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Active learning approaches in the multidisciplinary development of spatial skills[1]

Enfoques de aprendizaje activo en la formación multidisciplinaria de competencias espaciales

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Abstract

Active methodologies have proven effective in facilitating the understanding of complex content, particularly in artistic and spatial disciplines. This study examined the implementation of Project-Based Learning (PBL) and the Flipped Classroom model with 50 students organized into groups who, over 14 weeks, worked on the thematic analysis of a real scenographic space. Activities were structured progressively and assessed using rubrics and peer-to-peer (P2P) evaluation, fostering continuous, collaborative feedback. The results showed significant improvement in the practical application of knowledge, academic performance, and teamwork. Additionally, interest in the interdisciplinary nature of spatial analysis increased. The approach also enhanced key skills, including critical thinking, creativity, and decision-making. Constructing a tangible scenography is recommended as a practical complement to enrich the learning experience further.

Keywords: architecture, interior architecture, theatre, building design, literature.

Resumen

Las metodologías activas han demostrado ser eficaces para facilitar la comprensión de contenidos complejos, especialmente en áreas artísticas y espaciales. Este estudio analizó la implementación del Aprendizaje Basado en Proyectos (ABP) y el Aula Invertida con 50 estudiantes organizados en grupos, quienes durante 14 semanas trabajaron en el análisis temático de un espacio escenográfico real. Las actividades se estructuraron de forma progresiva y se evaluaron mediante rúbricas y evaluación entre pares (P2P), lo que promovió una retroalimentación constante y colaborativa. Los resultados evidenciaron una mejora significativa en la aplicación práctica del conocimiento, en el rendimiento académico y en el trabajo en equipo. Además, se incrementó el interés por la dimensión interdisciplinaria del espacio. La propuesta también fortaleció habilidades como el pensamiento crítico, la creatividad y la toma de decisiones. Se sugiere incluir la construcción de una escenografía tangible como refuerzo práctico para enriquecer la experiencia de aprendizaje.

Palabras clave: arquitectura, arquitectura interior, teatro, diseño arquitectónico, literatura.

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Introduction

In the field of visual arts, both theories and methodologies related to spatial skills (Moral-Sánchez, et al., 2023), particularly the characterization and thematization of spaces, have acquired an essential structural role in formal analysis and the creation of artworks, regardless of their communicative, expressive, or functional purpose.

These theoretical tools allow for an approach to the artistic work based on a structural understanding of its components, in which the analysis of forms serves as a key interpretative vehicle. In this context, the notion of spatiality emerges as a fundamental dimension in the configuration and reading of any visual, scenic, or graphic work.

Artists from various disciplines recognize space not as a passive element, but as an essential active entity that directly intervenes in the creation, perception, and meaning of the artwork (Yates, 2002). Thus, if we accept that space is inherent to all visual constructions, it is reasonable to conclude that every artistic manifestation necessarily involves a spatial dimension (Orta, 2010).

The study of space presents significant conceptual challenges due to its polysemic and cross-disciplinary nature. It is not an exclusive concept of technical-scientific fields such as architecture or engineering, but one that disciplines like psychology, sociology, economics, and even philosophy have also adopted as an object of study, given its influence on human dynamics (Calderón Guerrero & Lozada Nava, 2021).

From an objective perspective, space can be defined as the medium in which multiple elements coexist simultaneously, and whose relationships and distances can be quantified (Moliner, 2007). However, contemporary approaches have added layers of complexity by incorporating sensory, social, and cultural dimensions (Quiroga, 2024). Thus, space not only contains physical elements but also generates social and cultural connections over time (Panadero, 2000).

The dual nature of space—as emptiness and as container—makes it a conceptually complex entity to define, as it involves both the capacity to hold matter and to be determined by it (Soriano Colchero, 2021). Theoretically, the human relationship with space can be classified into three fundamental modes: the vital experience of inhabiting it, the pragmatic interaction of modifying or traversing it, and the symbolic and cognitive representation through which it is analyzed, interpreted, and communicated (Albrecht, 1981).

Consequently, any approach to the study of space requires an integrative perspective that considers its multiple geometries and the dynamic relationships between its components (Soriano Colchero, 2021). This analysis should also include the symbolic transformations that convert spaces into places or *locus* (de la Torre Dávalos, 2022), that is, entities imbued with cultural meaning (de Mola López et al., 2024).

From an educational and methodological perspective, formal architectural analysis is an essential tool for understanding the structural aspects of designed spaces (Baker, 2007). This practice relies on two key processes: characterization, which involves a descriptive phase where the essential attributes of an object or environment are identified (Bonilla et al., 2009); and thematization, understood as the act of intentionally endowing a space with identity through the creation of a narrative and symbolic context that influences its collective perception (Díez, 2015).

These tools, through their various methodologies, facilitate the breakdown and understanding of visual elements from a systemic perspective, addressing not only their formal characteristics but also their ability to express complex ideas, emotions, or concepts. Characterization, seen as the process of identifying and representing the essential visual traits of a form or object, and thematization, which structures these traits within a coherent narrative or conceptual framework, have gained increasing importance in both visual analysis and creative processes by enhancing the communicative effectiveness of images. The integration of formal principles such as symmetry, balance, proportion, or rhythm, along with the foundational rules governing the organization of visual components, is key to solidifying this knowledge (Baker, 2007).

From a pedagogical standpoint, creative disciplines have incorporated the study of characterization and thematization as fundamental pillars in the training of professionals in design, visual arts, and related fields. Various studies emphasize that this methodological approach not only enhances students' technical skills but also fosters the development of critical and reflective competencies—skills that are increasingly vital in contemporary artistic practice (Contero et al., 2009). Furthermore, these spatial learning strategies enable a deeper understanding of the various ways individuals interact with spaces—whether tangibly or symbolically—and the tools used to represent those interactions (Sepúlveda Sepúlveda, 2018).

