Kidbeats

DESIGN FOR BOYS AND GIRLS

Scientific paper and prototype testing

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DESIGN FOR BOYS AND GIRLS: TOWARDS THE DESIGN OF ENVIRONMENTS AND OBJECTS FOR LEARNING

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1. Introduction

Learning is the cognitive process responsible for the changes generated by experience that allow individuals to acquire new knowledge, strategies and behavioural skills essential for personal development and which involve adaptation to the environment.

In fact, it is through the ability to adapt to the environment that individuals find their own way of functioning, thus building the personal identity that is the result of their experiences.

At the root of learning processes is brain neuroplasticity, i.e. the brain's ability to modify 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 of learning processes is fundamental.

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).

Learning styles are not the same for every individual; there are different theories supporting learning, but all recognise the centrality of the environment as an educational context in which learning takes place.

In these theories, the environment is defined as the *third educator* (Malaguzzi, 2010), whereby the structure and organisation of space are identified as having significant potential for ensuring and/or improving the quality of learning.

The learning environment represents the physical or virtual space of action in which, through experience and interaction with others, the construction of knowledge is stimulated from an educational and training perspective.

In light of these considerations, the care taken in educational environments plays a fundamental role. These environments must be welcoming and stimulating (Steiner,

2010) and whose constituent elements – such as colours, sounds, lights and teaching materials – offer children the opportunity to express their potential, experimenting and exploring actively, with curiosity, so as to strengthen their skills.
Numerous learning spaces, tools and processes have been developed in the educational landscape. In fact, not only can we talk about learning in both analogue indoor and outdoor environments, but for several years now, the evolution of digital technology has paved the way for the digitisation of learning environments, offering the possibility of experimenting with increasingly innovative learning processes supported by the use of technology.

As regards the role that the object assumes as a learning tool, the child manipulates and explores the object, which is full of stimuli, and through it discovers his or her abilities, acquires knowledge and learns to attribute meaning to the surrounding world. Objects introduced into a playful context have positive benefits for learning processes: through play, children structure their personalities and consolidate their cognitive, emotional and relational skills (Vygotsky, 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 who use them: soft surface, suitable size for handling, etc. Furthermore, for educational purposes, it is necessary to understand the interests and needs of the child so that, by interacting with the object, they can gain confidence in their abilities and achieve specific goals.
For example, if we consider hearing, by creating an object with sound stimuli, children can develop listening skills and cognitive processes such as attention and auditory memory, with positive consequences for their emotional and motor development.

In light of this, it is important to value not only the environment but also the objects within it, which must be designed to have an educational function and thus ensure that children have the opportunity to develop their personality and exercise cognitive, emotional and social skills through independent and therefore active exploration and experimentation, involving

the use and stimulation of the senses and complies with 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. In particular, the term 'Universal Design' was first used in 1985, when architect Ronald L. Mace defined the design of products and environments that are useful for all people, but in fact indispensable only for those who do not need special adaptations or aids. This perspective then reached the world of education and teaching, thanks to the American research group CAST (Center for Applied Special Technology), with the aim of making curricula more accessible and catering to the individual variability of students, using flexible methodologies and inclusive assessment materials and processes (CAST, 2019). It has become a psycho-pedagogical reference model, aimed at guiding educational practice, identifying and limiting critical issues in teaching materials and proposing educational personalisation through an inclusive and flexible approach, with the ultimate goal of providing all students with equal opportunities and equity in learning (Sasson et al., 2022; Dalton, 2020).

In fact, UDL does not see disability as a gap to be filled, but rather as a strength of the system, which must therefore be valued and not limited. From 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 is no such thing as an *average* student, but that each student learns differently, based on multiple and diverse factors, including physical, emotional, behavioural, cultural, and others. The goal then becomes to improve the educational experience of each individual student by structuring a school and lessons that are truly tailored to the individual. In this perspective, therefore, the teacher/educator becomes, on the one hand, a de-constructor of disciplinary meanings and, on the other, a co-constructor of the student's learning capacity. All this is achieved through the application of three well-defined principles. The first principle, entitled *Providing multiple means*

