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The Possible Space: Innovative Approaches for Inclusive and Sustainable Education in the Age of On-Life

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Abstract: The aim of this contribution is to reflect on the design of learning environments and innovative methodologies for the creation of inclusive and effective educational spaces. From the provision of environments that can be understood as a space of the human and for the human, referring to the effective dialogue that exists between Embodied Cognition and Architecture, we will subsequently try to outline the inspiring principles of an inclusive and sustainable design also of the physical places of learning, referring in particular to Design For All (D4All) and Universal Learning Design (PUA). Technology is rewriting not only interactions and relationships, but the very places in which they take place: evaluation and validation of learning environments can be effective tools for making these new spaces, possible spaces for learning, care and relationships.

Keywords: Designing Learning Environments; Embodied Cognition; Inclusion; Special Educational Needs.

1. Introduction

The design of learning environments (Limone, P. 2012) has become increasingly important in the educational landscape. In a progressive evolution, from an interpretation concerning a simple spatial and physical arrangement, it has come to a more extended construct that includes psychological, pedagogical and technological aspects. New approaches regarding learning environments, understood as physical and relational spaces at the same time, focus on the importance of the provision of places that can be adapted to different learning styles and that can determine generative drives for inclusion processes (Sharma et al., 2019). The design of school environments must be seen as a dynamic process, constantly evolving, considering the diversity of students and educational needs (Mangiatordi A., 2017). In this sense, theories pertaining to the Embodied Cognitive Science paradigm (Pezzullo et al., 2011; Caruana and Borghi,2013, 2016) define the mind as a corporeal phenomenon, not only pertaining to brain functions (Nöe, 2009). Corporeality is, in fact, the necessary starting point for the development of cognitive processes. Knowledge is, therefore, the result of a constant interaction between brain, body and environment (Mufanò, 2017). For several years, scholars have recognised the need for a non-linear, plural and complex reading that can be representative of the variety and

unpredictability inherent to educational practice and pedagogical reflection on developmental and formative dynamics (Kaneklin & Scaratti, 1998; Demetrio, 1998; Contini, 2012; Canevaro, 2013). The contributions of the various disciplines that deal with the processes occurring in educational and training dynamics has given rise to a form of epistemic pluralism that has the merit of offering a multi-perspective view of such phenomena, avoiding reductionism and determinism and broadening epistemological possibilities in a simplistic direction (Berthoz, 2011; Gratani & Capolla, 2023). According to this plural perspective, cognition increasingly appears to be an embedded, embodied phenomenon, made possible, as mentioned, by the complex interactions between body, mind and environment (Pennisi, 2023). Starting from the construct of affordance and the ecological approach (Gibson, 1979) we can say that conformation, shape, texture, the arrangement of objects in space, perceptual qualities, light and even atmospheric conditions influence our perceptions, our way of thinking and acting. The ecological approach proposed by Gibson (1979) conceives cognition because of the interaction between the individual and the environment, in which the latter provides 'affordances', opportunities for action that the body perceives and interprets (Heft, 1989). The body, immersed in the space of the possible, through its movement, its sense-motor perceptions, its interaction with the world structures experiences and cognitive representations, inexorably uniting the physical plane with the mental plane, the material with the immaterial, the emotional with the perceptive. Neuroscience demonstrates the complexity of processing environmental stimuli (Gallese, 2005), and how such processing is linked to action and emotions. Activations from environmental stimuli spill over into the environment itself as a form of behaviour, in turn becoming part of the environmental system and recursively influencing perception (Gomez Paloma, 2013). In this sense, the body represents not only a biological, political but also a cultural mediator (Malara, 2020) for the learning process, it is a situated device of cognitive action and is, therefore, a subject and not merely an object of cognition; the global functions, i.e. the activities that give rise to categorization, memory and learning, are deeply rooted in perceptual and motor processes (Frauenfelder, Santoianni, 2002). As for the emotional aspects related to the environment and the body, consider how accelerated heartbeat, muscle tension, and cortisol activation are related to automatic responses to exogenous and environmental stimuli. When we think of the body, we are referring to a bridging device between action and cognition, a dynamic entity subject to modifications determined by the incessant exchanges of information in a continuous feedback loop that, through sensoriality, allows us to interpret stimuli essential to movement and spatial orientation, responding accurately and appropriately to both endogenous and exogenous stimuli. By integrating proprioceptive, visuospatial, and sensorimotor stimuli, the active contextualization of one's own bodily device in space is made possible, fostering social connection and both verbal and paraverbal communication, providing essential elements for the construction of learning and memory (Glenberg, 2010) by modelling our emotional and cognitive reactions (Niedenthal, 2007). The body that acts the possible space, or better still, the space of the possible, turns out to be a fundamental element for a theory of cognition that can understand and reflect on the agents and acts that contribute to the humanization processes of life in its educational and formative aspects, in the place that, by definition, implements and directs these processes, that is, the school (Tarozzi and Francesconi, 2013; Sidoti, 2018; Damiani & Gomez Paloma, 2018).