The content of disciplines focused on spatiality, traditionally embedded in Architecture and various Engineering programs, is particularly well-suited to be addressed through teaching methodologies that emphasize experiential, autonomous, and self-regulated learning. This approach aligns with the educational coaching model, understood as a process in which the tutor acts as a continuous guide and support throughout project development (Carcelén

González, 2019). These innovative learning dynamics are crucial in today's educational landscape, marked by the rise of digital technologies, widespread access to information, and the new forms of social interaction prevalent among students (Agramonte Rosell & Villacis Macias, 2024).

Within these so-called active methodologies—such as Project-Based Learning (PBL), the flipped classroom model (Somaa, 2024), and collaborative learning strategies—a learning environment is fostered in which students become the main protagonists of their own learning process. Through these dynamics, knowledge is acquired in a more direct, participatory, and immersive way, which increases both comprehension and content retention (Flores Zaragoza et al., 2024). Moreover, this approach is not limited to the acquisition of technical or theoretical knowledge, but also contributes to the development of fundamental transversal competencies. These include adaptability to changing contexts, creative problem-solving, and improved communication and teamwork skills. In this sense, students move beyond their traditional role as passive recipients of content and adopt a more active, critical, and participatory role in their own educational process (Sánchez et al., 2022).

The integration of active methodologies in higher education becomes especially relevant in disciplines where design analysis and spatial awareness take center stage. Due to their complexity, these fields require approaches that go beyond simple problem-solving and are better aligned with methodologies such as Project-Based Learning (Flus et al., 2024).

This is because the creative processes inherent to design are framed within ill-structured tasks—open-ended problems with no single correct solution or predefined path to reach it (Borgianni et al., 2024). For this reason, Problem-Based Learning is not the most suitable method in such contexts (García Martín & Pérez Martínez, 2018). In addition, these ill-structured tasks typically lack clearly defined objectives or closed contexts, requiring students to make their own decisions throughout the process.

This characteristic turns the task into a complex challenge that often unfolds over time and involves multiple resolution phases (Jonassen, 1997). As a result, sharing the process and outcomes becomes highly valuable. This shift justifies the transition from individual learning to interdependent learning, where peer interaction—through P2P (peer-to-peer) dynamics—encourages debate, co-evaluation, and the collaborative construction of knowledge (Chandra & Palvia, 2021).

The aim of these strategies is to foster active, experience-based learning that enhances both creativity and a deeper understanding of the content. At the same time, this approach promotes a critical mindset and greater motivation among students (Alba-Dorado et al., 2019).

Objectives

Building on the previously established theoretical and methodological framework, this research proposes the implementation of a teaching strategy based on active methodologies, specifically Project-Based Learning (PBL), with the goal of fostering students' competency development through an approach that combines "learning by doing" with "learning how to learn" (Skulmowski, 2024).

This proposal is grounded in extensive empirical evidence supporting the effectiveness of PBL as a pedagogical tool in university contexts, highlighting its ability to promote active student engagement, the resolution of real-world problems, and a coherent connection between theoretical content and its practical application (Krajcik et al., 2024).

The central aim of this project is to implement an active methodology centered on Project-Based Learning (PBL) to study forms in space, specifically aimed at university students pursuing a degree in Integrated Design. This teaching approach seeks to ensure that students not only internalize the theoretical foundations related to the notion of spatiality but also acquire practical skills that enable them to develop critical analyses within the framework of a design project experience.

The PBL methodology favors active immersion in authentic situations that stimulate a more meaningful and profound understanding of content, while promoting the integration of knowledge into practical contexts closely aligned with professional realities. Moreover, it is expected that the activities proposed within the project will contribute to increasing student motivation, encouraging their direct involvement in the learning process, and enhancing their ability to effectively apply the acquired knowledge.

This general objective is further refined into a set of specific goals that guide both the implementation and subsequent evaluation of the methodological proposal. These goals are outlined as follows:

- Understand and assimilate the key theoretical concepts related to the characterization and thematization of space.
- Develop a personal methodology for analyzing spatiality and visual forms.
- Apply the analytical techniques and tools presented by the instructor within the context of a practical project.
- Develop communication skills that enable the clear presentation of both the results obtained and the process followed.

- Acquire the ability for critical analysis of the proposals made by other peers, thus promoting a culture of formative evaluation and collaborative learning.

The final objective of this project is to strengthen the interdisciplinary approach to the concept of space, which has been previously discussed in the introduction of this communication. In this regard, the teaching team has decided to focus the project on a theme that facilitates the exploration of various areas of knowledge, specifically in the field of theatrical scenography. This choice aims not only to deepen the spatial analysis from a technical perspective but also to connect different disciplines, such as the visual arts and dramatic literature, which will enrich the students' comprehensive education.

To achieve this goal, a project has been proposed that focuses on the characterization and thematization of the dramatic space designed by architect Virgilio Marchi (Italy, 1895-1960) for the first act of the play *Enrico IV* (Pirandello, 1956) by the renowned playwright Luigi Pirandello (Italy, 1867-1936), whose first performance took place in 1922 (D'Amico and Tinterri, 1987, pp. 159). The dramatic work, known for its complexity and its profound analysis of the human condition, represents an excellent opportunity to examine how theatrical space contributes to the interpretation and understanding of the same drama. This play was chosen for their significant theatrical qualities, distinguished by their rich textual complexity (Iglesias, 2025).

Through this project, students are expected not only to acquire theoretical and technical tools for the study and analysis of a space but also to interrelate related disciplines, such as visual arts in scenography and dramatic literature, fostering a more holistic understanding of spatial design within specific cultural contexts. In this way, the aim is for students to develop a multidisciplinary vision that allows them to approach space not only as a physical, material, and technical component but also as a symbolic and dynamic element that interacts with other artistic languages, also related to spatiality. This approach will allow students to expand their analytical and creative capacity in the field of integrated design, adding a broader dimension to their academic and professional training.