engagement, emphasises the scientific evidence linking cognitive processes and motivational systems. Neuroscientific literature tells us that motivated students are more interested and learn more easily, partly because they understand why they are learning what they are learning (Cipollone, 2021; Botah, 2021). Clearly, each individual has different needs and different stimuli that activate them, so it becomes essential to diversify the means of engagement. The second principle, *which involves multiple means of representation*, refers to the different learning styles of different students. Each individual has preferences, and for each student there are teaching mediators that are more stimulating than others. In a situation where it is not possible to teach individually, it becomes essential to use flexible teaching methods that vary the sources of information, such as textbooks, videos, audio or slides, in order to respond to the different needs of the class (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 assessment methods, so that students can express what they have learned in the ways that suit them best, perhaps even incorporating technologies that can facilitate communication and participation (Evmenova, 2018). The application of UDL therefore helps students achieve their learning objectives, increasing their level of engagement and making them more aware and confident in this process, which often proves problematic and challenging (Dalton, 2020; Capp, 2017).

3. Design for children

The creation of tools or objects intended for children is a rather complex issue, which requires and has required considerable attention to the variables to be taken into account in order to preserve the well-being of the child, while at the same time preserving the objectives of their use. Children use a wide range of objects and media in their activities: they use them to explore, to learn, for support, to play, out of interest, etc. All too often, children are not taken into account when objects are designed, and sometimes this even happens when

Design for children. Childhood experiences have a major impact on children, with long-term consequences for society and the future. It is therefore essential to ensure that children's needs and rights are taken into account at the design stage. As the United Nations states, 'the best interests of the child is a dynamic concept that requires appropriate assessment in a particular context' (UN GC No. 25). Children have the right to participate in their communities and to influence issues that affect them. We should design so that children are creators and contributors, not just consumers. Design decisions actively shape the culture surrounding the product or service and influence children's lives. Designing for Children's Rights (D4CR) has identified principles for designing objects and media that are appropriate and designed for children (D4CR, 2023). Specifically, these guidelines take into account three focal points in design, which correspond to three macro areas: *Design for Inclusion, Design for Play and Learning, and Design for Safety and Sustainability,* for a total of ten points that help us understand how to design the ideal object, capable of responding to the needs and characteristics of children. The first point is entitled *'Gather and respect children's perspectives' and* emphasises how essential it is to take children's perspectives into account when designing objects they will use. It therefore suggests incorporating children's input into the design process and also seeking input from experts in children's well-being, needs and age-specific development in order to gain a 360-degree view. The second principle, entitled *Everyone can use,* emphasises that objects must not discriminate against children in any way on the basis of characteristics such as sex, gender, age, ability, language, ethnicity, nationality or socio-economic background. Every game or object created must be designed to be suitable for every child, bearing in mind that children may not use it for its intended purpose. The third and final point of the macro area of *Design for Inclusion* is entitled *Use communication that children can understand.* This point opens up a reflection on a issue much discussed regarding the methods of

communication used with children (Cameron-Faulkner, 2018). It is common to think that children are not always able to understand and that it is therefore preferable to avoid talking and explaining certain information. What the literature says, however, and what this principle supports, is that children are able to understand what is said to them, if it is done in a language that

able to understand and from a point of view that they are able to comprehend. To simplify this step, we can consider using different types of communication, such as images, videos, texts and sounds, always keeping in mind the characteristics of the child we are addressing. The fourth principle, which falls within the macro area of *Design for play and learning*, is entitled *Allow and support exploration*. This point suggests the importance of allowing children to explore and experiment freely. 'Let them do it themselves', as Maria Montessori said (Isaacs, 2018). We must therefore allow children to explore and make mistakes, helping them to correct them, either on their own or with an adult. We must also encourage curiosity and continually offer children new opportunities to acquire new skills. The fifth point, *Encourage children to play with others,* emphasises the importance of collaboration with peers, as this can contribute to the development of good social and interpersonal skills. For this to be possible, it is essential that educators create a healthy social environment, not highlighting differences with the aim of discriminating, but rather turning them into resources for the group. The last point of the second macro area is called *Create a balanced environment.* When designing an object or tool, it is essential that there is a balance in the methods, timing and spaces to make it healthy and stimulating. With this in mind, it is essential to create a balance between moments of rest and moments of activity, and it is important to set limits that regulate the timing and methods of play. The third macro area is called *Designing for safety and sustainability.* Point seven (the first in this macro area) is entitled *Keeping children safe and secure.* This point explains the central importance of creating appropriate objects and tools that do not compromise children's safety. From this perspective, it becomes essential to help children understand why and