2. Embodied Cognition Design

Spatial characteristics are decisive for the processes of adaptation, accommodation and relating to and in the world. According to Thompson (2007), the nervous system, the body and both physical and cultural environments decisively restructure human development processes, interacting with each other with complex and recursive dynamics, incorporating genetic, cellular, social and cultural factors, giving rise to a co-evolutionary process involving brain, body and environment. For more than a decade, there has been a constructive dialogue between Pedagogy and Architecture (Gomez Paloma, Vanacore, 2020), in an interpretation that sees learning environments as representing a possibility of extension of the human mind (Clark, 2003, 2004, 2005, 2006), understanding their inescapable and fundamental role in the interconnection of cognitive processes. According to Gallese and Gattara, space can elicit immediate emotional reactions (2021). The realization that cognition is embodied and depends on bodily characteristics, our perceptual and motor systems, in a dynamic integration between nervous system, body and environment, should also be acquired by those involved in the design of spaces for learning and education. For Lefebvre (2015), space consists of three dimensions: experienced, perceived and conceived. Physical experience, cognition, and intellect are subject to dynamics of integration, interpolation, and interconnection capable of generating meaningful environments. This assumes a crucial character in the redevelopment and design of buildings intended for human education, in the need to promote an increasingly dense dialogue between corporeal cognition, engineering and architecture. The nature of space is social, intimately linked to cultural and meaning systems representative of anthropological and social patterns. At the basis of space design work always remains the body:

> Whether the action on the project is carried out in an indirect and mediated manner, or whether the collaboration between disciplines appears direct and explicit, the point or plane that unites in architecture the many theoretical, methodological and practical approaches of the many knowledges it makes use of is the experimental one. [...] At the basis of all "tests" and, in general, of all the architect's work, there is a theme that constantly hovers, even when it is not declared and presents itself in the form of measure, perspective cut, colour or volumetric conformation, and it is that of the body." (Fiorillo, 2014, p. 88)

Already Law 107/2015 (the Good School) initiated innovative projects inspired by Embodied Cognition Design (ECD), emphasizing the importance of environmental design in relation to teaching practices. Projects that can create spaces that respond to modern learning needs, integrating empathic and technical dimensions (Black et al., 2012). The process that has invested Italy with the activation of the projects envisaged by the National Recovery and Resilience Plan, in particular "Next Generation Classrooms" and "Next Generation Lab", envisaged by the School 4.0 Plan very clearly orient and address the need for a systemic and integrated approach for the implementation of learning environments suited to the new socio-cultural context:

> The concept of environment is connected to the idea of a 'learning ecosystem', formed by the intersection of places, times, people, learning activities, tools and resources. Therefore, it is not only space and technology that are sufficient to create an innovative environment, but

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training, time organisation and teaching methodologies are fundamental. The responsibility for enabling the space for pedagogy and transforming it into a 'learning environment' is entrusted to the school manager for the organisational aspect and to the teachers for the didactic aspect, but it requires the active involvement of the entire school community to make the transition process towards a more effective training and educational model sustainable. (School Plan 4.0, p.3)

Education, therefore, cannot be isolated from the architectural context, as both influence the learning experience, and both share an essentially pragmatic nature that is structurally linked to the dynamics of movement. According to Gallese and Gattara (2021):

