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Inclusive spatial learning experience. An exploratory framework to deliver human-environment interactions

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ABSTRACT

The design of the built environment strongly influences people's needs, how they learn, behave, and build relationships. Education and learning are part of the nature of human beings, and allow them to develop skills, advance culture, and answer needs. In the current context, the incremental use of technological devices inside spaces has brought several positive outcomes, but also various challenges due to increased complexity. Limitations in considering the diversity of human needs confronted with architecture and technologies may raise stigmatization and exclusion. This article explores the links between the learning theories and the paradigms of user-centered design, providing theoretical affinities able to reduce the exclusion of people during interaction with spaces and objects. The process of the inclusive spatial learning experience aims to stimulate designers to deliver inclusive spaces that provide a progressive discovery of their characteristics and technologies, with the final goal to improve the experience for people with different abilities, age, gender, culture, and various roles within the specific architecture they use and live.

Keywords: adaptive user-object-space interaction, design paradigms, experiential knowledge, inclusive design, inclusive spatial learning experience, progressive exploratory experience.

INTRODUCTION

Currently, inclusive education in all its forms is a basic human need (UN, 2015), a social practice that allows to develop skills, advance culture, and answer human needs (Carr, 2003). Among the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda (UN, 2015) approaching the various facets of current worldwide challenges, fostering education, and designing inclusive and accessible environments – either urban or rural, natural or artificial, outdoor or indoor, virtual or physical – becomes crucial to ensure equal opportunities and meet most of human needs.

Such needs have been analysed through various studies, starting from the theory of the psychologist Maslow (1943) often used for its immediacy and simplicity in transferring concepts (Desmet & Fokkinga, 2020). The scientist claims that basic needs, such as physiological and safety, should be met prior to higher needs, such as psychological and self-fulfilment (Maslow, 1943). Further approaches kept developing these concepts, showing different types of needs (Deci & Ryan, 2000; Tay & Diener, 2011; Sheldon et al., 2001) and

getting to study the connections between the satisfaction of requirements and the pleasurable experiences during the use of technology (Hassenzahl & Diefenbach, 2012). Despite the differences among these approaches (Talevich et al., 2017; Desmet & Fokkinga, 2020), the existence of different sets of distinct needs and priorities emerges clearly, within which a specific "sense of place" (Jorgensen, 2001) is revealed.

By connecting these theories with the goals defined by the 2030 Agenda for Sustainable Development (UN, 2015), a strong relationship is highlighted between the design of products, spaces and services, and the capacity to satisfy the needs of the community. People tend to customize the surrounding environment, objects, technologies, and services they use, which sparked the evolution of different design approaches (Ali & Al-Kodmany, 2012). During the past few decades, the design of the built environment and technologies within it strongly developed, and countless products and services have been created aiming to meet people's continuously changing needs and preferences (Goi, 2017; Wu et al., 2019).

The synergy between architecture and the new technologies for enhancing efficiency, sustainability, comfort and accessibility, have brought new opportunities in this direction, such as to fulfil the psychological wellbeing (Committee on Technology of the National Science & Technology Council, 2019), the physical health (Peek et al., 2016), and to feel more included and motivated (Zallio & Clarkson, 2021). Moreover, the intertwining between physical and virtual has the potential to increase the levels of information acquired by the user until enhancing the overall experience of the environment. The development and use of technology brought in fact several positive outcomes for building occupants (Al horr et al., 2016), but also various challenges due to increased complexity (Ra et al., 2019). Low skilled individuals, people with different abilities, or tentative users may encounter tangible challenges when using new technologies or simply when entering a building that has counter-intuitive technology (Zallio et al., 2020). Notwithstanding the user-friendly design and configuration of several technologies for the built environment, it is possible to witness different forms of exclusion for a variety of users when going through their experiential journey (Zallio et al., 2019).

Considering these challenges that manifest for certain users, particularly when approaching a new space or a new technology for the first time (Yu-Chang et al., 2012; Ishikawa, 2022), an increasing need to reimagine how architecture and technology should adapt to users, and how to transfer efficiently the large amount of information needed to address such challenges, appears. This raises the question of how far education and learning approaches can inspire the design process to enable users for a progressive discovery of the space, its technologies and the architectural characteristics, without feeling overwhelmed by the large amount of information received while getting to know and using a space.

