Comunicar, n. 79, v. XXXIII, 2024 | Media Education Research Journal | ISSN: 1134-3478; e-ISSN: 1988-3478
www.comunicarjournal.com

Intelligence and Spatial Intuition in the Digital Reculturation of Secondary School

La inteligencia e intuición espacial en la reculturización digital de la educación secundaria

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ABSTRACT
Promoting spatial intelligence and intuition in secondary school is critical for future architecture and engineering professionals to develop their skills. Secondary schools, based mainly on digital tools, work in this direction. However, given the performance of undergraduate students, there is still room for improvement in acquiring this skill. The main drawbacks identified in developing spatial intelligence using digital tools are the need for more development of spatial vision and its lack of correlation with the physical environment. This work aims to present the experience, and results obtained in the 4º ESO+EMPRESA program of the Community of Madrid to promote spatial intelligence. The experience used a workshop methodology to relate digital and classic spatial didactics, thus interpreting the built and urban space. This activity had a favorable development among secondary school students, in which students with architecture degrees also collaborated. The results obtained in the workshop highlight that secondary school students could correlate digital and classical media to understand the relationship between urban wandering and architectural design. The workshop results confirm that using mixed spatial methods is fundamental to achieving adequate spatial development where digital tools must complement classical ones.

RESUMEN
Fomentar la inteligencia e intuición espacial en educación secundaria es clave para que los futuros profesionales de la arquitectura e ingeniería desarrollen sus habilidades. Los centros de educación secundaria, basándose principalmente en herramientas digitales, están trabajando en esta dirección. Sin embargo, teniendo en cuenta el rendimiento de los estudiantes de grado, aún queda margen de mejora en la adquisición de esta competencia. Los principales inconvenientes identificados en el desarrollo de la inteligencia espacial empleando herramientas digitales son la falta de desarrollo de visión espacial y de su falta de correlación con el medio físico. El objetivo de este trabajo es presentar la experiencia y resultados obtenidos en el programa 4º ESO+EMPRESA de la Comunidad de Madrid para fomentar la inteligencia espacial. La experiencia empleó una metodología de taller para relacionar didácticas espaciales tanto digitales como clásicas interpretado así el espacio construido y urbano. Esta actividad tuvo un desarrollo favorable por parte de los grupos de estudiantes de secundaria, en la que colaboraron también estudiantes del grado de arquitectura. Nuestros resultados muestran que el alumnado de secundaria logra correlacionar medios digitales y clásicos para comprender la relación existente entre la deambulación urbana y el diseño arquitectónico. Los resultados también confirman que la inteligencia espacial se desarrolla mejor empleando didácticas mixtas. Y se puede concluir que, para alcanzar un desarrollo espacial adecuado, las herramientas digitales han de ser complementarias a las clásicas.

KEYWORDS | PALABRAS CLAVE
Digitalisation, Didactic, Secondary Education, University Education, ICT, Learning Theory.
Digitalización, Didáctica, Educación Secundaria, Educación Universitaria, TIC, Teorías del Aprendizaje.

Received: 2023-09-29 | Reviewed: 2024-07-29 | Accepted: 2024-08-15 | Online First: 2024-09-30 | Published: 2024-10-01
DOI: https://doi.org/10.58262/V33279.7 | Pages: 72-84

1. Introduction

The digitalization of everyday life has profoundly altered our understanding of humanism and the world in which we live, particularly in the realm of education. The integration of digital tools into schools has significantly transformed the learning experiences of young students (Gutiérrez Martín & Tyner, 2012; Hieu, 2023). This shift has led to both an increased digital divide—due to disparities in access to devices and programs—and challenges in translating digital experiences to physical contexts. Addressing these consequences requires careful reflection, as the digitalization process is both irreversible and unstoppable.

Although the digitization trend has accelerated since the 1980s, its roots extend further back. For instance, Marshall McLuhan's theory of the Global Village from the 1960s (Alshaikh, 2024; Gutiérrez Pequeño, 2008) significantly influences today's interconnected and virtual society. Similarly, Manuel Castells' "Galaxia Internet" (Alcalá Casillas, 2017) reflects this social evolution. Today, while our society is highly interconnected, it faces issues related to interpersonal relations, reasoning, and attention.