Observing the world is something more complex than simply activating the visual brain. Vision is multimodal; it includes the activation of motor, somatosensory and emotion-related brain circuits. Any intentional relationship we may have with the outside world has an intrinsically pragmatic nature: hence the reason why it always has a motor content. More than fifty years of research have shown that motor neurons also respond to visual, tactile and auditory stimuli. The same motor circuits that control the motor behaviour of individuals also map the spaces around them, the objects at hand in the same space, thus defining and shaping their representational content in motor terms. The space around us is defined by our body's motor potential. The premotor neurons, controlling the movements of the forearm, also respond to tactile stimuli exerted on it, to visual stimuli activated within the peripersonal space of the arm or even to auditory stimuli coming from the same peripersonal space (p.164-165).

In order to become possible, space must be experienced through all the senses, it must be open to the corporeity of the individual and must creatively and actively stimulate both the possible experience (Munari, 1977) and the possibility of experience:

Studying bodily sensations, self-identification and self-localization with respect to the architectural unit or the observer's form and space could be compared with architecture as an extension of the body volume (Pasqualini et al., 2013, p. 9).

The design of school buildings and spaces cannot disregard these dimensions, in adherence to a narrative and re-elaborative perspective of human reality stretched in its learning and socialization processes. If architecture can be read as an extension of the body's volume, if the space that surrounds us can be defined by our body's motor potential, the design of learning environments must express its research towards a spatiality that can be experienced by all in different, flexible and customizable forms, moving in a highly inclusive and complex dimension. A research that can put the corporeal experience at the centre as an emotional experience of well-being (Mallgrave, 2013).

3. Fundamental Principles of Sustainable and Inclusive Design: Design 4 All and Universal Design for Learning

The European Union has adopted several policy documents concerning the implementation of D4All (Design for All), such as the ResAP Resolution (2001) on the introduction of Universal Design principles into the curricula of all professions working in the built environment, the Recommendation (2009) of the Committee of

Ministers to Member States on achieving full participation through Universal Design. Europe opens up the possibility of investing in the development of intelligent and user-friendly environments (Smart Health Age Friendly Environments), in adherence to a holistic approach aimed at optimizing relational and physical environments. In all this, digital support can promote independent living, equity and active participation in society (Dantas et al., 2021a). To achieve these goals, it is necessary to involve citizens, communities and specific sectors such as information and communication technologies (ICT), the construction industry, urban planning and the health and social care sector (Dantas et al., 2021a). The SHAFE approach is in line with the Design for All (D4All) concept. According to the Stockholm Declaration of the European Institute for Design and Disability (EIDD, 2004), D4All has its roots in Scandinavian functionalism and the ergonomic design of the 1960s, as well as the socio-political concept of 'Society for All' promoted by Sweden. D4All is a tool and approach that aims to provide equal opportunities for everyone to participate in all aspects of society:

> To achieve this goal, the built environment, everyday objects, services, culture and information - in short, everything that is designed and made by people to be used by people - must be accessible, convenient to use for all members of society and responsive to evolving human diversity (EIDD, 2004, p. 1)

Accessibility and inclusion are key elements in the design of living environments. Therefore, they are even more valid and applicable to learning environments. Educational environments must ensure that every learner, regardless of their physical or cognitive abilities, could actively participate and learn effectively (Florian & Black-Hawkins, 2011). This approach involves the use of assistive technologies, the creation of physical spaces that are accessible to all, and the adoption of personalized teaching strategies that are shaped according to the student's learning style. Learning environments must be designed to meet the diverse needs of learners, ensuring that barriers to participation and learning are removed. (Florian & Black-Hawkins, 2011). The designed space must be designed to stimulate learners cognitively as well as emotionally: for meaningful learning to occur, to proactively deal with the demands of the world, it is necessary to have accumulated, throughout one's development, sufficient responses to the attunement demands that each individual places on his or her reference adults. Conversely, it is necessary to balance the 'emotional balance' to foster a predisposition to learning and nurture the 'basic trust' necessary to be open to the world and relationships (Battistelli, 2022). Environments, to encourage students' attention, engagement and motivation, must use visual, acoustic and interactive stimuli (Woolfolk, 2016). Creating spaces that promote psychological well-being, as well as stimulating cognitive learning, is essential to foster a meaningful educational experience (Caprino et al., 2022). Each student has a unique way of learning. The environment must therefore be designed to be flexible, adapting to the specific needs of students and enabling personalized learning (Tomlinson, 2014). Spaces that allow for different modes of interaction, study and collaboration are crucial for inclusive education. According to Vygotsky (1978), learning is a social process. Learning environments must therefore facilitate interaction between learners by promoting the design of collaborative spaces, which encourage cooperation, for the development of social and cognitive skills. For an environment to be considered inclusive, it is useful to refer to principles inspired by Universal Design for Learning, which we find