This exploratory research links the evolution of learning theories and experiential design paradigms in architecture, providing analogies that have the potential to contribute to reducing people's exclusion when interacting with spaces and objects. The aim is to highlight the need to design adaptive spaces that meet the different needs of an extended range of users. Such environments provide a progressive learning experience of the space, objects, and technologies within. These technologies can be represented by a combination of advanced indoor maps, intelligent tools for indoor analysis, automatic systems for light control, acoustics, climate, accessibility, and sensors and safety actuators, but also technologies for virtual and mixed reality for future work and leisure spaces.

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The paper is structured into three parts, namely an introduction of the main learning theories that have emerged over time: the overall development of design approaches. Finally, the discussion shows how the design of increasingly inclusive, accessible spaces that stimulate positive emotions, can be imagined through an inclusive spatial learning experience that can be transferred to any type of architecture, from cultural spaces and formal education ones, to healthcare, administrative, office spaces and beyond.

1.EVOLUTION OF THE LEARNING PROCESS AND THE MULTIDIMENSIONAL HUMAN NEEDS

The current section illustrates the results of an introductory overview of some of the most prominent theories of learning used across the world and their transformations, aiming to explore their relationships, map their evolution, and develop an understanding of highlights applicable to the field of design (Hart, 1998). The critical-analytical study of several scientific contributions regarding the theories of learning highlights behaviorism, cognitivism, constructivism (including experiential, adaptive, and inclusive learning), and andragogy (DeVries & Zan, 2003; Pange et al., 2010; Guney & Al, 2012; Millwood et al., 2013; Zhou & Brown, 2015; Zhang et al., 2017) as the main theories that have guided the changes in the educational field and which have the potential to be transferred to the design approaches.

Since Comenius, one of the founders of modern pedagogy, the importance of paying major attention to the learners' minds and to the way they learn, has become evident (Sadler, 2007). Even so, behaviorism, a theory developed and supported by Pavlov (1897), Thorndike (1905), Watson (1913), Gurthie (1935), and Skinner (1948) (Millwood et al., 2013), has often been criticized as it did not take into consideration the non-observable cognitive and affective processes of the learner (Guney & Al, 2012), who was considered a passive user in the process. Over time, the figure of the learner evolved into an active participant of the learning process and theories such as cognitivism have emphasized the new mental processes to explain how people gain theoretical and experiential knowledge (Guney & Al, 2012). According to these theories, the learners-users build knowledge progressively through experience based on their own specificities. Thus, users have to "translate" information through the filter of contextual experience and build on the already acquired knowledge, able to absorb and reflect on new information. As explained by Gitt (2009), there are various levels that characterize information in all its forms. From the lower statistical level, through syntax, semantics, pragmatism, and apobetics, they all have a specific function in exchanging information from sender to recipient as Figure 1 shows, and these contribute to the learning process.

In fact, constructivism claims that learning is a process of building knowledge rather than acquiring it and it takes into consideration the learner's social, cultural, and contextual conditions, other than his own needs, by encouraging the individual to build knowledge through experience based on the personal level of cognitive development (DeVries & Zan, 2003). Context and process on the one hand, and the user's specificities on the other hand, become fundamental for the process of building knowledge. A theory that studies the variety of the users' background, mostly focused on adult learning, is Knowles' andragogy (Knowles, 1984), where the need to share contents through different ways becomes evident. This theory considers the users' previous experience, and it highlights the importance to develop autonomous learning environments able to encourage user-centred experiences.