as something that may not be safe, so as to warn them. Point eight, entitled *Do not misuse children's data*, highlights how essential it is, during the research phase for the creation of an object and during the design phase, to protect children's data, without in any way monetising, sharing or selling personal data to other parties. The ninth principle is *Help children recognise and understand commercial activities and* states that marketing should be clearly labelled so that children cannot confuse it with information, and that it should be clearly indicated when your product or service requires children to download content or commit to the exclusive use of your product. Finally, the last point of the guide, *Design for Future,* emphasises the importance of reflecting on children's rights and the role they play in the new world and the new future. Children must be involved and informed about the critical issues facing our world in order to raise their awareness and stimulate reflection on the present and the future. In conclusion, these guidelines are intended to provide a basis for the design of objects, tools and spaces that are designed and suitable for children and to stimulate reflection on crucial aspects for the creation of media aimed at supporting the adequate stimulation and development of children. The ultimate goal when designing environments and objects for children must be to educate educators to understand children and to educate children to understand their world and their role in it.

4. Learning through the body

"Education must involve both body and soul and result from an active and vital participation of all the organs of the body" (Dewey, 1961: 83). The complex and multifaceted learning process is linked to the analysis of information through the simultaneous stimulation of multiple senses. For this reason, it is essential to recognise the active role played by the individual who, immersed in a multisensory learning space, feels the activation of all sensory receptors, from those at a distance such as the eyes, ears and nose to those that come into direct contact with stimuli such as the skin, membranes and muscles. These hypotheses can

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

From early childhood, individuals are 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).

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

The unique thing about children is that they explore and understand the world through their bodies. Thus, the acquisition of knowledge proceeds through the analysis of the surrounding reality, in which spatial cognition is supported by the spontaneous and natural acting out of the child who, through active exploration, continuously carries out mental operations of verification, confirmation or refutation of previous ideas (Oudgenoeg-Paz & Mulder, 2021). This type of learning, based on direct experience, allows individuals to process information more deeply, which is linked to a better quality of cross-curricular skills acquisition. The use of the body as a means allows individuals to know, recognise, discover, explore, reflect and create new patterns, enriching or refuting previous ones. Pleasant sensory impressions improve our mood and increase the body's rhythmic activity (Maggi, 2020), so it follows that the learning process is directly linked to how our body perceives and processes environmental stimuli. Some studies have shown that a learning space that simultaneously activates the senses and, as a result, enables children to play an active and participatory role in the process of acquiring

information leads to better quality acquisition compared to traditional educational methods, in which children are seen as recipients of external knowledge (Chierichetti & Tombolini, 2023). The body is recognised as a teaching mediator, through which the subject comes into contact with a specific dimension of sensory perception and acquires knowledge of the world, developing their own unique analysis of it (Piccinno, 2019). The adoption of active pedagogy makes the child the main protagonist. The experiential learning process can be linked to a specific context or, at the same time, to generalisable and diverse living spaces. In fact, 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 and a facilitator. The body has always been a mediator of knowledge, fulfilling this role through movement, relationship and action. (Maggi, 2021). The body and movement therefore take on essential importance in the various stages of a person's education (Munafò, 2017) and should therefore take on greater significance in educational practices applicable from nursery school onwards, where the individual is the agent of the educational process in its entirety. Body, mind and environment interact in an inseparable and dynamic way; a project based on design research that takes these assumptions into account could therefore be functional and supportive of the natural process of development and information acquisition. Theories of embodied cognition and child-specific co-design Focused educational spaces are becoming increasingly important *in Interaction Design for Children,* demonstrating their potential and benefits (Schaper et al., 2023). Such design is based on concepts related to *Design Thinking,* an embodied experience process that sees knowledge and meaning of the world as a construction given by experiences directly lived by the body in action (Diethelm, 2019). Furthermore, it is essential to take into account the basic concepts of embodied design techniques, such as: supporting children in connecting to lived experience and bodily sensations in a specific environment or context, considering the dynamics that en r dynamics that allow children to reflect on

their lived experience, consider design thinking as a process embodied in experience, support children in translating intangible knowledge based on their bodily experience into visual, tactile and somatosensory results, and understand the impact of the social and physical environment on children's sensorimotor experiences and bodily actions, in order to enrich their knowledge base. children, to enrich their sensorimotor experiences sensory of children through appropriate technological solutions (Schaper et al., 2023).

