, which divides the parietal lobule into two parts (connected to the visuomotor coordination and which is therefore activated in the presence of graspable objects) there are three types of neurons: visual, visuomotor and motor. This shows that while observing the surrounding world the anterior area of the intraparietal sulcus automatically programs the action that leads to grasping an object, regardless of whether the individual actually wants to grasp it. From this, it can easily be deduced that the motor system itself is equipped with multisensory properties. Movement, touch, vision, hearing and smell are implicated with each other every time one looks at the surrounding world, just as proprioception is also implicated (Caruana Borghi 2016).

In light of what has been hitherto outlined, it is appropriate to recognise the importance of designing learning environments that give centrality to the bodily element and leave the child the possibility of moving and exploring freely. Environments whose composing objects are designed for the same purpose, i.e. with the aim of being manipulated by the child, so as to ensure the opportunity for him to live stimulating and interactive experiences.

Universal Design for Learning and specifically Design for Children are the result of the recognition of the centrality of these elements in the development and learning process of the child, who must be acknowledged as a participant and protagonist of what concerns him, that is, a creator and active contributor of the process of building such objects and learning environments too.

The child should be let free to explore and interact with objects that stimulate him sensorially, in order to facilitate cognitive, motor and emotional development.

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