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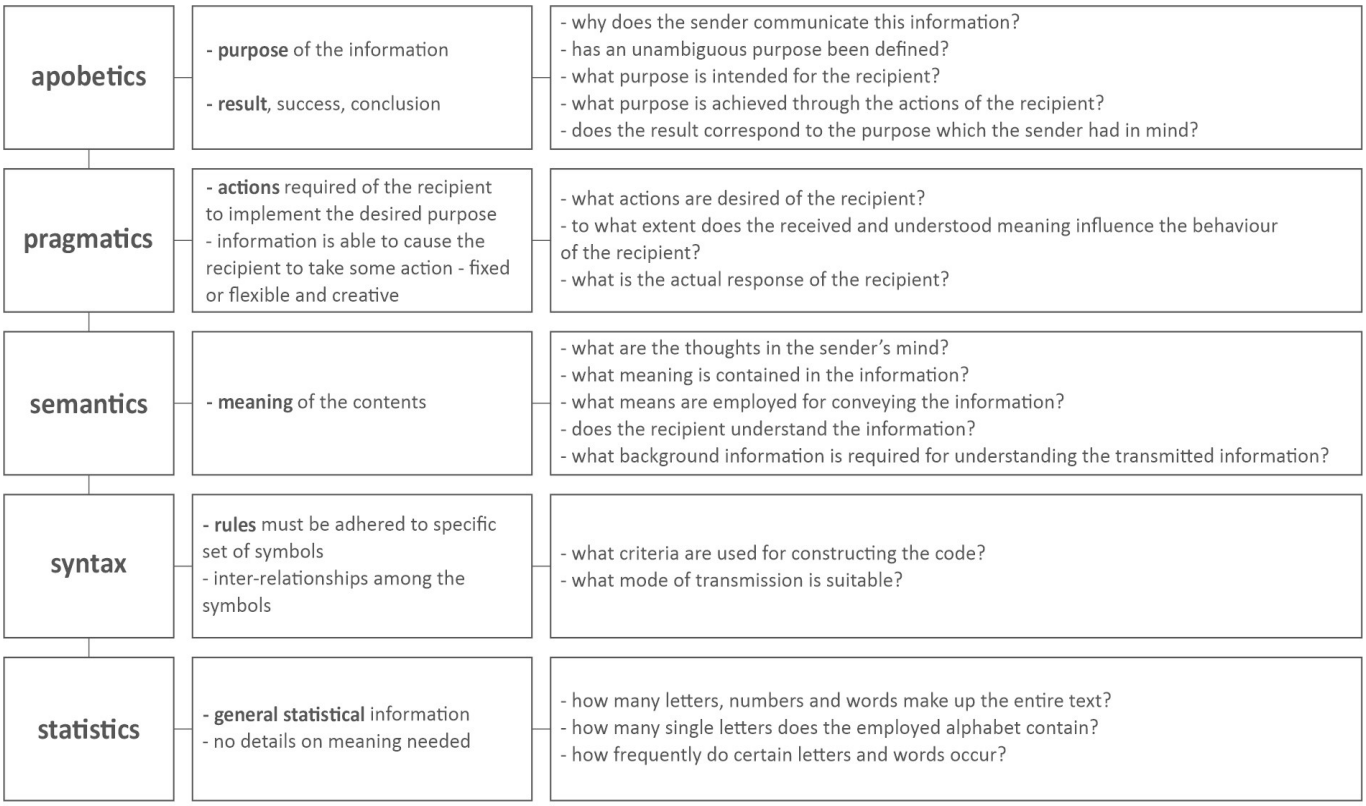

Figure 1. The five levels of information (Gitt, 2009).

The users-learners differ from one another through characteristics such as intellectual capacities, preferences of learning, cognitive and learning styles, previous knowledge and experiences, self-efficacy and meta-cognition, i.e., the awareness of own cognitive processes (Mödritscher et al., 2004).

The evolution of the line of thought on learning towards approaches where the instructor creates contents and methods to transfer it according to the users' capacities, preferences and needs, appears evident throughout history. Several doctrines, such as the theory of multiple intelligences (Gardner, 2011 [1983]), the experiential learning theory and the learning style inventory (Kolb, 1984), the perception-based theory (Gregorc, 1985), the learning styles questionnaire (Honey & Mumford, 1986) and the VARK model (Fleming, 1995), show evidence of approaches referred to specific behavioural patterns and preferences from different learners (Campbell et al., 1996). This variety in the learning styles has brought to "adaptive learning" (Beldagli & Adiguzel, 2010), an alternative to the "one size fits all" approach and evolving into "adaptive e-learning" through a dynamic process caused by the advancement in technology.

The issue concerning inclusion and accessibility imposes its importance when the ideal learning space becomes adaptable, flexible, able to embrace a multi-function, multi-use, multi-age, and suitable for all use (Space for Learning, 2015). Some of the principles highlighted in the Guide to Universal Design for Learning (New Zealand Government, n.d.) are referred to the use of multiple ways of engagement, representation, action, and expression, which can be completed by presenting information through various sensory channels to reach different cognitive levels (Smithsonian Museum, 2010; European Parliament and Council, 2019).