5. The environment as a *third teacher*

The environment plays a co-star role in the formative and educational process of the individuals who inhabit and use it, as it transmits messages and communicates information, serving various developmental objectives. Malaguzzi (2010), founder of *the Reggio Emilia Approach,* defines the surrounding environment as a *third teacher* for children, important for improving the quality of learning alongside adult role models, such as parents, educators and teachers, and peers. Space is therefore conceived as a pedagogical device, as a resource, within which the layout of the rooms, furnishings and materials reflects the educational approach adopted; for this reason, it must be consistent with the teaching method used and coherent with the educational and teaching activities that will take shape and life within it (Galletti & Weyland, 2022). A worthy predecessor of this vision was the approach of Maria Montessori, who emphasised the value of the physical environment in nursery schools, where furnishings and materials must be 'child-friendly', i.e. accessible to young children, in order to guide the development of autonomy and enhance their process of discovery and learning (Montessori, 1970).

In light of this, the contribution offered by architectural psychology (Amicone, Petruccelli & Bonaiuto, 2017) is fundamental, as it aims to identify the environmental factors and conditions that can facilitate or hinder the learning process. The effects on students' well-being and behaviour are uneven, depending on different lights, sounds, temperatures,

spatial organisation, the presence of furniture, wall colours or the 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), which shows 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 the psychophysical, motivational and cognitive aspects of the individual.

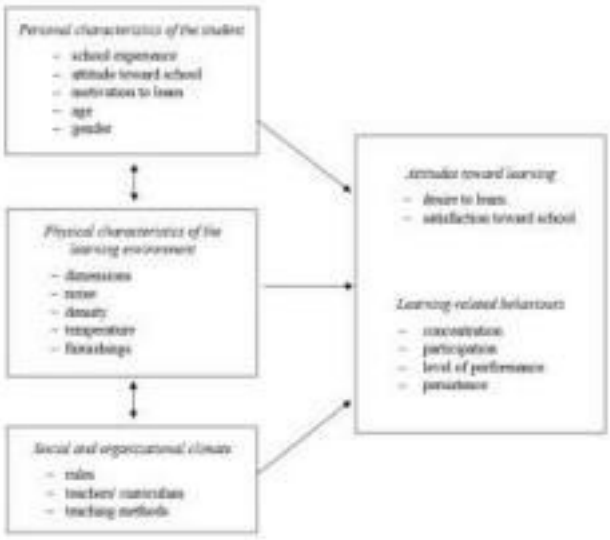

Figure 1. Schematic summary of the environmental psychology model for places of education and learning (Gifford, 2014)

Every element or material present in the environment influences the behaviour and actions of the student. A physically stimulating environment offers children the opportunity to acquire new knowledge, practise skills, express creativity, stimulate imagination, formulate hypotheses, make discoveries, experiment, draw conclusions, i.e. improve their abilities. The wealth of materials also offers the opportunity to satisfy different interests, allowing children to choose freely between the activities offered by the school.

The organisation of spaces and environments is therefore an essential aspect to be taken into account in the design of

educational, as a factor in the development of perceptual, cognitive and motor skills. The choice of certain furnishings, objects and materials strongly influences the way children perceive and experience space. Spatial characteristics can encourage or, conversely, inhibit attitudes of exploration and discovery, communication and interaction, autonomy and socialisation (Benati, Cristoni & D'Alfonso, 2014). In order to provide an inclusive learning environment that guarantees the participation and well-being of every child and student, it is essential to structure it on the basis of three fundamental concepts: *legibility, affordance and semantotopy*. *Legibility* allows the purpose of a given space to be understood immediately and the activities that take place within it to be predicted thanks to the presence of objects and information. *Affordance* implies that spaces and objects implicitly suggest certain actions to the observer who perceives them. Finally, *semantotopics* concerns the design and layout of spaces in such a way that they convey a unique reading of the meaning of their use (Sandri & Marcarini, 2019).