Recent studies suggest that current generations may be less intelligent than their predecessors (López-Vidales & Gómez-Rubio, 2021), despite having access to vast amounts of information and advanced methods of retrieval. One potential cause of this decline is the over-reliance on mobile and tablet applications. However, in the academic literature there are papers available with different positions regarding their use (Alonso Mosquera, Gonzálvez Vallés, & Muñoz de Luna, 2016). Research indicates that the design of these devices is focused on capturing and holding attention (Monge Roffarello & De Russis, 2022; Wang, 2024), which can undermine long-term knowledge acquisition and the pursuit of delayed rewards, such as professional development or life planning. This concern is consistent with the emerging attention economy (Bhargava & Velasquez, 2021).

In this context, companies and organizations contend to capture and maintain user attention by creating products, applications, and services designed to promote continuous content consumption through brief, repetitive stimuli (Myllylahti, 2018; Xie, Guo, & Zhao, 2023). This approach to entertainment and social interaction, characterized by "viralization," represents one of the detrimental aspects of digital reculturalization (Felício & Peres, 2023).

Education is a crucial sector within this process of digital reculturalization. Over recent decades, numerous changes have been introduced, and it is now common for educational projects to incorporate digital programs and experiences, such as challenges or self-learning modules (Román González, 2016). In this methodology, students are tasked with addressing and solving various problems presented by their teachers or tutors. However, these digital dynamics are often implemented on a limited scale, typically confined to specific courses or subjects, without comprehensive oversight of the applications and services students utilize. Consequently, there is a need for enhanced vertical coordination—both within individual courses and across different educational stages. Such coordination is essential for establishing effective continuity, enabling students to progressively develop digital skills that will support their professional decision-making while minimizing distractions (García Martín, 2012; Salouhi & Al-Bakri, 2022).

There is a notable deficiency in spatial intelligence within engineering and architecture disciplines, particularly concerning the understanding of space and its graphic representation. This is a significant issue because spatial vision is crucial for both academic success and professional performance. The development of spatial intelligence is greatly influenced by early experiences and education. Although some individuals may have an innate predisposition, these skills can be improved and strengthened throughout life. Activities such as play, walks, and excursions are effective in stimulating spatial abilities in childhood (Frick, Möhring, & Newcombe, 2014), as they promote exploration, understanding of spatial relationships, and problem-solving related to navigation. Even in challenging situations or with limited resources, creativity and adaptation can provide opportunities to develop these skills.

Howard Gardner's theory of multiple intelligences highlights the importance of recognizing and nurturing different types of intelligence, including spatial intelligence. Engaging in activities that involve manipulating three-dimensional objects, solving spatial puzzles, and visual representation can stimulate these skills. The increasing reliance on virtual tours and applications, however, risks detaching spatial learning from physical reality, potentially undermining the development of spatial skills.

Similarly, graphic representation, particularly hand drawing, is vital for developing spatial cognitive skills and reinforcing psychomotor abilities (Doug, 2019; Liben & Downs, 2013). This is especially important in technical training for fields such as architecture and engineering. The choice of graphical representation and writing tools can impact how students process and retain information, underscoring the need for thoughtful curriculum design in technical disciplines.

Within this context, the Fuenlabrada Microcity activity was implemented through the 4º ESO+EMPRESA program of the Community of Madrid, involving secondary school students alongside architecture students and professors. The activity aimed to enhance participants' spatial skills using both digital and analog methods, following the principles of Howard Gardner's Multiple Intelligences (D'Souza, 2007; Manee, Bua-In, & Thawornsujaritkul, 2023). Additionally, the activity had a secondary objective of promoting STEM vocations in the fields of engineering and architecture. To achieve this, the activity employed a hybrid workshop methodology, integrating both classical and digital spatial education models. The following sections detail the materials and methods used, describe the exercises conducted, present the results obtained along with the social benefits, and outline the conclusions reached for the development of future work.

2. Materials and Methods

The proposed activity follows a workshop-style methodology that promotes camaraderie and social relationships among participants, who are students from different schools and age groups. The activities include a walk, the use of training modules in spatial programs and games to transfer these skills to the physical built environment. All of this is part of a hybrid strategy aimed at developing spatial awareness, spatial vision, and their graphic representation.

The workshop included activities over a span of three days, with two-hour sessions each day. Given this timeframe, careful planning was undertaken to appropriately integrate participant relationships, training, and the experience of digital and analog transposition within the activity. To this end, previous experiences with Minecraft by volunteers were gathered to obtain practical and experiential information, understand the in-game experience, how participants interact, and how this influences the development of spatial skills. The collected information was adjusted to a model that incorporates Information and Communication Technologies (ICT) and Learning and Knowledge Technologies (LKT), with the aim of effectively combining them with traditional techniques such as drawing, thereby ensuring the proposed activity is conducted with confidence and success.