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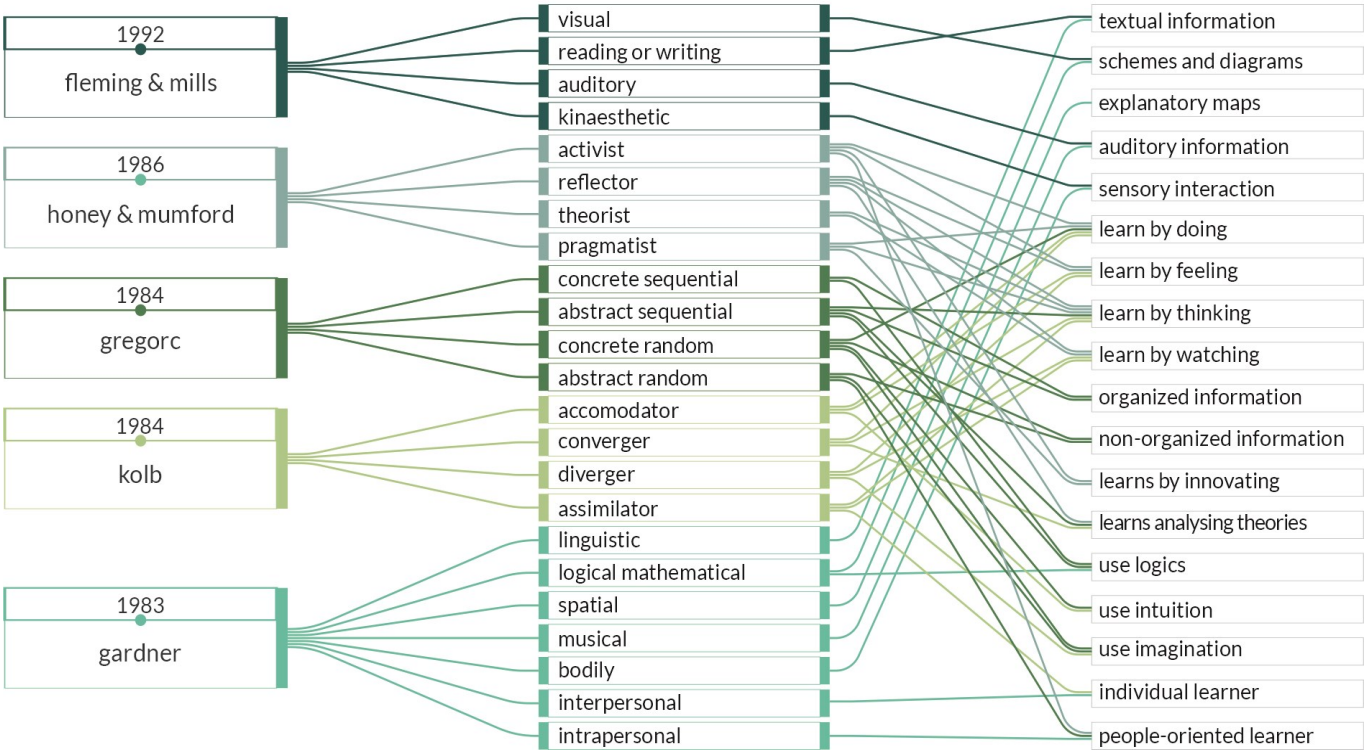

Figure 2. The diversity of human needs with reference to learning.

Figure 2 shows a synthesis of the similarities and differences in the various learning styles analysed, highlighting connections between the theories of various scientists, and representing the multidimensionality of users' needs based on the diversity of preferences in acquiring information. The image provides a visual framework of some of the characteristics of the different learning styles that have influenced and encouraged the evolution of the most recent theories based on a user/learner-centred approach.

Nowadays the introduction of advanced technologies in all fields of daily life has brought to transformations in the user-artefact-space relationship, stimulating a growing interest in the complexity of the learning process from international scientists. Neuroscience studies the mechanisms taking place in the brain by often paying attention to cognition both referred to the basic mental processes – such as sensations, attention, and perception – and to complex operations such as memory, learning, use of language, problem solving, decisional processes, reasoning, intelligence (Smith & Kelly, 2015). This leads to the study of the interaction with objects and architecture also through correlated disciplines, such as neuro-aesthetics and neuroarchitecture.