3. Methodology

The pedagogical approach proposed in this communication is based on the implementation of active methodologies, highlighting Project-Based Learning (PBL), which promotes a "learning by doing" approach rather than following the traditional model focused on passive theoretical teaching. The design of this methodological process is inspired by the principles established by García Martín and Pérez Martínez (2018), who emphasize the importance of involving students in the practical learning process, allowing them to apply the concepts acquired through a specific project.

In this way, students are faced with the direct application of knowledge, addressing a real project that allows them to make informed decisions and perform critical analyses. This methodological approach emphasizes the need to transform theory into practice, which is essential for the development of competencies that facilitate solving complex problems in the field of design and planning. Instead of limiting themselves to learning concepts abstractly, students encounter specific situations that require them to adapt their knowledge to real contexts, contributing to a deeper and more contextualized understanding.

The theoretical knowledge necessary for the proper execution of the project is provided to students through the Flipped Classroom methodology, using the university's Virtual Campus. Through this model, essential bibliographic materials and relevant resources are provided to allow students to build the theoretical foundation prior to the practical phase of the project. This approach favors learning autonomy, enabling students to manage their time efficiently and adequately prepare before tackling the practical tasks, thus promoting a more effective integration of theory and improving their performance in the project.

The group of participants in this project consists of 50 students from a university in Madrid, all of whom are enrolled in the Bachelor's Degree in Integrated Design.

The students who took part in the study were selected from pre-existing groups within a Space Design subject, offered in the final year of the academic program.

The inclusion criteria were:

- being enrolled in the course during the semester in which the study was conducted,
- having completed at least 80% of the program credits,
- having previously taken the Interior Design and Project courses,
- and providing informed consent to participate in the research.

No additional exclusion criteria were established.

The composition of the 50 students is summarized in the following table (see Table 1):

Table 1.

Student Profile

Age Range	Self-Perceived Gender	Number of Students
22-25 years	Woman	23
	Man	14
	Other genders	1
25-30 years	Woman	6
	Man	4
	Other genders	0
30-34 years	Woman	0
	Man	2
	Other genders	0

Note: Source: Own elaboration.

This group is characterized by a notable diversity of educational backgrounds, which significantly contributes to the dynamics of learning, creating an environment conducive to interaction and collaboration among students. Such diversity in approaches and experiences fosters a constant exchange of ideas, enriching the educational process and promoting the generation of innovative solutions through collective work (Macías Borrego, 2024).

To maximize interaction and promote effective collaboration both among students and with the instructors, the participants have been organized into 10 groups of 5 students each. The students were randomly assigned to these groups through the platform that hosts the university's virtual learning environment. This structure not only facilitates closer and more collaborative work but also allows instructors to provide more personalized supervision, ensuring that each group receives the necessary support to progress in their development and achieve their learning objectives.

The proposed project focuses on the critical analysis of a real scenographic space, which provides students with the opportunity to apply a variety of techniques and theories related to the characterization and thematization of spaces. Throughout this exercise, students have the chance not only to strengthen their analytical skills but also to explore the interaction between the physical and symbolic elements of the space, understanding how these contribute to its function and the message it conveys. The project is organized into a series of successive tasks that allow for a practical and progressive approach to learning, ensuring that students can effectively assimilate and apply the concepts and techniques they have learned (see Table 2)

Table 2.

Task System within the Project-Based Learning approach proposed.

Task	Description
Task 1	Research process. Proposal to create a manual or white paper on the characterization and thematization of spaces.
Task 2	Creation of a description sheet for spatial analysis.
Task 3	Application of the methodology developed in the tables from Task 2 to the scenography of Enrico IV by Marchi for Pirandello.
Task 4	Presentation and communication of the results obtained. P2P process.

Note: Source: Own elaboration.

The project will be carried out over a period of 14 weeks, with a structured plan that offers a progressive and continuous approach in which different aspects of spatial analysis are addressed throughout the various sessions (see Table 3). This time distribution is designed to provide students with adequate opportunities to conduct in-depth research, reflect on the concepts learned, and effectively apply the techniques of spatial characterization and thematization discussed.

Throughout the process, students will receive feedback from both peers and instructors, allowing them to adjust their work and improve continuously. The session planning facilitates ongoing monitoring of each group's progress, ensuring that all participants are aligned with the project's objectives and can receive personalized support when necessary.

In addition, this approach enables students to gradually face the challenges of the project, reinforcing their learning through practice, reflection, and peer collaboration. In this way, the organization of the project supports a dynamic teaching-learning process, in which students have the opportunity to continuously enhance their skills in a manner adapted to the project's demands.

For the completion of the tasks associated with the different stages of the process, students were granted continuous access to the institutional resources and learning infrastructure made available by the university.

Table 3.

Planning and Distribution of Sessions within the Proposed Project.

Week	Activity		
1	Introduction and Pre-test		
2	Group Distribution and Task Assignment		
3-5	Task 1	3	Research Process
		4-5	Manual Development
6	Group Tutoring Session 1		
7	Task 2		
8	Group Tutoring Session 2		
9-12	Task 3	9-10	Research Process
		11-12	Spatial Analysis Application and Results Development
13-14	Task 4	13	Preparation of the Presentation and Communication. Selection of Materials.
		14	Presentation Session of Results (P2P)
			Post- Test

Note: Source: Own elaboration.

Assessment played a key role in the conclusion of the Project. Its design made it possible to evaluate both the individual performance of each student and the quality of the work carried out by the team as a whole.

To achieve this, various assessment methodologies were implemented, offering a comprehensive perspective on the learning process and project development. Students were assessed based on their active participation, level of commitment to the research process, and their individual contributions to the final outcome of the project.