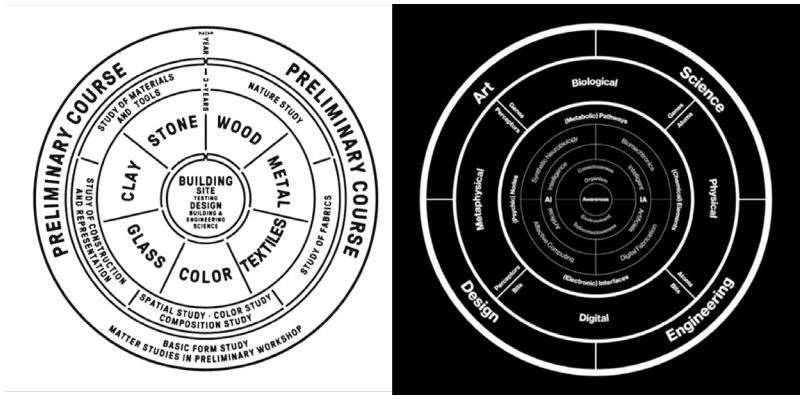
The volunteers who participated in this preparatory phase of the activity are second-year students from the Bachelor's Degree in Fundamentals of Architecture (GFA) and third-year students from the Bachelor's Degree in Aerospace Engineering in Transportation and Airports (GIATA), both degrees affiliated with the School of Engineering in Fuenlabrada. The process of collecting this information included a group interview concerning the use of spatial tools and games, along with an analysis of the learning processes that the students had experienced. The interview sought to identify the challenges faced in understanding space and its representation during their university studies. The results of the analysis show that prior education, both pre-university and university-level, significantly influences the spatial challenges identified.

Among the university students who collaborated, the experiences of five volunteers who completed Humanities and Social Sciences High School programs stand out. All of them were GFA students who lacked spatial and technical drawing knowledge and struggled with spatial graphic comprehension and expression due to the high theoretical content of their coursework. In contrast, university volunteers who attended Technological and Science High School reported that their technical drawing courses had a significant theoretical component, with practical work primarily based on graphic representation programs, such as Computer-Aided Design (CAD). However, these students also expressed a lack of spatial knowledge and skills, which became evident in their university-level graphic representation courses. This was often due to the absence of subjects related to the arts and plastic arts, which were optional in the High School programs they had completed. This disconnect between spatial training in secondary school and high school is a significant issue currently faced by Architecture and Engineering students.

Additional results from the interview indicate that the volunteers have had, and continue to maintain, a relationship with spatial strategy games, such as Minecraft or SimCity. These volunteers mentioned that they found these games to be more useful for their university programs than their secondary and high school education. However, all GFA student volunteers reported difficulties in courses such as Architectural Representation or Drawing from Nature, where mastery of spatial communication through traditional drawing tools is essential. In contrast, the GIATA student volunteers indicated that they do not experience challenges with classical spatial communication, as their academic pathway primarily involves the use of digital tools. However, they do encounter spatial challenges related to understanding scales and their representation, as well as mastering CAD tools.