Particular attention is placed on space perception and on the users' capacity to find their way through cognitive maps. These become tools to re-elaborate the environment in the mind, contributing to support users in acquiring, representing, and using knowledge on specific environments (Ishikawa, 2022). The diversity of the 'spatial ability' (Ishikawa, 2022) among different users, together with the diversity in learning styles, indicates the need for future studies toward building an inclusive experience of knowledge of the environments. This will allow adaptive use and will contribute to reducing 'spatial anxiety' (Lawton & Kallai, 1994; Alvarez-Vargas et al., 2020), i.e., the anxiety in executing spatial tasks (e.g., navigation, wayfinding, mental manipulation or objects rotation, perspective taking).

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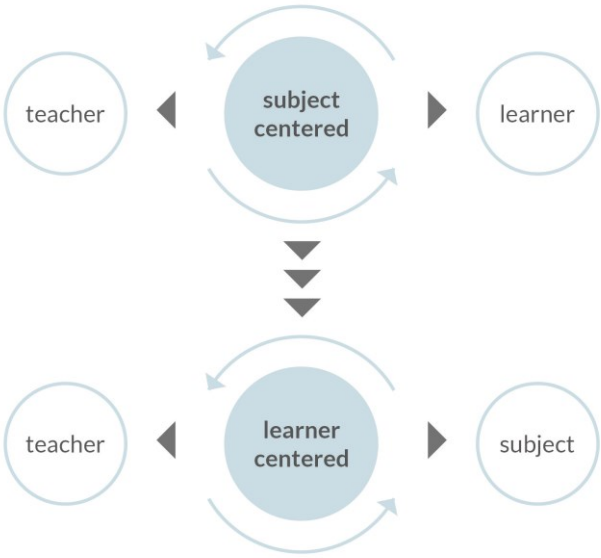

Figure 3. Change of focus of the learning theories from subject centered to user/learner centered.

The theories identified in this section do not define sharp boundaries as they are intertwined and present several mutual interest points. Over the years, the goal of the learning theories remained generally unchanged, however, the approach used to transfer theoretical and experiential knowledge strongly evolved. As shown in Figure 3, the focus shifted from an approach focused on the subject to be transferred, to a learner-centered approach, where the listener becomes an active part taker of the process and interacts in the learning experience. As it is in the inner nature of every human being to approach new subjects and to use new products during an experiential journey, affinities can be defined between the learning theories and the approaches for the design of products, services, and the built environment.

2.DESIGN APPROACHES TOWARDS A HUMAN-CENTERED PERSPECTIVE

Similarly, in the field of design some approaches were developed to encourage the design of adaptive spaces and provide a discovery of the space based on users' needs. The reflexive architecture deals with constructions developing and responding intelligently to the surroundings, to users, to the context of use, with the support of emerging technologies (Spiller, 2002). Particularly interesting is also the experiential graphic design approach (Berry, 2014) aiming to enhance dialogue between users and spaces through coordinated visual communication and information systems both at a digital and physical level. With the significant progress in the field of technologies, human factors and the development of products in the last centuries, design evolved in a similar way to the learning theories in the educational field with reference to the attention on the user-learner. The critical-analytical reading of a selection of scientific studies explaining the theories and practices of design methods and contributing to widening knowledge in the specific field research highlighted the gradual shift of focus towards a human-centered perspective.

The culture of design is meant to include the totality of disciplines, phenomena, knowledge, analytical instruments, and philosophies that the design of useful objects must consider, as well as how much these objects are produced, distributed, and used in the context of social

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and economic patterns (Vitta & Nelles, 1985). If in the first-place industrial design was seen as a process of giving form to an object for the sole purpose of solving a particular challenge a user experienced (Auernhammer et al., 2022), the advances in ergonomics and human factors fields have imposed a sociopsychological approach into crafting tools and products according to user needs, aspirations, and desires (Dreyfuss, 1960).