Assessment served a dual purpose: it measured the students' involvement in completing specific tasks as well as their engagement in collaborative group interactions. To ensure objectivity and clarity, detailed rubrics were used, allowing for precise measurement of the achievement of the stated objectives. Additionally, evaluation took place at both individual and group levels, enabling a balanced assessment of personal performance and students' ability to work effectively in a team.

This methodology offered a comprehensive, well-defined, and detailed view of the project process, allowing for the identification of individual achievements and the collaborative interactions among students within each group. The final assessment considered several key aspects, such as the responsibilities assigned to each member, each student's individual contribution, and the overall quality of the materials developed by the group.

These assessment components proved fundamental in ensuring that each student's participation in the overall project was considered, along with their capacity to collaborate effectively and apply the knowledge acquired throughout the course.

All of this provided a balanced framework to evaluate both the process and the final learning outcomes. The detailed evaluation of all these aspects is presented in the following table (see Table 4).

Table 4.

Proposed Assessment within the Project.

Activity	Role	Assessment Tool	Percentage of Final Grade
Task 1	Individual Work	Rubric	10%
	Group Participation		10%
Task 2	Individual Work	Rubric	10%
	Group Participation		10%
Task 3	Individual Work	Rubric	15%
	Group Participation		15%
Task 4	Group Participation	P2P Rubric	30%

Note: Source: Own elaboration.

In summary, the methodological concepts applicable to this experience are presented in the following table, organized according to the tasks and objectives to be achieved (see Table 5).

Table 5.

Methodological Framework: Tasks and Achievable Objectives.

Object	Dimension	Indicator	Evidence	Levels
Mental rotation	Spatial manipulation	Time & accuracy	Pre/post standardized items	Init: many errors, low precision · Int: medium accuracy, needs aids · Adv: >80% accuracy, moderate time · Exp: >90% accuracy, fast and consistent
3D from 2D	Volumetric reconstruction	Accuracy in 3D from 2D	Tasks 2–3 deliverables	Init: incomplete or major errors · Int: mostly correct, partial mistakes · Adv: accurate with small adjustments · Exp: precise, conceptually justified
Part–whole & scale	Dimensional coherence	Consistency in measures	Task 2 tables/graphics	Init: incoherent measures/scales · Int: mostly correct dimensions · Adv: precise with minimal deviations · Exp: precise and able to justify choices
Plan reading	Symbols & projections	Errors in interpretation	Tutorials + Task 2	Init: frequent confusion of symbols/views · Int: generally correct with doubts · Adv: accurate, rare clarifications · Exp: interprets confidently, explains to peers
2D ↔ 3D in PBL	Theory–project link	Quality of analysis	Task 4 P2P + team work	Init: fragmented, weakly grounded · Int: partial, basic theory–practice link · Adv: coherent and well supported · Exp: critical, innovative, contextualized analysis

Note: Source: Own elaboration.

4. Results

The results obtained in this study indicate that the "learning by doing" approach, implemented through Project-Based Learning (PBL), has a positive impact on students' ability to understand and analyze forms, as well as on their capacity to apply acquired theoretical concepts in practical situations.

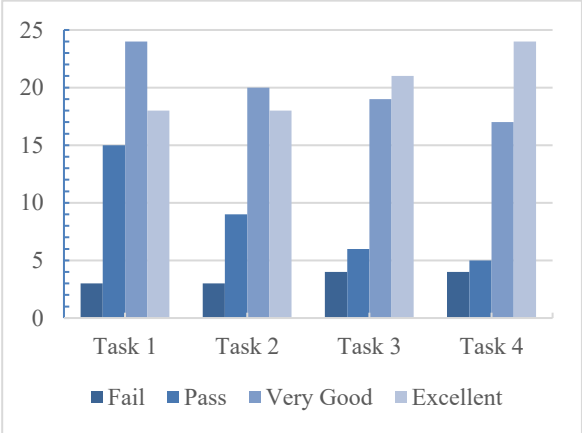
To carry out a comprehensive assessment of this experience, both the academic results achieved by students and their overall perception of the process—collected through the Post-Test conducted at the end of the project—are presented. This approach provides a more complete view of the effect the learning methodology had on their educational development, as well as on the enhancement of key competencies in the field of design.

This active methodological approach not only facilitates the acquisition of necessary theoretical knowledge but also allows students to develop practical skills essential to their future professional careers. By implementing action-centered activities, students are exposed to real-world scenarios in which they must apply the previously learned concepts. This process not only strengthens their theoretical understanding but also equips them with more effective tools to address and solve complex challenges that may arise in their professional paths.

In this context, the results related to students' curricular performance show that outcomes were highly favorable. Specifically, 92% of students successfully reached the required performance level within the proposed Project framework, as clearly reflected in the analysis presented in Figure 1.

Figure 1.

Evaluation Results by Task within the Project



Note: Source: Own elaboration.

These results not only demonstrate that the students fulfilled the established objectives, but also highlight the effectiveness of the pedagogical strategies applied

throughout the Project, emphasizing the importance of an active and practical approach to learning.

The results presented indicate a clear improvement in student performance across the evaluated tasks. There is a progressive increase in the number of students achieving an Excellent grade, rising from 18 in Task 1 to 24 in Task 4. In contrast, the number of Pass and Very Good grades shows a decreasing trend: Pass grades declined from 24 in Task 1 to 17 in Task 4, while Very Good grades dropped more sharply, from 15 to 5 over the same period.

As for Fail grades, these were associated with students whose attendance was irregular or who did not participate in the assessments. In the final evaluation, 42% of students earned an Excellent grade, and 36% received a Very Good grade. These results suggest a progressive consolidation of learning, as a growing number of students were able to reach higher levels of achievement as they advanced through the project tasks.