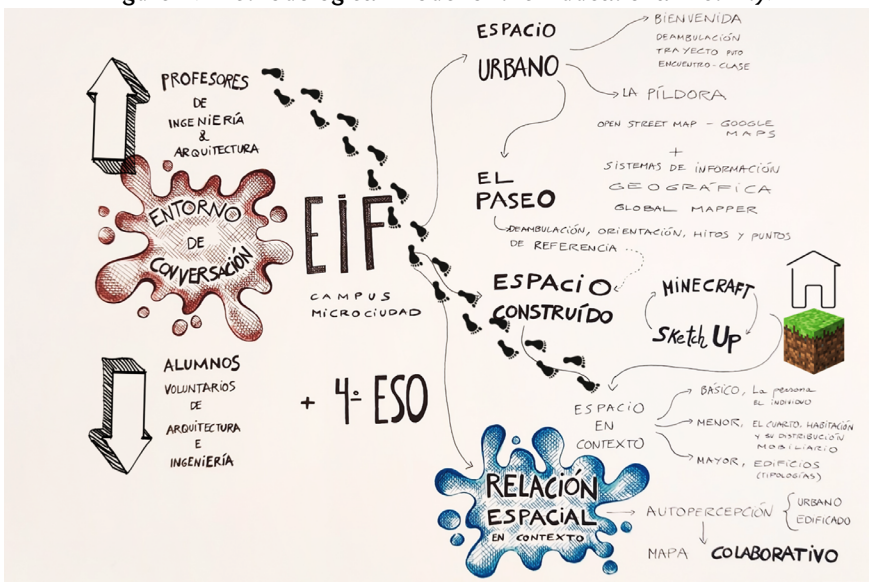
Based on this information, the methodology implemented in the 4th ESO+EMPRESA program was finalized, employing a hybrid workshop strategy tailored to the age and prior training of the participants. This strategy integrates essential digital competencies (ICT and TAC) with classic graphic expression models, such as drawing. The goal of this strategy is to help students reconnect with their own spatial intelligence and to foster interest in STEM disciplines, which are crucial for technical university education. The design of this workshop combines successful models from various educational methodologies, including Maria Montessori's "cosmic education" principles of the "tree of education" designed for children, as well as principles from the Bauhaus educational model combined with Neri Oxman's modes of creativity.

Figure 1: Diagram of Bauhaus (1925) Educational Model, Along with Neri Oxman's (2016) Modes of Creativity.



The activity also included two digital and analog training modules focused on urban planning and architectural graphic representation. GFA and GIATA students who participated as volunteers in the previous study contributed to the development of these modules. As a result, the effectiveness of the tools in applying urban planning concepts and enhancing spatial perception in the built environment was evaluated. This evaluation followed the methodological model depicted in Figure 2.

Figure 2: Methodological Model of the Educational Activity.



The following three sections of the article are dedicated to detailing the activities conducted on each day of the program. Specifically, the urban space methodology used on the first day, the built space methodology employed on the second day, and the context space methodology explored on the third and final day are described.

2.1. Urban Space Methodology

The first day of the program focuses on urban space methodology. During this session, participants engage in activities designed to foster social interaction and develop an understanding of key concepts related to the urban environment, its planning, and ambulation. Urban space is a complex dimension that requires orientation skills to navigate and comprehend its scale.

The day begins with an assessment of the secondary school participants' spatial orientation within an urban context. This is accomplished by organizing a test in which participants are challenged to navigate from a meeting point to the classroom where the workshop takes place. This activity is designed to put into practice the principles taught during the workshop, with a focus on urban planning. The URJC Fuenlabrada campus serves as a case study, representing a micro-city with a similar organizational structure. During the tour, a supervising professor is present to assist students who encounter difficulties in navigating the campus. This activity highlights a significant spatial limitation among the students, as many struggle to correlate the map with the actual route. This issue was observed in students using both Google Maps and paper maps of the campus.

Once in the classroom, a training module introduces the fundamental principles of urbanism, drawing connections to the prior spatial orientation test. The primary objective of this module is to help participants understand the relationship between physical and digital space and the process of identifying physical references in the environment. The module also emphasizes the utility of both digital (Google Maps) and analog (paper maps) tools for understanding urban layouts and spatial dimensions—insights supported by the experiences of GFA and GIATA university volunteers. The module covers map and plan reading in both physical and digital formats, clarifying that the top margin represents north, the bottom margin represents south, the right margin corresponds to east, and the left margin indicates west. It also addresses the basics of urban cartography, including contour lines, their relationship with urban layouts, and slopes, with details like contour line shading towards the north to aid in topographical understanding. To further explain the relationship between wandering and orientation in urban space, concrete examples are provided on how to interpret spatial information on maps and plans, including identifying landmarks or reference points, locating routes, and understanding distances between locations. These landmarks—such as towers, iconic buildings, parks, or sculptures—help individuals establish a mental network that facilitates orientation and urban navigation.

The training module also covers various digital tools for urban space orientation and planning, including Google Maps, OpenStreetMaps, and geographic information systems. First, the features of Google Maps are explained, including the default view, satellite view, and terrain view. Although primarily a navigation tool, its popularity makes it essential for understanding the relationship between walking and orientation in the urban fabric. Second, OpenStreetMaps is introduced as a collaborative tool in this field. Unlike commercial and proprietary maps, OpenStreetMaps allows anyone to establish landmarks, share routes, and contribute information, thereby enhancing urban space literacy. Geographic information systems are briefly discussed, with an emphasis on their application in executing urban plans, creating maps, and planning routes digitally. The Global Mapper program is used as an example to demonstrate the use of georeferenced databases and their applicability.