In the following decades several approaches developed in this direction. By keeping the focus on user-centered approaches, design paradigms of Universal Design, developed by Mace in the early 1980' (Mace et al., 1991) materialized as a response to the rising demand of spaces designed to answer the needs of impaired people. Developments in the area brought growing attention to the need to consider the users' diversity as in the case of Transgenerational Design (Pirkl & Babic, 1988), which claims the necessity to design for a multi-generational population and brings to an analogy with Knowles' andragogy (1984) in the educational field.

Inclusive Design then emerged as an approach fostering the recognition of exclusion and extending design to a wider range of users. Later, the birth of Design for All from the European Institute of Design and Disability (EIDD, 2004) highlights a growing attention towards the users' diversity and a prerequisite to focus on individual needs, similar to the evolution in the educational field.

The essence of design belongs to the process of discovering a constraint or issue commonly shared by different people and addressing it in a meaningful way (Hara, 2011). As an example, in the Asian culture, the design focuses on the role of emptiness and according to Hara, it is definable as "not self-expression", a concept that is strongly rooted in the society. Hara (2011) strongly argues that the foundation of a problem is implicitly embedded in society. Every person has an extraordinary capacity to experience the pain (or problem) from their personal perspective. It is evident that design itself is not a mutually exclusive paradigm that is self-sufficient to its success. Interaction with an object and even more with a space depends both on the information that the object or space provides, and on the designer's capacity to render their functioning clear and intuitive to the user (Buiatti, 2014).

Design, especially when is supported and confronted with contextual factors, such as user needs and environmental dynamics, can release its biggest potential. A project that takes into consideration diversity and inclusion has the potential to empower users of all abilities, genders, ages, and religions, to feel part of a community, benefit from products and technologies, and experience buildings and spaces at their best (Zallio & Clarkson, 2021). Diversity and inclusion should, in fact, be seen not as a "categorization" of users, but as a way to be acquainted with the users' variety, to analyse the different requirements, and to take into consideration the possibility for design to be flexible, to adapt to the various needs and be able to consider the extended range of users.

In this direction, the 'experiencescape' (Rossman & Duerden, 2019) suggests that people, places, rules, objects, relationships, and "blocking", are interconnected elements that support the design of an environment where people can be inclusively engaged through different experiences, as Table 1 shows.

The design experience itself becomes a "symphony" of cognitive processes in the brain (Whalen, 2019). Recently, through the intertwining between design and neurosciences, the "six minds of experience" have been studied, showing a sequence of processes that take place during interaction with new products, thus impacting the acquisition process.

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Table 1: Components of the 'experiencescape' (Rossman & Duerden, 2019).

Element	Description
People	All individuals involved in the experience, including participants and stagers, whether physically present or not
Place	The place in physical space and chronological time in which the experience occurs
Objects	Physical, social, and symbolic objects that play a recognized role in the experience
Rules	The rules that influence experiences, from codified laws to social expectations
Relationships	The relationships people in the experience share that influence their interactions
Blocking	The "choreography" of people's location and movement through an experience

In a first phase, vision, attention, and automaticity, together with the wayfinding processes, lead the user towards the proposed objective through the first interactions with the product.

Language becomes fundamental to support the user into understanding the product, while he starts building expectations in the mind through the memory process. Finally, the decision-making process taking place in the user's mind before acquiring a new product is followed by an emotional process that can impact decisively the acquisition (Whalen, 2019). These phases are mostly reflected in the interaction with spaces and products within them, from traditional furniture to the most advanced technologies.

It is therefore necessary to design spaces able to embrace the users' needs through different paradigms of design. Even so, what can be done when people with impairments, older people or those with different skills and knowledge in using a particular space or technology, still experience exclusion?

What is the relationship between a physical space and a learning experience for different users?

There is a strong baseline of knowledge about designing inclusively and ensuring access to the widest range of users. However, it is relevant to highlight the importance of learning theories and how their approach provides inspiration to reimagine the user journey as an inclusive learning experience that the occupants of architecture have through the built environment.

3.DISCUSSION: INCLUSIVE SPATIAL LEARNING EXPERIENCE TO DELIVER HUMAN-ENVIRONMENT INTERACTIONS

By analysing the inter-relationships between the learning theories and the user-centered design approaches, it is possible to develop new knowledge referred to the inclusive and adaptive experience of the built environment. The foundations of the pedagogical learning theories have shown the importance of shaping knowledge transfer by considering the different characteristics of the user-learner. This highlights the capacity of people with different abilities, gender, age, culture, to learn through experience, creating interconnections based on progressive customized discovery according to the varied needs and through different ways of knowledge transfer.