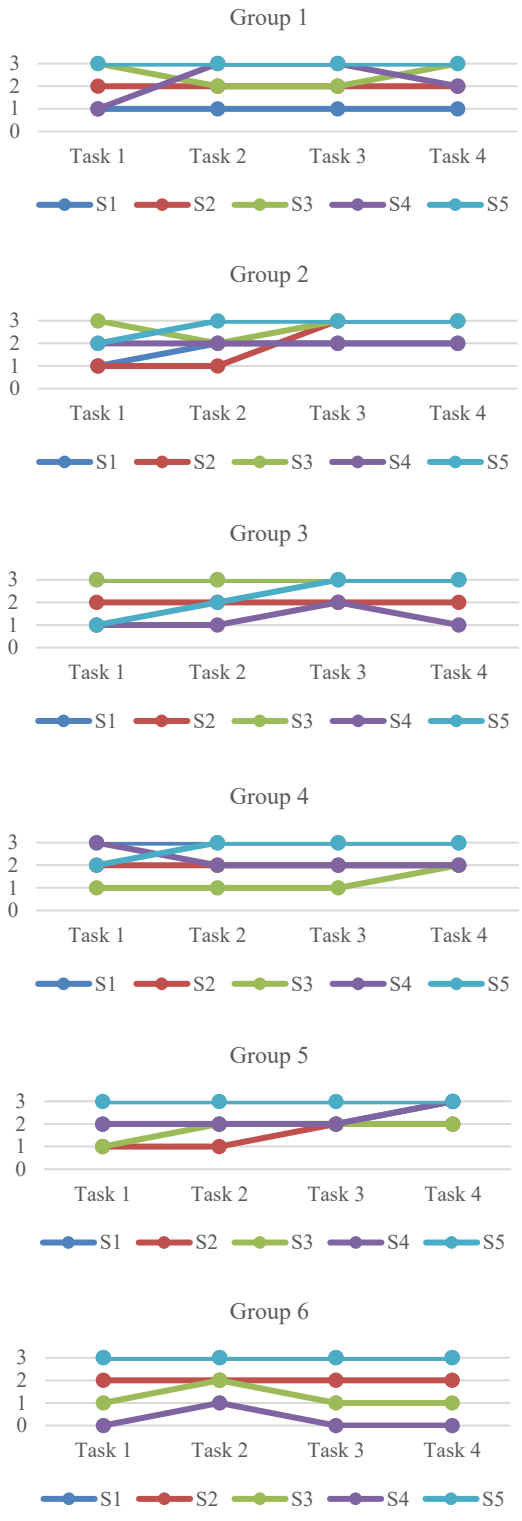
The implementation of the "learning by doing" methodology enabled students to develop valuable teamwork skills, while reinforcing their theoretical knowledge through practical application. Within this context, students assumed roles as both learners and future professionals, allowing them to practice essential competencies such as decision-making and problem-solving.

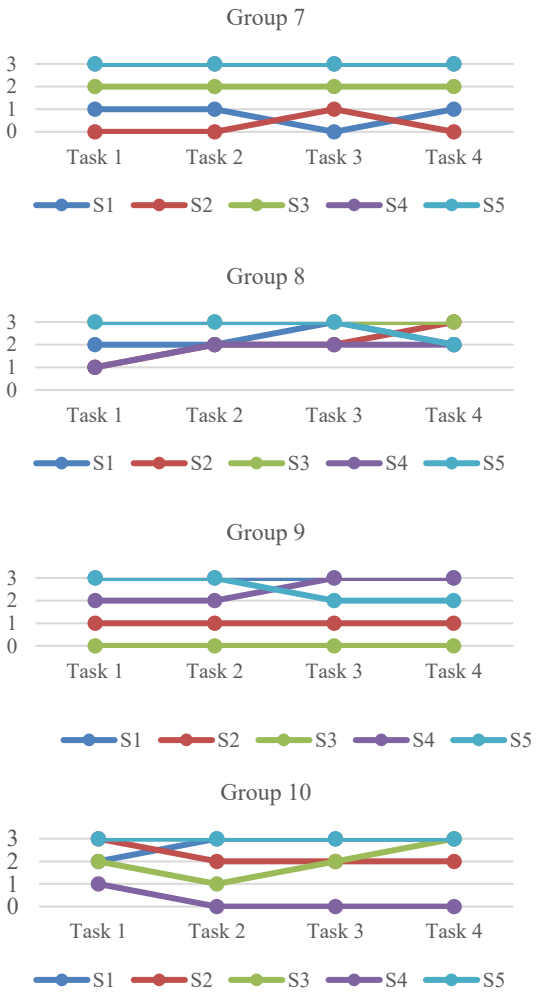
This approach provided them with the opportunity to recognize their own potential while simultaneously strengthening their skills, thereby enhancing their confidence and professional capabilities.

In summary, the next figure (see Figure 2) is presented to provide a comprehensive overview of the task progression for each participant within the respective groups. This figure illustrates the evolution of individual contributions over the course of the study, allowing for a clear comparison of performance and engagement across all participants

Figure 2.

Student performance by group and by task.





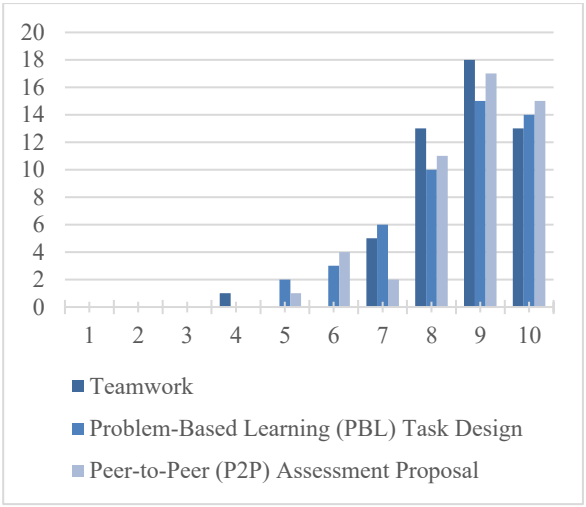
Note: In the figure, 'S' denotes a student. Similarly, the vertical axis values in the figures correspond to the following performance levels: 0 = Fail; 1 = Pass; 2 = Very Good; 3 = Excellent.