The final part of the first day involves a campus walk to apply the theory from the training module. Participants practice spatial orientation based on cardinal directions and wandering by establishing landmarks. The methodology of Jane Jacobs is followed, with a series of tours around the campus allowing participants to observe, experience, and learn about the relationships between different plots and buildings, under the supervision of faculty volunteers (Riley, Ketola, & Yadav, 2022; Ruitenberg, 2020). Participants are also asked to choose three urban or building landmarks during the tour, helping them establish a personal connection to the urban environment (Jiang et al., 2023; Wunderlich & Gramann, 2021). This exercise not only aids in spatial memorization but also contributes to the collective understanding of urban space. The landmarks selected by the participants can later be used to replicate routes based on wandering and orientation, and the routes can be shared through collaborative applications like OpenStreetMaps.

Figure 3: Secondary School Students Performing the Microcity Wandering Exercise.

2.2. Day 2: Built Space Methodology

The second day of the program focuses on the methodology of the built space, which pertains to the spatial scale most familiar to people. This scale includes spaces of everyday use, such as rooms, offices, corridors, stairways, and hallways, varying in size depending on their function—whether residential, administrative, public, etc.

The difficulty in discerning between compatible uses and scales represents a significant challenge, particularly in technical and architectural fields. This issue was also highlighted by the GFA and GIATA volunteers consulted during the activity's preparation. Specifically, regarding the built space methodology, these volunteers play a crucial role in defining approaches that facilitate the understanding of both the function and form of buildings. Another aspect of their involvement is preparing a training module for secondary school students to grasp the magnitude of physical and digital spatial scales and their relationship to the urban environment, building on the previous day's activity.

To this end, the principles of the game Minecraft are introduced, a tool previously employed in similar activities to develop spatial skills through the creation of worlds at different scales (Carbonell-Carrera et al., 2021). In this case, the methodology is adapted to focus on the understanding of spatial scales, their graphic representation, and the relationship between urban and built spaces. This is achieved by explaining the connection between the digital tools used in the game and spatial representation, using examples of classical models of representation through freehand drawing, where sketching serves as a traditional spatial tool translated into the digital context (Groleau et al., 2012). Regarding architectural space constructed in digital format, a practical demonstration is performed using the SketchUp program. This allows participants to relate spatial principles to the combination of basic geometric elements and understand how these elements can be used to configure a volumetric architectural program (Carmona-Medeiro, Antequera-Barroso, & Domingo, 2021).

The second part of the day consists of three practical exercises based on a classical representation model adapted to three constructed scales. The aim of these exercises is to reinforce the content covered in the training module. GFA and GIATA student volunteers also participate, helping to bridge the gap between educational levels. This pedagogical approach integrates theory and practice while carefully considering the appropriateness of the content for the participants' abilities and needs.

In the first exercise, participants are asked to represent their own room in detail, which is an excellent

way to teach the fundamental principles of spatial layout and composition within the context of built space. By using a familiar environment, they are given a practical and meaningful opportunity to apply the concepts learned in the training module. Through the analogy of container and content, the idea of how the elements of space interact and organize to create a coherent and functional spatial design is effectively conveyed. This exercise not only enhances their understanding of theory but also helps them appreciate the importance of planning and design in built spaces.

The second exercise involves using the human body as a spatially scaled reference element (Dewi et al., 2020). This strategy helps participants understand the relationship between their own body and the space they inhabit. This practice fosters awareness of their representation in space, which in turn deepens their understanding of the graphic communication between space as a container and the arrangement of furniture as content in their room. This understanding is crucial for appreciating how space design and organization can impact comfort and functionality in daily life.

In the final exercise, participants are tasked with graphically representing one of the buildings or urban landmarks on campus that they selected during the previous day's tour. This activity provides an excellent opportunity to practice and evaluate their spatial memory and representation skills. It not only helps them develop these skills but also fosters an appreciation for architectural details and the ability to represent them graphically. By choosing a building or landmark they personally experienced during the tour, they are encouraged to establish a deeper connection with the built environment of their campus. In summary, this exercise effectively concludes the workshop by applying the concepts and skills learned in the spatial context. Students are encouraged to develop a deeper spatial understanding by employing and combining drawing with the SketchUp tool concerning their built environment (room, housing, building, and street). Additionally, Minecraft is recommended as a tool for developing spatial strategies, encouraging students to connect the imaginative process with the principles of architecture and urban space they have learned.