Since people with different needs might experience spaces in different ways, it is important to transfer the principles from the learning theories and apply a similar approach to design. Recent studies showed that navigation and orientation through space depend on how accurately people can represent this environment in their minds and on how flexible they are

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in manipulating such representation based on the activities to be made (Ishikawa, 2022). According to the user-centered design approaches, when people enter a building or any space for the first time, they experience different journeys depending on their own capacities and on the pre-established objectives (Zallio, et al., 2016). During interaction with objects and technologies within an environment, it is important to reduce the counter-intuitive experience since it can lead to exclusion, and non-satisfaction and it does not meet the different human needs (Desmet & Fokkinga, 2020).

To enable an extended range of users to reach full satisfaction and fulfilment of needs, and by following the Inclusive design principles, architecture, and technologies should therefore ensure an inclusive and accessible experience by providing differently skilled individuals with the possibility to learn to use the space in a progressive and adaptive way. It is important to highlight that any kind of learning experience should be seen as an opportunity for continuous evolution and not as an ending process.

Using different levels of information and experiential knowledge, designers and architects can enhance the design of architecture as a learning experience where users experience different interactions following a model of progressive discovery. Specifically, the different components of the experiencescape (Rossman & Duerden, 2019) have been considered and correlated to specific features of the information levels (Gitt, 2009) and to the processes identified as the "six minds of experience" (Whalen, 2019) (Fig. 4), to define several steps of the inclusive learning experience for the design of built environments (Fig. 5).

The first step allows people and places to come into contact as components of the experiencescape (Rossman & Duerden, 2019) and it introduces users to the different levels of spatial complexity. This can therefore be related to the statistics level (Gitt, 2009), since the user investigates how many and which spaces, objects, and technologies compose the entire architectural experience, an overall view without providing insights on functionalities. The process of vision, attention, and automaticity (Whalen, 2019) is activated. This step is crucial to create the basis for understanding the general layout, how to best navigate, and the itineraries within architecture, therefore it is connected to the wayfinding process (Whalen, 2019). The users' first interactions with the space take place, when they enter the physical and virtual space in search of information, they orient and start understanding where to go to reach certain aims. The needs for orientation are different based on the capacities, age, gender, and culture (Ishikawa, 2022), and according to the role users have in a specific building.

The process continues with the progressive discovery where exploration, participation, experimentation, and creation, accompany users during their journey within the space. In this second step, the user starts interacting with the space, observing its syntax (Gitt, 2009), how the elements are displayed, the sensory characteristics, and the first rules (Rossman & Duerden, 2019) that allow him to move through space. Memory (Whalen, 2019) is activated to create analogies with already known spaces and elements useful to the individual to foster exploration.

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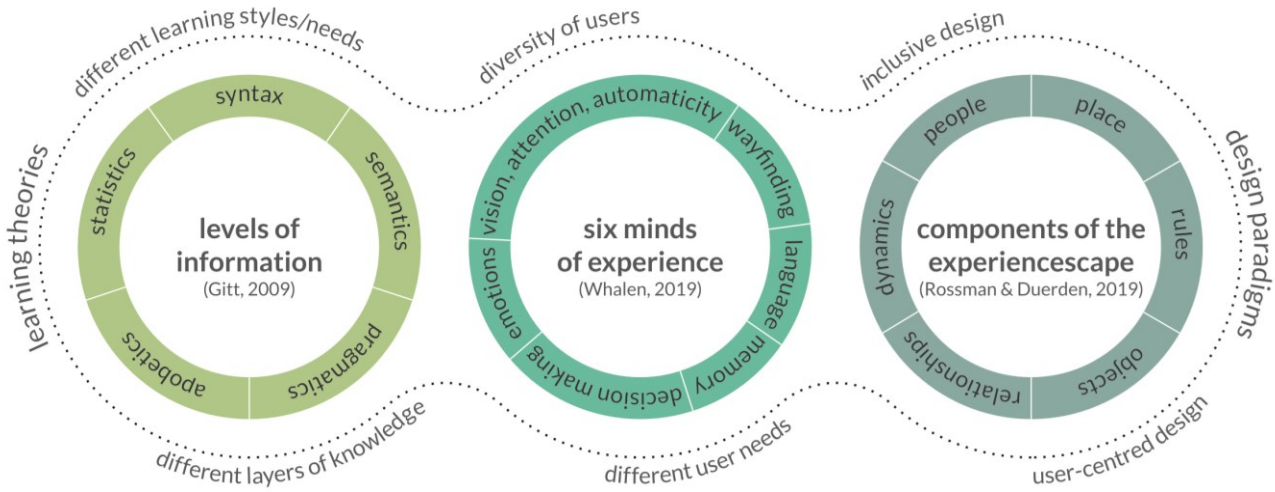