Source: Own elaboration.

The following figure (see Figure 3) presents the Post-Test evaluation from the student group regarding teamwork and the methodology applied.

Figure 3.

Assessment of the methodology in the Post-Test.



Note: Source: Own elaboration.

The previous figure illustrates the average ratings provided by students regarding three key dimensions: teamwork, the design of tasks under the Problem-Based Learning (PBL) approach, and the proposed Peer-to-Peer (P2P) assessment. These ratings are expressed on a scale from 0 to 10, where 0 represents the lowest rating and 10 the highest. A positive trend is observed in the results, with a significant concentration of responses at the score of 9, which is the most frequent in all three evaluated aspects: 36% for teamwork, 30% for task design, and 34% for P2P assessment. This pattern suggests a highly favorable perception by students regarding the methodological components used in the project.

Furthermore, the development of the project has fostered the acquisition of key transversal competencies, such as critical analysis, creativity, and the ability to solve complex problems—skills essential for both academic performance and the professional future of students. As they faced applied contexts, students not only consolidated specific knowledge but also strengthened abilities that transcend the boundaries of the subject.

In particular, there is a notable involvement of students in collaborative tasks and those that required complementary skills, such as documentation structuring, the creation of visual materials, and the effective communication of ideas. This trend suggests that the methodological proposal not only facilitates the learning of content but also stimulates the holistic development of students.

Finally, the interdisciplinary dimension that characterizes this methodological proposal proves to

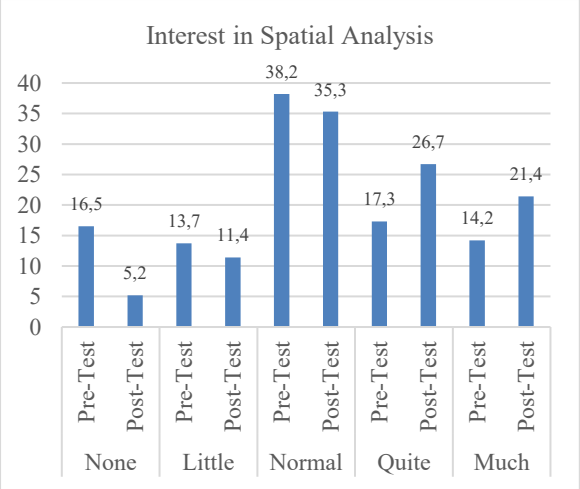
be a decisive factor in the achievements obtained. The combination of knowledge from fields such as visual arts, architecture, and literature enriches the students' analytical approach, enabling them to tackle projects from multiple angles.

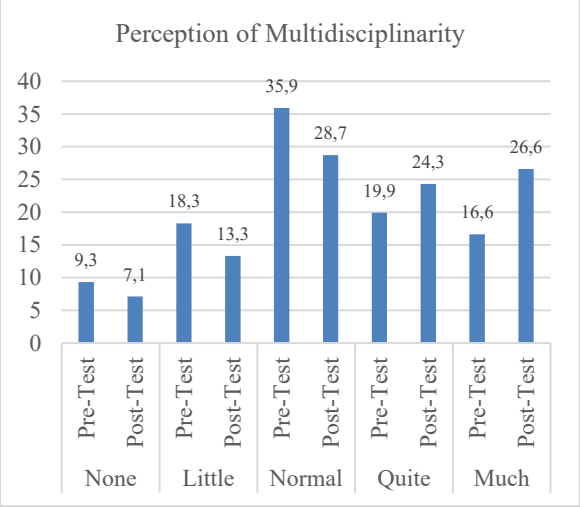
This intersection of disciplines not only broadens students' conceptual understanding but also strengthens their ability to make connections across various areas of knowledge, promoting a critical, creative, and reflective attitude. Moreover, this approach fosters collaborative learning environments where the exchange of perspectives is constant and valuable—an indispensable quality in a dynamic and interconnected professional market.

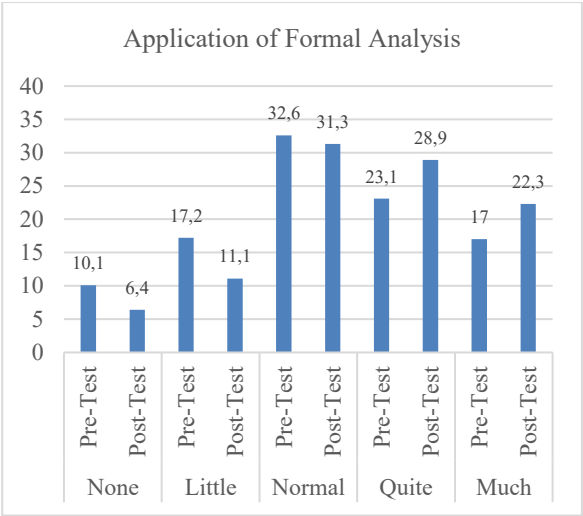
In line with this, the results obtained in the Post-Test show an increase in students' interest upon discovering the multidisciplinary potential of formal analysis, which positively impacts their motivation and assessment of the course at the conclusion of the project (see Figure 4).

Figure 4.

Comparison of Pre-Test and Post-Test Results.







Note: Source: Own elaboration.