Figure 4: Secondary School Students Performing the Constructed Walking Exercise.

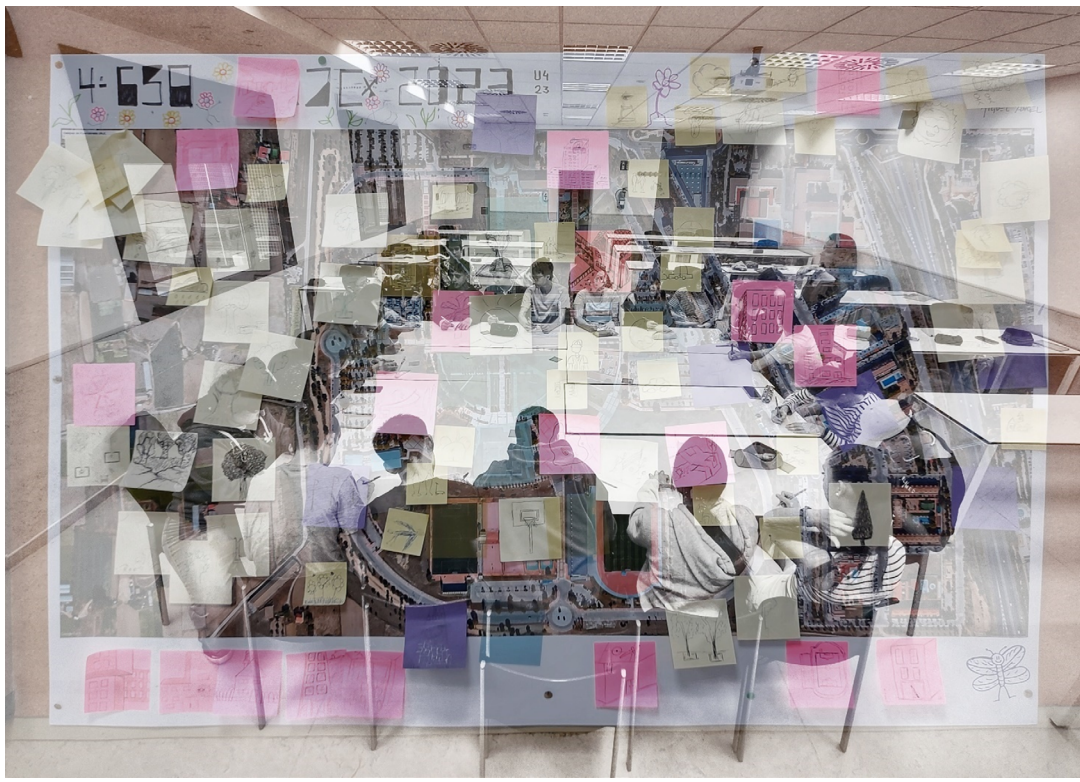
2.3. Day 3: Context Space Methodology

On the third day of the program, the collaborative approach was consolidated to encourage participation and joint learning among 4th ESO students. Following the TAC principles and the collaborative foundations of OpenStreetMaps, a teamwork methodology was promoted, involving all participants in constructing a

collaborative map of the Fuenlabrada campus. A large-scale printed orthophoto (A1 size) was provided as a solid visual basis for the project. Participants used sticky notes to mark spatial references and establish routes on the map based on common landmarks identified during their previous exercises.

This final exercise successfully integrated hybrid knowledge, encompassing both digital and classical elements, within a collaborative environment. The methodology allowed participants to apply theoretical knowledge and reinforced the importance of collaboration, communication, and the integration of digital and analog skills in urban and built space design and planning. This approach prepared them to address real-world challenges more effectively in their academic and professional futures.

Figure 5: Secondary School Students Performing the Context Exercise.



3. Results

In the 2023 edition of the 4th ESO+EMPRESA program, the methodology described in the previous section was implemented, yielding relevant results in the development of participants' spatial skills and the integration of digital and analog tools. The hybrid methodology applied in each workshop exercise enabled participants to address spatial challenges across different scales, perspectives, and media, fostering the development of digital skills while creating effective learning environments. Through two training modules and their real-world applications, the program stimulated interest in STEM disciplines among participants and provided a clearer understanding of the relationship between digital spatial applications and the urban and built environment. Detailed results for each specific methodology employed, along with their degree of innovation in spatial education, are presented below.