enunciated in the work of Andrea Mangiatordi (2017): a. *Equitable use:* avoiding differentiated designs that only address a particular disability in such a way that it does not only involve a particular category of users but favours the use of the space by all; b. *Flexibility*: guaranteeing users the possibility of having different alternatives for using an object. c. *Perceptibility of information*: information that is on an object or present in the environment must be perceptible through all our senses, for example by using Braille in the case of the visually impaired; d. *Tolerance for error*: it must be considered that in a space or when using an object it is possible to make mistakes, such as pressing an incorrect button that could unintentionally activate a function, or becoming disoriented in a space; e. *Contained physical effort*: Physical effort must be contained on the part of the user, repetitive and excessively tiring actions must be avoided. In this way the objects or space are not accessible but become additional obstacles to the enjoyment of the context; f. *Appropriate size and space for approach and use*: posture must also be taken into account: for example, many people in wheelchairs who have to perform actions while seated or even consider the different hand sizes among different age groups. Therefore, implement a design that is adaptable to all. At the centre of design is ultimately the human being connected to the environment, an environment that takes into account the biopsychosocial sphere referred to by the International Classification of Functioning (2002).

Design for All (Steffan, 2006; Persson et al., 2015; Mosca, 2023) is understood as the ability of design to analyze, understand, modify and then synthesize responses that can go towards modifying the living conditions of all, through a multidisciplinary approach that is inclusive of particular specialties and differences (Ghedin and Mazzocut, 2017). In the educational sphere, D4All can be translated into the taking on of pluralities and the valorisation of diversity. The school model emphasises the aspects of inclusiveness rather than those of selection. The design of the environment does not have a predetermined target group and is not aimed at solving a problem for anyone, but rather at working proactively to eliminate possible barriers before they manifest themselves as such. The aim is to reasonably accommodate (Ferri, 2017; Roversi, 2023) spaces to meet cognitive, physical and communicative needs (Pupo, V. 2023). Furthermore, it can be argued that through this type of design, environments will be adapted for those with disabilities as well as for those without special needs, as the environment will be designed inclusively from the outset without any further adaptations afterwards. The application of Design for All in schools has its roots in CAST - Center for Applied Technology, 2011 - which published guidelines. The aim is to improve school access for all students, which in the same way as Design for all, also in the school context aims to improve the learning experiences of all students and not only those with disabilities. The substantial difference is that in the school context, the ultimate goal is not only the construction of buildings or products that meet the guidelines, but the environmental, ergonomic, physical and structural solutions to foster learning. This is an important distinction between Universal Design for Learning (Savia, 2015) and simple access orientation. This work has been done in collaboration with many valuable pedagogues, neuroscientists, education and technology professionals. Universal Design for Learning (PUA) is a pedagogical approach that aims to overcome the difficulties caused by adherence to rigid curricula in educational processes by helping learners to become experts and autonomous (Mulè, P. 2020). Such rigidly structured curricula unintentionally erect barriers to learning. Students who find themselves in a borderline situation, such as those who are gifted

and highly able or students with disabilities, are particularly vulnerable. Even students considered as 'average' may not have met their educational needs. When curricula are designed to meet the needs of an imaginary 'average' (Magnanini, A., 2021) they do not consider the real variables at play and the different channels used by students to structure their learning paths. The PUA suggests flexibility in objectives, methods, materials and assessments that enable educators to meet different needs. The PUA structure encourages the creation of flexible, highly customizable projects from the outset, with the aim of promoting a meaningful learning pathway for each student (Mulè, P. 2020). The guidelines suggested by the PUA are essentially based on three basic principles:

Principle I: Provide multiple means of representation (the 'what' of learning). Information presented to learners is learned in different ways for each learner. In sensory disabilities (blindness or deafness), as well as with specific learning disorders, or in the presence of language or cultural differences, different ways of approaching content are required (Malaguti et Al., 2023). The acquisition of information can proceed more quickly and effectively through visual or auditory means than through written text. When multiple representations are used, the potential for learning is activated, as learners can make internal connections independently, relating them to already acquired concepts. There is no single optimal mode of representation for all learners; providing differentiated options of representation is crucial.

Principle II: Provide multiple means of action and expression (the 'how' of learning). Each learner has a personal way of approaching a learning process and, subsequently, of expressing what has been learned. Individuals with significant motor disabilities (cerebral palsy), those who have difficulties with strategic and organizational skills (executive function disorders), or those with language difficulties and so on, have very different approaches to learning. Action and expression require strategy, practice and organization: aspects subject to high variability between learners. There is no single means of action or expression that can be optimal for all learners; different options for action and expression must be provided.

Principle III: Provide multiple means of involvement (the 'why' of learning). The emotional-affective-relational element is a crucial element of learning. There are numerous intervening variables that influence the individual's perception of affectivity: neurobiological factors, socio-cultural factors, personal interests, subjectivity, intersubjectivity, prior knowledge, etc. Novelty and spontaneity involve and motivate some students, while others prefer stable learning routines with few surprises. Some students may prefer individual work, others feel comfortable in small or large group dimensions. There is no single optimal mode of engagement for all learners in all contexts. It is essential to provide multiple options for involvement (CAST, 2011/2015, transl. Savia & Mulè).

These principles make it possible to enhance diversity by applying the principle of personalization, which does not only concern the physical environment but also the educational products themselves, which must be used differently (Mangiatordi, A. 2017). Information must be communicated in a simple and effective manner by resorting, for example, to the presentation of knowledge using a variety of mediators

that can be iconic, verbal, tactile, also taking into account people with sensory disabilities. Along these lines, we cite as an example the Easy To Read guidelines, which consist of simplifying concepts and using words that can be easily understood by anyone:

> The Easy-to-Read Guidelines were created to specifically facilitate persons with intellectual disabilities, but have the general objective of making information accessible, so they can be adopted when facilitating knowledge that is too difficult to understand in order to allow access to knowledge to all those who have difficulties in understanding the content. With regard to the intellectually disabled, issues concerning the full accessibility of knowledge and the learning of new information can be supported by transforming the same data into a clearer and easier-to-understand format. Facilitated documents represent in this regard the concretization of the expression of a need, with the aim of bringing everyone closer to the acquisition of new skills, soliciting the exchange of knowledge, in order to consequently aspire to active participation in society (Giaconi, C., & Del Bianco, N.2019, p.304).

The design of knowledge and places of knowledge is fundamental to ensure accessibility for all for learning that can be further facilitated or enhanced through the redesigning of environments in a functional manner involving heterogeneous professionals who can fully respond to the plurality of students' needs.