The analysis of the data presented in Figure 3 highlights a notable advancement in the three evaluated indicators following the implementation of the project. Regarding the interest in spatial analysis, a significant growth is observed in the highest rating category, "Much", which increased from 14.2% in the initial phase (pre-test) to 21.4% after the intervention (post-test), representing a relative increase of 50.7%. Likewise, the "Quite" category also shows a remarkable improvement, rising from 17.3% to 26.7%, with a positive variation of 9.4 percentage points. These increases in the higher ratings are accompanied by a clear reduction in the less favorable categories, such as "None", which decreased from 16.5% in the pre-test to 5.2% in the post-test, reflecting a 68.5% drop. These results demonstrate a clear change in students' perceptions, indicating increased interest and motivation toward spatial analysis after participating in the project.

Concerning the perception of multidisciplinarity, the results show a clearly favorable evolution. The "Much" option, corresponding to the highest rating level, experienced a notable increase, rising from 16.6% in the pre-test to 26.6% in the post-test, representing an absolute improvement of 10 percentage points. Similarly, the "Quite" category also showed an upward trend, increasing from 19.9% to 24.3%. On the other hand, the lower ratings—"Little" and "None"—decreased significantly, reinforcing the impression of a greater appreciation by students for the integration of various disciplines in the project. Specifically, the "None" category was reduced from the initial 9.3% to 7.1% after the implementation, highlighting the positive impact of the experience on students' awareness of the value of multidisciplinarity.

Regarding the application of formal analysis, the data reflect a relevant improvement following the project experience. The "Much" option, representing the

highest level of engagement, increased from 17% in the pre-test to 22.3% in the post-test, representing a relative growth of 31.2%. Similarly, the "Quite" category rose from 23.1% to 28.9%, translating to an improvement of 5.8 percentage points. These increases correspond to a decrease in the lower ratings: for example, the "None" category experienced a significant drop, decreasing from the initial 10.1% to 6.4% in the final evaluation, which represents a 36.6% reduction.

In general terms, the results obtained confirm that the intervention had a favorable impact on the three analyzed indicators. The responses corresponding to the highest levels of rating, "Much" and "Quite", show significant increases in all cases, suggesting an improvement in student engagement and understanding. At the same time, there is a sustained reduction in the lower categories, "Little" and "None", which reinforces the idea of a positive evolution in students' perception and skill development. This consistent trend in the results points to a consolidation of learning and validates the effectiveness of the pedagogical strategies implemented throughout the project.

In summary, based on the initially proposed table (see Table 5), the results obtained are presented in the following table (see Table 6). In this new table (Table 6), the columns Dimension, Indicator, and Evidence have been removed for improved readability and comprehension, as they are the same as those presented in Table 5.

Table 6.

Methodological Framework: Tasks and Achievable Objectives of the results.

Object	Levels	Interpretation
Mental rotation	Init: 10.1 / 17.2 / 32.6 / 23.1 / 17.0 · Post: 6.4 / 11.2 / 31.3 / 28.9 / 22.3	Improvement at high levels (Fair+Much 40.1% → 51.2%): students increase declared ability to apply mental rotation
3D from 2D	Init: 10.1 / 17.2 / 32.6 / 23.1 / 17.0 · Post: 6.4 / 11.2 / 31.3 / 28.9 / 22.3	Increased practical application: lower "None/Little" and higher "Fair/Much" suggest better 2D→3D transfer
Part–whole & scale	Application Init: 10.1/17.2/32.6/23.1/17.0 — Perception Init: 9.3/18.3/35.9/19.9/16.6 · Application Post: 6.4/11.2/31.3/28.9/22.3 — Perception Post: 7.1/13.3/28.7/24.3/26.6	Joint increase: application +11.1 pp, perception +14.4 pp; shows improvement in execution and awareness of scale importance
Plan reading & projection systems	Init: 10.1 / 17.2 / 32.6 / 23.1 / 17.0 · Post: 6.4 / 11.2 / 31.3 / 28.9 / 22.3	"None/Little" decreases and "Fair/Much" increases: fewer declared errors, higher confidence in plan reading
2D ↔ 3D in PBL	Application Init: 10.1/17.2/32.6/23.1/17.0 — Interest Init: 16.5/13.7/38.2/17.3/14.2 · Application Post: 6.4/11.2/31.3/28.9/22.3 — Interest Post: 5.3/11.4/35.3/26.7/21.4	Clearly positive: Interest rises strongly at high levels (+16.6 pp); Application also improves (+11.1 pp), suggesting higher engagement and better practical transfer in PBL

Note: Source: Own elaboration.

5. Discussion

The results obtained in this study allow us to assert that the introduction of scenography as an authentic learning context constitutes an effective pedagogical strategy for teaching spatial and design competencies in higher education.

The observed evolution in academic performance, with a significant increase in "Excellent" grades and a reduction in lower categories, as well as the heightened interest in spatial analysis and appreciation for interdisciplinarity, provide consistent evidence that situating learning within a scenographic framework is not only motivating but also facilitates the transfer of knowledge and skills. However, understanding the mechanisms underlying these changes requires a critical engagement with recent literature on situated learning, distributed cognitive load, co-creation, and the transfer of spatial skills.

Firstly, from the perspective of situated learning, the findings align with the proposals of Lave and Wenger (1991) and subsequent developments emphasizing the importance of authentic and contextualized settings for meaningful knowledge acquisition (Lave & Wenger, 1991). The fact that students engaged with a problem anchored in a real and recognizable referent—the scenography—appears to have enhanced the perceived relevance of the task, which in turn translated into greater intrinsic motivation. The post-test results, showing an increase in the "Much" category for interest in spatial analysis (+50.7%), confirm that contextualization not only reduces ambiguity, as noted in previous studies (Drasgow et al., 2024), but also acts as a catalyst for sustained engagement. This

combination of clarity and motivation nuances the existing literature: whereas some studies suggest that the thematization of spaces may introduce distractions (López & Salas, 2019), in our case a synergistic effect between thematization and deep learning was observed.