The language of space is perceived and interpreted by individuals from an early age and, like any language, is an element that contributes to the formation of thought. This interpretation, which allows us to analyse and distinguish reality, is multisensory and involves both sensory receptors, such as sight, hearing and smell, and immediate receptors in the environment, such as the skin, membranes and muscles. Children, in fact, possess an innate perceptive competence and sensitivity that is enhanced at this stage of life compared to others; for these reasons, it is important to take into account lighting, colour, smell, sound and touch elements, which play a prominent role in the sensory definition of spaces (Bobbio, 2020).

In light of this, it is essential that pedagogy and architecture work together to create educational environments that are functional for children's development and learning. The following sections consider different types of educational environments.

6. Analog environment. Designing indoor and outdoor spaces to improve children's learning experience.

The place where the learning process takes place plays a key role in learning; this place must have specific characteristics so that it is appropriate, welcoming and inclusive. The new pedagogical vision is linked to the architectural aspect, seeking to strengthen the child's active learning by involving them responsibly in the school environment. In fact, it is not only essential to take into account the safety of children, for which play equipment should be designed and built with child safety, for which play equipment must be designed and built according to safety standards appropriate to the age and abilities of children (Antonacci, et. al. 2019): it is also essential to adopt an educational perspective, so that school architectural structures can contribute to improving learning and teaching. The Ministry of Education has drawn up guidelines entitled *Designing, building and living in schools* to design and propose innovative educational pathways and environments to make students active protagonists. innovative environments to make students active protagonists of their learning paths (Alvisi et al., 2022). One of the main aspects discussed is that schools must be both *internal* and *external*, where outdoor spaces, such as courtyards, terraces and hanging gardens, become primary learning environments, just like classrooms. These environments These environments should promote effective learning processes that allow children to find new and creative solutions and to exercise divergent thinking instead of the convergent thinking stimulated by traditional teaching. The child must be at the centre of all learning processes: in this regard, it is useful to recognise the importance of guiding the child towards intuition and creativity, as proposed by Camillo Bortolato's *Analogical Method.* It is based on the use of images, metaphors and analogies, which are considered fundamental for learning new concepts. *Analogical languages* are, in fact, *languages of images* that establish correspondences with reality and support the process of abstraction and understanding of reality itself.

(Antonietti, 1999). This method has its roots in other important educational innovation methods such as the Montessori approach and socioconstructivism. Since analogical languages are linked to imagination, it is essential to design an environment that stimulates children's creativity and encourages each child's desire to learn, respecting their learning stages, skills and understanding, which differ for each subject. For this reason, teachers welcome the individual needs of children, 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 analogue method leaves it up t s to let 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 pupils to learn through experience. As stated in the above-mentioned ministerial guidelines, outdoor environments are as important as indoor spaces. This means that outdoor education must be taken into account when designing tools and spaces for children. *Outdoor education* is an educational practice that uses outdoor spaces as places of education and training. Children surrounded by nature have the opportunity to play, have fun and explore the environment in search of new things to discover. This type of educational ' ' aims to immerse children in sensory experiences that allow them to develop motor skills, improve interpersonal skills and creativity, and educate them to respect the environment. The practice of outdoor education is essential for children to become independent and responsible. It can therefore be said that being outdoors educates the body, mind and social awareness, helping to increase knowledge and respect for the natural environment (Crudeli, et. al., 2012). Nursery school is the first educational setting, outside the family environment, where 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 common outdoor games used in an educational setting may include

a wide range of activities, such as:

- Climbing frames and slides: these allow children to develop agility and strength in their arms, legs and core muscles, as well as balance, as they climb and slide down the structures.
- Swings and seesaws: excellent for developing coordination and balance.
- Sandpits and water play: promote creativity and sensory development by allowing children to explore by manipulating materials such as sand and water.
- Bike paths and tricycles: help develop motor skills and improve balance.

These activities allow children to improve their physical, cognitive and social development through interactive and fun experiences, during which they learn to work in groups thanks to interaction with other children, learning to share and communicate effectively. The development of these social skills is essential for success at school and in everyday activities (Montessori, 1918). *Outdoor Education* is an educational model that should be considered integrative and complementary to traditional learning and teaching methods; the innovation lies in offering children and teachers the opportunity to learn through observation and experience in real-life 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.