3.1. Exercise 1: Urban Space

The spatial orientation assessment conducted on the first day was completed by only 22 of the 45 participants enrolled in the program, as the others arrived at the classroom by different means. The test revealed that a significant proportion of 4th ESO students struggled with locating themselves

on a map (digital or physical) and following a travel direction based on the cardinal points. Only 5 of the 22 participants who took the test successfully positioned themselves on the campus map and followed the westward route to reach the training building. The remaining participants used the Google Maps application but encountered difficulties in understanding their direction of travel and spatial location.

The training module effectively established a meaningful connection between the digital world and the real world in the context of urban and built space. The challenge of navigating from the campus entrance to the classroom, along with the difficulties experienced, provided valuable lessons on reading digital maps, blueprints, and urban signage, and their relationship with mobility applications such as Google Maps. The walking exercise, which involved exploring open and enclosed spaces, contributed to an understanding of the differences in scale between urban planning and building design.

The explanation of the OpenStreetMaps application was crucial in relating essential landmarks used in urban navigation. This application helped participants understand how digital maps can represent and facilitate orientation within the urban environment. Additionally, it underscored the importance of unique buildings that break the urban monotony—landmarks that play a crucial role in creating mental maps and personal orientation.

Finally, the visit to unique buildings on campus allowed participants to experience the transition between indoor and outdoor spaces and understand the differences in interior space design. It also fostered the development of their spatial intelligence by challenging them to identify and remember landmark spaces within buildings. These hands-on lessons are essential for those seeking a deeper understanding of architectural design and space planning. This activity was crucial in improving their ability to navigate and comprehend the built environment.

In conclusion, the activities on the first day allowed participants to connect the digital environment with the real world and awaken their spatial skills. This hands-on experience provided participants with tangible evidence of the relevance and applicability of spatial skills in their daily lives and potential future careers. It also broadened their interest in space-related fields such as Engineering and Architecture by demonstrating the real-world value of these skills.

3.2. Exercise 2: Built Space

The training module helped participants relate spatial training using digital applications, common in Engineering and Architecture, to the cognitive process of spatial imagination for creating functional spaces. Tools such as SketchUp enabled participants to understand how basic geometry is applied in urban planning and building design, linking it to previous exercises involving imagination and memory. This approach allowed participants to effectively translate and represent classical environments in digital formats and vice versa.

The hybrid approach was crucial for participants to grasp the relationship between scales in known, imaginary, and digital spaces, and to develop fundamental graphic representation skills. This allowed them to appreciate spatial principles in built environments and their relationship to broader scales, such as urban spaces.

The results indicated that participants developed a solid understanding of spatial principles in built environments and made meaningful connections between the real and digital worlds within the context of Engineering and Architecture. This suggests that the methodology was effective in achieving its educational objectives by fostering an understanding and appreciation of spatial implications in designing and planning the built environment.

3.3. Exercise 3: Context Space

In the first two exercises, participants applied educational principles from technological environments (ICT) and creative and technological learning (CT) to address spatial concepts at different scales. On the third day, a collaborative exercise was introduced to consolidate participants' spatial perceptions within the Microcity of the Fuenlabrada Campus and to evaluate the use of tools from the training modules. Undergraduate volunteers and teachers supervised and assessed the process and representation solutions presented by the secondary school students. This exercise combined scales in collaborative settings,

integrating urban and building landmarks according to participants' interests and personal uses, thereby enhancing cognitive understanding of location, navigation, and spatial communication.

The main outcome of this activity was that secondary school students rediscovered their spatial awareness. Additionally, using digital examples for communication in learning, students effectively solved the spatial representation of the Fuenlabrada campus in both urban and built environments. The methodology also allowed participants to practice spatial visualization through imagination and abstraction, using colored sticky notes to collect spatial references through group consensus. Each color represented a different group, and consensus, according to Gardner's theory of multiple intelligences, was a key aspect of the learning process. This was evident in the collaborative map created by the 45 participants, demonstrating their ability to effectively understand and represent space as a whole.

Figure 6: Result of the Collaborative Context.

4. Conclusions

Reviewing contemporary educational models in the context of digital reculturalization is essential to balance the benefits of classical education with the development of digital competencies, especially given the challenges and opportunities presented by artificial intelligence. This review involves not only adopting advanced technologies but also transforming how knowledge is understood and conveyed in secondary school, high school and university. It is crucial to adapt models to various intelligences identified by Gardner, within a more inclusive framework, to enable all students to develop real skills.