Regarding distributed cognitive load, our data suggest that the use of graphic materials and the opportunity to transition from 2D representation to 3D manipulation functioned as supports that freed cognitive resources, facilitating comprehension and problem-solving. The progression in the categories of formal analysis and application, with a notable increase in responses rated as "Much," reinforces the hypothesis that visual externalization of tasks operates as a form of cognitive scaffolding.

The third axis of analysis concerns co-creation and peer feedback. The high valuation of peer-to-peer assessment (34% at the maximum score) and its association with the progressive increase in academic performance indicate that this component not only strengthened the collaborative dimension but also stimulated processes of self-regulation and critical thinking. These findings are consistent with recent research highlighting the role of mutual assessment as a driver of deep learning and the development of metacognitive and self-regulatory competencies (Correa-Gorospe & Ortega-Ruiperez, 2024). However, in contrast to prior reports of student resistance to peer evaluation (Kaufman & Schunn, 2010), this study reveals a predominantly positive reception, likely mediated by clear rubrics and interdisciplinary contextualization.

A fourth aspect pertains to the transfer of spatial skills across disciplines. The increase in the application of formal knowledge to new situations (+31.2% in the "Much" category) suggests that the learning achieved within the scenographic framework was not confined to the theatrical domain but was perceived as useful for fields such as architecture, design, and visual arts. This finding aligns with studies advocating for the integration of spatial training within the general curriculum (Cotabish et al., 2024), while adding a novel nuance: transfer is enhanced when learning occurs in an interdisciplinary environment combining narrative, materiality, and visual representation.

Based on these elements, a conceptual explanatory model can be proposed in which procedures (situated tasks, 2D–3D progression, graphic visualization, peer assessment) interact with mediators such as intrinsic motivation, collaboration, structured feedback, and students' initial geometric knowledge. These mediators modulate the observed outcomes: improved academic performance (92% success rate), increased interest and motivation, development of spatial competencies, and positive perception of interdisciplinarity. Thus, the data allow the articulation of a framework integrating pedagogical processes, mediation conditions, and learning outcomes, offering both empirical and theoretical contributions to the ongoing debate on active methodologies in higher education.

In sum, the results of this study converge with recent trends emphasizing the efficacy of situated and collaborative learning, while also introducing relevant divergences regarding the potential risks of thematization and cognitive load. Contrary to literature that warns of ambiguity or overload, our findings demonstrate that, under a structured design with appropriate mediators, the scenographic context enhances clarity, increases motivation, and facilitates the transfer of learning. This opens avenues for further research aimed at systematically exploring the interaction between pedagogical procedures, affective and cognitive mediators, and learning outcomes across diverse disciplinary contexts.

Conclusions

Based on the results obtained in this research, it is possible to conclude that the implementation of the Project-Based Learning (PBL) methodology has had a positive impact on students' academic performance, as well as on their formative experience and overall assessment of the methods employed.

The use of an active methodology has allowed students not only to acquire and assimilate theoretical knowledge but also to apply it effectively in real-world contexts. This has facilitated a deep understanding of the content and its integration with practical situations. In this regard, the application of knowledge has been enhanced by solving a real case, providing students with the opportunity to tangibly experience the challenges faced by professionals in their field. This approach has helped students not only internalize theory but also develop key skills such as problem-solving, decision-making, and the ability to analyze and adapt learned content.

A notable aspect of this process has been the implementation of the peer-to-peer (P2P) participatory model, which has played a crucial role in shaping a collaborative learning environment. Through the exchange of ideas and constant discussion among students, a space for dialogue has been created that has enriched the understanding of the content and facilitated a more dynamic learning experience tailored to the needs and rhythms of each individual.

This model has been especially valuable as it has promoted critical thinking, stimulated joint reflection, and encouraged peer cooperation, resulting in a more holistic and enriched learning process. Students have not only learned to work autonomously but have also

improved their ability to collaborate effectively in groups, a key competence for their future professional careers.

Regarding the collaborative dimension, teamwork has been another fundamental pillar supporting the educational process. Students have had the opportunity to consolidate their knowledge through constant interaction with peers, enabling them to face real challenges, collaborate on decision-making, and share responsibilities within a collective project. This type of interaction has been crucial in strengthening students' interpersonal skills, such as negotiation, organization, and task management, all of which are essential in any professional environment. Group interaction has also fostered the development of technical and creative skills, as each team member has contributed their particular knowledge and abilities, enabling a richer, more comprehensive solution to the problems presented.

Finally, after implementing the proposed methodology, the possibility of complementing the project with an additional phase focused on the creation of a set design by the students, conceived from the analyzed dramatic text, was highly valued. This extra phase would not only allow students to apply the knowledge gained in the project at a more concrete level but also provide them with the opportunity to address technical and spatial challenges in materializing their ideas. Creating their own set design would allow students to experience firsthand the difficulties and design processes involved, providing a more realistic and professional approach to the project.

The inclusion of this practical component is also aimed at promoting continuous improvement and refining previously developed ideas, enabling students to correct errors and adjust their design approaches based on the results obtained in previous phases. Additionally, this supplementary phase would allow them to reflect on the decisions made throughout the process, refine details, and perfect their technical skills in project execution. This exercise not only strengthens the connection between theory and practice but also offers an opportunity for the development of key design skills, such as space management, material selection, team coordination, and technical execution.

In conclusion, the methodological experience demonstrates that the PBL model, supported by a collaborative and participatory approach, has enabled students not only to acquire the specific knowledge of the subject but also to develop key skills and competencies for their future professional careers. The project has not only facilitated the acquisition of technical knowledge but also promoted the development of transversal skills such as critical thinking, creativity, problem-solving, and teamwork. In this way, the methodology used has contributed to a richer, more integrated, and valuable educational experience, preparing students to face the challenges of the professional environment effectively and with confidence.

Conflict of interests

Authors do not manifest any conflict.

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