7. Digital environment

Digital learning environments are the result of the digital innovation we are witnessing, which has required changes in the teaching, educational and pedagogical landscape, where conventional learning environments are becoming digital by exploiting the potential of technology. The greatest functionality of digital learning environments lies in the possibility of personalising learning, respecting the uniqueness and individuality of each student. A digital environment is created with the support of tools and devices digital for facilitating the processes of

learning processes, making them customisable and synchronised with the cultural reality of today's digital native students (Shonfeld, 2021).

1.1 Digital environment, Augmented Reality and specific tools

The most established learning theories say that picking up and internalising content is easier and better when it's taught in ways that match the learner's cultural background (Duijzer, 2017). Starting from the theoretical framework mentioned above, we would like to draw attention to possible learning support tools characterised by ease of application, which makes them easy to use in the process of building digital environments. Recent university research (Lembo et al, 2023; Cipollone et al, 2023) has shown that the use of augmented reality conveyed through QR codes that can be scanned by smartphones has enabled students to improve their learning processes and, consequently, their educational performance.

This is because students were given the opportunity to interact with educational content that was previously two-dimensional, but is now three-dimensional and superimposed on the physical reality of the subject. This resulted in an *enhanced learning* experience in which students interacted with the virtual object by manipulating it. The result was improved performance generated by the implementation of learning processes. The digitisation of learning environments also offers a further advantage: the recruitment of data from which teaching methods and strategies can be personalised. In fact, the design of acoustic and visual sensors to be applied to the teaching environment allows the persistence of acoustic and visual comfort to be monitored throughout the time students spend in the classrooms. Starting from the initial design stage, it is necessary to focus on measures aimed at achieving the aforementioned acoustic comfort, which includes: reducing external noise, ensuring low internal noise levels, good sound insulation, controlling noise from internal sources and optimising reverberation (Garai, 2017). Compliance with these conditions is aimed at achieving

verbal communication and better understanding between students and teachers, which has always been considered essential in educational settings (Garai, 2017). The acoustic reference parameters for the various requirements and the corresponding optimal values can be found in legislative documents and technical standards, both national and international (UNI EN ISO, 9921). Equipping learning environments with appropriate technological equipment, such as PCs, tablets, etc., also promotes the social dimension of online learning: in this perspective, educational resources take on the characteristic of a broad spectrum that can be accessed anywhere and at any time. Video lessons, interactive simulations and virtual laboratories are part of a digital learning environment and e-learning context, a set of educational experiences through which students can experiment with new and more innovative learning processes (Penna, 2011).

8. Design for children in a digital environment

The design of products for children must respond to the ability of a rapidly developing child to retain attention. 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 therefore determined by the quality of the object and the capabilities of the agent, and explains how children interact with objects. Since *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 games may include new forms of toys, called smart toys, which include both tangible objects and electronic components that facilitate 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.

inside toys, so that children can build richer interactions, either directly or through the computer. 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 considered cognitive tools that help children build their own learning experiences (Cagilltay, 2014). Scientific research has considered three concepts for the development of an educational toy: randomness, empathy and play value (Gielen, 2010).

9. Digital environment for children

In this regard, we would like to draw attention to recent research that has evaluated the benefits of digital environments in early childhood. Research conducted over the last decade has evaluated the latest generation of media within an integrated perspective that takes into account pedagogy in terms of interactive learning methodologies such as 'learning by doing'. The results show that new technologies bring benefits to learning processes thanks to their interactivity and multisensory potential (Celentano, 2014). Specifically, a digital educational game has been developed that is characterised, on the one hand, by a multiplicity and variety of content stimuli 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 contexts, such as virtual and/or immersive classrooms, represents a development opportunity for e-learning. These methods respond to the complexity of the individual already in early childhood, a complexity for which it is essential to consider even complex learning devices that see reality and virtuality as entities that are no longer separable but rather integrable, in order 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, offered to a control group, with multisensory digital storytelling, offered to the experimental group. The