Figure 4. Conceptual elements useful to define the new inclusive learning experience for the design of built environments

A further step concerns the first interactions with objects as components of the experiencescape (Rossman & Duerden, 2019), where the user can observe them and gets access to the first levels of exploration which allow to understand the use and purpose of objects and technologies. He starts to associate significance (semantics level from Gitt, 2009) through the activation of "languages" that should be adaptive based on the personal level of expertise (Whalen, 2019) and through the different sensory channels to satisfy the requirements of an extended range of users (Chivăran et al., 2022).

This allows us to advance through the space and to further investigate the various functionalities related to personal preferences until we learn the advanced characteristics of objects and spaces. It is about understanding and enabling the actions that the user desires (the pragmatics level by Gitt, 2009) and being able to build relationships (Rossman & Duerden, 2019) between objects, between users, between spaces and between objects-users-spaces, participating and sharing the experience with other people in the same context. By activating the decision-making process (Whalen, 2019), the user decides which actions to take and studies the desired information based on the specific objective.

Finally, through the dynamics or blocking (Rossman & Duerden, 2019), the user moves freely through the space with the awareness of environments, objects and of various components. Emotions (Whalen, 2019) become a fundamental aspect that guides the satisfaction of the experience itself. It can be related to the apobetics level (Gitt, 2009) where the results obtained by users and the correspondence with their initial objectives can be studied. The user should reach a fluid use and interaction with the space and objects due to the learning dynamics that have been developed in the various phases.

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Figure 5. Steps of the inclusive learning experience to deliver user-environment interactions.

As shown in Figure 5, the built environment should release several multisensory stimuli that accompany users through the inclusive spatial learning experience and enable the discovery of environments, objects, technologies within the architectural context during the various steps.

While the user advances through the building, the experiential journey helps to increment spatial knowledge and arrive to a major understanding of the functions and of the message provided by the environment itself. Therefore, it is expected that by following the approach of the inclusive learning experience, the user will be able to experience space with major opportunities, feeling included and aspiring to satisfy the different types of needs.

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4.CONCLUSIONS AND FUTURE IMPLICATIONS

The current contribution explores the links between the evolution of the learning theories and the design paradigms, illustrating the analogies in the shift of focus towards a major attention for the different needs of users. From the theoretical framework, it emerges the need to design spaces in an adaptive way to allow the individual to learn how to interact with the overall space and with all the components within, by following a model of progressive discovery. This will enable people – considering their specificities – to use and enjoy the various levels of experience and to enhance it at its biggest potential. The focus is shifted from a design for "conventional" users to the design of architecture where inclusion, equity, and accessibility become fundamental (Zallio & Clarkson, 2021).

Such an approach will increase awareness towards the design of inclusive and adaptive spaces able to provide a continuous learning experience that allows users to gain professionality in use, ability in navigation, and opportunities to experience space in an efficient way, giving birth to a new paradigm strongly connected to the evolution of the pedagogical learning theories. The potential is to obtain resilient, durable, inclusive architecture capable to adapt, providing educational experiences for all users, from the non-experts to the differently abled individuals and to those coming from various cultures.

This inclusive spatial learning experience will have to be tested with reference to accessibility and usability characteristics by applying it to specific case studies, from educational and cultural environments (e.g., museums) to healthcare or office spaces.

This research constitutes a milestone for a larger project funded under the European Union Horizon 2020 research and innovation program that aims to bridge the gap between the design of futureproof buildings and the practice of Inclusive design. Further work is planned to better define, test, and evaluate the framework of the inclusive spatial learning experience through application in different types of environments.

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