4. Augmented Reality, Virtual Reality, Artificial Intelligence: new spaces, new possibilities

Augmented reality (AR) and virtual reality (VR) represent technologies that have the potential to revolutionize the design of learning environments. Such technologies enable immersive experiences that can be used to simulate real environments or create virtual spaces in which students can explore abstract or complex concepts in an interactive way (Castronova et al., 2020). The use of artificial intelligence (AI) in the design of educational environments is leading to the creation of highly personalized learning experiences. AI platforms are able to collect data on students' progress and adapt content in real time, thus responding to individual needs (Kukulska-Hulme, 2012). Web 2.0 has now broken down the barriers that divided formal and informal learning, laying the foundations for a new anthropological reading of the function of the digital in learning contexts. The new technologies enable the design of operational, interactive and experiential learning settings that can produce effective spin-offs in human learning processes. Artificial Intelligence, today, contributes to rewriting the possibility of constructing accessible spaces that can be used for learning, although constant and continuous reflection is required on the real implement ability of its potential in educational contexts and on the need to place the use of AI for educational purposes at the centre of the processes, the students immersed in their learning processes on the one hand, and on the other, supporting a widespread critical training of teachers who find themselves using powerful tools for analyzing teaching activities without ever freeing themselves, indeed increasing the possibility, of conquering new spaces of human relations with learners (Cesaretti, 2021). Artificial Intelligence Literacy (Burgsteiner & Kandlhofer, 2016; Ranieri et al., 2024) can enable, for example, practices for the critical literacy of students in Artificial Intelligence by helping them to understand basic knowledge, technologies and concepts of AI, use it, evaluate it and understand its ethical implications; or support teaching-learning processes (Luckin et al, 2022), from the perspective of Artificial Intelligence in Education

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(AIED), making it possible to rewrite the educational offer according to logics that are more responsive to the needs of personalization of teaching, making learning more engaging and stimulating curiosity and motivation in students (Baker et al., 2021). With respect to the facilitation of teaching-learning processes, AIs can be used to create intelligent, highly interactive tutoring systems that allow for the personalization of teaching content; they can recommend educational content by analyzing student performance data, highlighting strengths and weaknesses; they can contribute to the monitoring of learning by using student usage data, detecting problems and enabling the implementation of formative assessment processes that are not only linked to performance; automating performance evaluation processes (Ranieri, 2024). Although it is necessary to always keep in mind the ethical implications both with respect to privacy, since AI processes sensitive and personal data of students, and with respect to the real adherence to the socio-cultural constructs of the reference environments and, lastly, with respect to the possible atrophy of human relations and interaction, of educational care (Palmieri & Prada, 2008), which is and will always be a fundamental value for learning and for the humanization of life.

5. Conclusions

In light of the above considerations, the validation of learning environments is a fundamental tool to ensure that the spaces designed meet the real needs of students. It is therefore essential to promote research paths that propose a high degree of interactivity between academia and educational institutions, allow for shared reflection, and open up to an increasingly complex, increasingly connected form of epistemic pluralism. Through direct observations, real-time student observation and performance monitoring, feedback collection and direct feedback, crucial information can be gathered and categorized for the development of strengths and areas for improvement in an educational environment (Visscher et al. 2003; Imms et al., 2016). In this sense it will also be necessary, in the coming times, to make an evaluative synthesis of the actions undertaken at the Italian and European level in order to understand whether the interventions promoted by the legislator have actually had a perceptible impact on the construction of innovative learning environments that take into account the social, cultural, psychological, anthropological complexity in which the educational institutions are reflected also with respect to the social, territorial and community fabric of reference. In view of the fact that in order to be able to contribute to the construction of educational knowledge, research needs a dual line of development, namely the theoretical and the empirical, it will be necessary to strive to build epistemic processes such as to be able to connect recursively with practice (Mortari et al., 2020), offering and opening up horizons for pedagogical and didactic experimentation. Not only: in such complex times, it is relevant to reflect on the relationship between educational research and public policies (Girotti, 2020) also in consideration of the replicability of experiences favoured by the actions of policy makers (Corsi & Sarracino, 2011; Viganò & Lisimberti, 2011; Bottani, 2009). The exercise of the ethical responsibility of research assumes, all the more so, a profound relevance in the construction of a recursive dialogue with the institutions in the face of increasingly substantial and substantial investments, also taking into account the complexity and difficulty in providing answers such as to be able to direct educational policies, maintaining an organic and coherent design that can allow the sharing and study of emerging data (Mortari, 2010). In the future, the design of learning envi-

ronments will increasingly focus on an integration between emerging technologies and innovative pedagogical approaches. In particular, technologies such as VR, AR, and AI will play a central role in the evolution of educational models, creating highly customisable and potentially inclusive environments (Schunk, 2012). The creation of possible, inclusive and personalised spaces supported by innovative technologies is a key step in promoting education that is truly accessible to all. Continuous research and innovation are essential to ensure that learning environments meet the needs of a rapidly changing educational world.

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