The sample consisted of children aged between 3 and 4 years. This study is a continuation of previous research conducted on 5-year-old children. The aim was to use EMOJ to investigate the emotions aroused in children by the oral retelling of the story and to assess, through a recording protocol, the level of information acquisition in both groups. The results showed that children who participated in multisensory digital storytelling demonstrated a greater ability to orally recall the salient points of the story presented, remembering more details than children who received conventional storytelling. In addition, we investigated whether these results were influenced by gender and found that boys and girls performed similarly in both methodologies. The second objective of the research was to verify whether children became emotionally activated during the retelling phase and, if so, to assess the type of emotion predominantly experienced. In the control group, 62% neutrality was observed, corresponding to an emotional state of intensity 0 and a totally neutral facial expression. Where emotional activation was recorded, however, the main emotion detected was joy. A higher level of emotional activation was recorded in the experimental group. Once again, the emotion predominantly felt was joy. A good relationship therefore emerged between the level of information acquisition and the positive emotions felt in the oral recall phase. In conclusion, it can be deduced that multisensory digital storytelling positively influences children's ability to recall stories, resulting in greater emotional activation in the recall 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 in 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 believed 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 individual development and learning: the body, movement and the environment – and the objects that compose it – which are inextricably linked. In this conceptual framework, knowledge is understood not as a static and passive recording of symbols, but rather as an interactive and iterative process of exchange, manipulation and continuous reworking, in which the perceiver does not obtain the object as something given, but dynamically constructs what they know about the world, themselves and others, also based on the environment in which this exchange takes place.

In this perspective, the body is understood as a multifaceted centre of translation, connecting the external and internal worlds, the subject and the object: the reality that is experienced, interpreted, known and r the reality that is experienced, interpreted, known and shared is, therefore, the product of mediative processes between the subject and the environment, the medium of which is corporeality and its exploratory movement. The individual discovers reality precisely through constant interaction with the physical environment, moving and acting within it: every object becomes a perceived object because movement allows it to be experienced and incorporated into an interpretative system (Lo Presti, 2016; Piaget, 1937). The individual, in fact, does not perceive the world as an external and passive observer who merely stores data from the outside world, but rather actively and dynamically experiences perception as continuous exploration (Varela, Rosch and Thompson, 1993; Gibson, 1979). Neurological data support the hypothesis of a practical perception aimed at action and interaction with the surrounding world: in the front part of the intraparietal sulcus, which divides the parietal lobe into two parts (connected to visuomotor coordination and 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 programmes 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

endowed with multisensory properties. Movement, touch, sight, hearing and smell are all involved whenever we observe the world around us, as is proprioception (Caruana Borghi 2016).

In light of the above, it is important to recognise the importance of designing learning environments that focus on the physical element and allow children to move and explore freely. Environments whose objects are designed with the same purpose in mind, i.e. to be manipulated by children, so as to ensure they can enjoy stimulating and interactive experiences. Universal Design for Learning and, specifically, Design for Children stem from the recognition of the centrality of these elements in the development and learning process of children, who must be recognised as participants and protagonists in their own lives, i.e. creators and active contributors to the process of constructing these objects and learning environments. Children must be allowed to explore and interact with objects that stimulate their senses in order to facilitate cognitive, motor and emotional development.

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PROTOTYPE TEST

The "Usability Observation" activity was carried out at Explora, the Children's Museum, on 23 April 2024 with the aim of testing and observing the behaviour of the sample in relation to the use of the "Kidbeats" prototype. This tool allows various sounds to be emitted from coloured sticks, so that the child can independently choose the sound or colour they prefer by inserting the stick into the appropriate space.

The tools used by the research team were designed to investigate the child's behaviour in relation to the proposed activity. In particular, the NEPSY-II, sub-test A1, was designed to investigate the level of visual attention in view of subsequent manipulation with the prototype. This test was administered after obtaining parental consent and was not intended for diagnostic purposes, but only to investigate the attention level of the sample selected by the Museum.