This research demonstrated that, using classical and digital techniques, secondary school students could develop spatial skills. Those already possessing these skills were able to establish complex spatial correlations between classical, digital models, and the physical environment. Secondary education plays a fundamental role in developing spatial skills in future professionals. However, it often lacks a structured organization that allows students to progress effectively in spatial education. Furthermore, spatial skills are frequently limited to artistic formative itineraries focused on the representation of

figures and shapes, without a deep understanding of their environmental relationships or scaling in complex spaces like cities.

Secondary and high school students rarely approach the relationships between function, form, and scale except in technology subjects focused on three-dimensional representations. Although spatial training is offered in secondary education and high school, students often face significant difficulties in their early university years in Fine Arts or Architecture and Engineering programs.

Both 4th ESO students and volunteer undergraduate students expressed concerns about how space education is approached within the educational system. They noted that space education is often presented as isolated units without clear connections to other areas of study. This lack of integration is particularly problematic for students planning to pursue studies in Architecture or Aerospace Engineering, as spatial perception and representation are multidisciplinary and encompass various scales, from territorial and urban planning to smaller-scale construction problems.

The application of Gardner's theory of multiple intelligences in educational settings has proven to improve students' abilities in self-training and problem-solving, fostering intergenerational solidarity and academic interests that might otherwise be neglected. Positive results from this strategy in Spanish schools help address changes in the educational model and reduce high dropout rates (Antelm Lanzat et al., 2018).

For Engineering and Architecture degrees, it is crucial that secondary and high school students develop strong spatial skills. This workshop allowed secondary school students to explore university education in specific fields and evaluate its viability for their future training. However, pre-university training often focuses excessively on the visualization and manipulation of digital objects in three dimensions without an adequate understanding of context or scales. These aspects are crucial in the first years of university degrees and represent the greatest challenges for university students. Therefore, pre-university training should emphasize a deeper understanding of spatial concepts rather than just technical skills, whether digital or classical. This approach can help overcome difficulties that undergraduate students face when using new digital tools for design and simulation. Spatial knowledge also aids in understanding how these tools connect to the physical principles of Engineering and Architecture.

Thanks to the methodology implemented in the 4th ESO+EMPRESA activity, participants were encouraged to explore their personal skills and connect them to potential vocations and interests. This approach assisted them in making informed decisions regarding their choice of high school to best align with their aspirations. It is important to highlight that project- or workshop-based educational approaches, like those used in this activity, provide valuable opportunities to ignite students' interest in specific careers. This, in turn, contributes to reducing the risk of school dropout.

Additionally, the activity demonstrated that fostering interaction between participants, volunteers, and faculty is crucial for creating a positive impact on digital re culturalization. This approach not only enhances the development of spatial skills but also promotes collaboration among students to address the challenges presented in the workshop. The use of a hybrid methodology, combining digital tools with traditional drawing techniques, proved effective in helping participants relate essential spatial concepts. This represents a key scientific contribution of the workshop, as it moves beyond the usual focus on digital innovation seen in many Architecture and Engineering programs. By highlighting the advantages of both digital and traditional tools, students were encouraged to explore and develop their spatial concepts independently. However, it was noted that while students preferred digital tools, these did not always fully meet the objectives of the activities. This underscored the importance of faculty and volunteer guidance in effectively integrating and applying both digital and classical tools to enhance spatial skills development.

As a result of the experience, it is notable that the methodological program, developed in collaboration with the volunteer undergraduate students from the Fuenlabrada School of Engineering, successfully imparted valuable skills to the secondary school participants. The program highlighted the importance of integrating digital and traditional skills, enhancing cognitive development not only for their current education but also for their pre-university orientation. Many participants expressed an interest in pursuing careers in Architecture and Engineering, indicating that the workshop not only provided new knowledge and skills but also sparked a genuine interest in STEM disciplines. Consequently, the workshop contributed

significantly to the development of spatial cognitive skills and helped to inspire potential career paths among the participants. Given the success of these outcomes, future editions of the Science and Innovation Week organized by Fundación Madri+d will continue to incorporate combined thematic workshops. These future workshops will aim to explore spatial intelligence alongside other forms of intelligence, engaging a diverse range of participants across different levels of training.

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