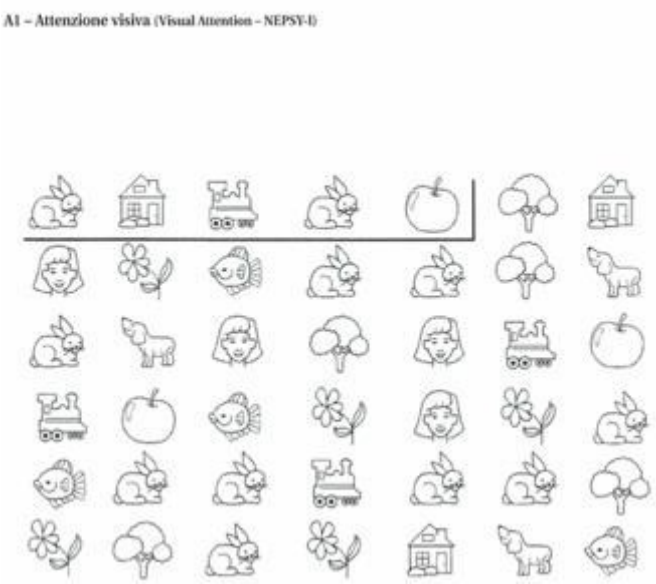

Figure: Example of a subtest in NEPSY-II.

In addition, an observation grid was created to note salient points during interaction with the object (Appendix 1).

In addition, an observation grid was created to note the salient points during interaction with the object (attached to the documentation).

After using a play space, the children's level of attention was assessed, the prototype was explained, and the children moved on to a phase of direct, free interaction with it, during which their behaviour was analysed. The children were then asked to tell their parents about the activity, and the parents completed a questionnaire. Analysis of the attention profile of the sample showed that 50% had an average level.

- Eighty-seven per cent of the children interacted spontaneously with the object, while the others were prompted by the observer to carry out the activity.

The most attractive components were the volume control, the red play button and the colour of the buttons.

- 25% of children preferred the music sounds presented, and 25% paid attention to the 40 Hz sound.
- 100% understood the sound-key relationship, and interaction was continuous in 75% of cases.

of the sample, the remaining part leaves and collects the object. In addition, 100% of the children were found to have a good level of eye-hand coordination and perceptual senses, with none showing difficulties in interacting with the instrument or in the sequences of manipulation and correlation between the stimuli present.

Through direct observation, the children's interest in understanding how the instrument works and identifying the different sounds emerged.

Parents' opinions were also surveyed, revealing that the sample was generally able to explain how to use the instrument, specifically 75% without any difficulty, and 62% showed enthusiasm in recounting their experience.

Seventy-five per cent of parents reported that their children enjoyed the item, saying that they were 'impressed by the sounds', 'really liked the game', 'it was easy to use' and 'it was interesting that the child could decide for themselves which song to listen to', while others reported that they liked the item in part because it was 'too bulky'.

CHI NON LEGGE,
A 70 ANNI
AVRÀ VISSUTO UNA SOLA VITA:
LA PROPRIA!
CHI LEGGE AVRÀ VISSUTO
5000 ANNI...
UMBERTO ECO

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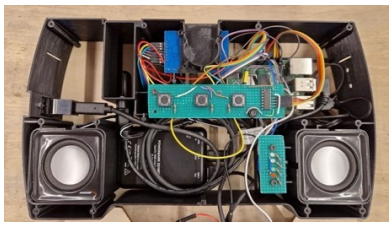
ANNEX 1

	Yes	No	Partially	Notes
Does the child interact spontaneously with the object?				(specify if encouragement is needed)
Does it prefer certain components?				(specify which ones) 
Does it prefer a particular colour?				(specify which sound it is associated with)
Which sound does he/she prefer?				
Has he/she understood the correlation between sound and coloured key?				
Do they demonstrate that they are using their hearing intentionally to listen to sounds?				(active search for sound)

Do they have hand-eye coordination?				(has praxic difficulties/blindfolded...)
Can they grasp and manipulate objects without impairment?				
Can they maintain a steady position?				
Is interaction with the object continuous?				
Does he/she let go of and pick up the object?				(if yes, specify how many times)
Does he/she intentionally use his/her senses to experience stimuli? (actively explores the object)				(hands/mouth/nose...)
Is there any perceived difficulty in interacting with the instrument?				(if yes, specify behaviour)

Is there a perceived difficulty in the sequences of manipulation and correlation between stimuli?				(if so, how?)
Do the coloured parts arouse greater interest?				(if yes, specify the colour)
Is the child able to use the parts of the object synchronously?				
Do the visual symbols on the object allow for greater emphasis?				
Are the sound effects linked to visual or tactile equivalents?				
Is key information provided in the dominant language?				
Are cues and prompts used to direct attention to key features?				