

Millenium, 2(30)




DESENVOLVIMENTO DE COMPETÊNCIA GEOESPACIAL NO ENSINO DE TURISMO COM APRENDIZAGEM POR
PROJETOS, QGIS E QFIELD

DEVELOPING GEOSPATIAL COMPETENCE IN TOURISM HIGHER EDUCATION THROUGH PROJECT-BASED LEARNING
WITH QGIS AND QFIELD

DESARROLLO DE COMPETENCIA GEOESPACIAL EN TURISMO SUPERIOR MEDIANTE APRENDIZAJE BASADO EN
PROYECTOS CON QGIS Y QFIELD

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RECEIVED: 14th June, 2025

REVIEWED: 28th April, 2026

ACCEPTED: 20th May, 2026

PUBLISHED: 12th June, 2026

DOI: <https://doi.org/10.29352/mill0230.42013>

RESUMO

Introdução: A competência geoespacial é essencial para o planejamento turístico sustentável; no entanto, os SIG continuam marginais no ensino superior em turismo. Este estudo aborda essa lacuna ao explorar a aprendizagem baseada em projetos (PBL) como uma abordagem pedagógica para fomentar a competência geoespacial através de tarefas aplicadas de SIG.

Objetivo: Examinar como a aplicação da aprendizagem baseada em projetos com aplicações móveis de SIG promove competências técnicas em SIG, competências críticas de pensamento espacial e envolvimento.

Métodos: Foi realizada uma atividade de aprendizagem baseada em projetos com 19 estudantes do terceiro ano do curso de Turismo da Universidade de Zaragoza. Os estudantes utilizaram o QGIS e o QField para coletar e processar dados geoespaciais do centro histórico de Zaragoza, além de criar e interpretar mapas temáticos baseados nos conjuntos de dados resultantes. O desenvolvimento das competências foi avaliado por meio de duas fontes: um relatório final (incluindo mapas e análises escritas) e um questionário pós-projeto.

Resultados: A maioria dos estudantes apresentou desenvolvimento nas competências em SIG e na compreensão da dinâmica do turismo urbano. Contudo, o desenvolvimento das habilidades críticas de pensamento espacial variou, revelando a necessidade de um suporte pedagógico mais robusto para fomentar as capacidades reflexivas.

Conclusão: Os resultados demonstram que a integração do SIG com a aprendizagem baseada em projetos potencializa o desenvolvimento da competência geoespacial na educação em turismo. Apesar de alguns desafios, a abordagem promoveu competências técnicas, pensamento crítico e motivação.

Palavras-chave: competência geoespacial; aprendizagem baseada em projetos; educação em SIG

ABSTRACT

Introduction: Geospatial competence is essential for sustainable tourism planning; however, GIS remains marginal in tourism higher education. This study addresses this gap by exploring project-based learning (PBL) as a pedagogical approach to foster geospatial competence through applied GIS tasks.

Objective: Examine how the application of project-based learning with mobile GIS applications promotes technical GIS skills, spatial thinking skills, and student engagement.

Methods: A project-based learning activity was conducted with 19 third-year tourism students at the University of Zaragoza. Students used QGIS and QField to collect and process geospatial data of Zaragoza's historic centre and create and interpret thematic maps based on the resulting datasets. Skill development was assessed using two sources: a final report (including maps and written analyses) and a post-project questionnaire.

Results: Most students showed development in GIS skills and understanding of urban tourism dynamics. However, the development of critical spatial thinking skills varied, revealing the need for stronger pedagogical support to foster reflective abilities.

Conclusion: The findings demonstrate that integrating GIS with project-based learning enhances the development of geospatial competence in tourism education. Despite some challenges, the approach promoted technical skills, spatial thinking, and motivation.

Keywords: geospatial competence; project-based learning; GIS education

RESUMEN

Introducción: La competencia geoespacial es esencial para la planificación turística sostenible; sin embargo, los SIG siguen siendo marginales en la educación superior en turismo. Este estudio aborda esta brecha al explorar el aprendizaje basado en proyectos (ABP) como un enfoque pedagógico para fomentar la competencia geoespacial a través de tareas aplicadas con SIG.

Objetivo: Examinar cómo la aplicación del aprendizaje basado en proyectos con aplicaciones móviles de SIG promueve habilidades técnicas en SIG, habilidades de pensamiento espacial crítico y la implicación del alumnado.

Métodos: Se llevó a cabo una actividad de aprendizaje basada en proyectos con 19 estudiantes de tercer curso del grado en Turismo de la Universidad de Zaragoza. Los estudiantes utilizaron QGIS y QField para recopilar y procesar datos geoespaciales del centro histórico de Zaragoza, así como para crear e interpretar mapas temáticos basados en los conjuntos de datos resultantes. El desarrollo de habilidades se evaluó mediante dos fuentes: un informe final (que incluía mapas y análisis escritos) y un cuestionario posterior al proyecto.

Resultados: La mayoría de los estudiantes mostró un desarrollo en las habilidades de SIG y en la comprensión de la dinámica del turismo urbano. Sin embargo, el desarrollo de las habilidades de pensamiento espacial crítico fue variable, lo que revela la necesidad de un mayor apoyo pedagógico para fomentar las capacidades reflexivas.

Conclusión: Los resultados demuestran que la integración del SIG con el aprendizaje basado en proyectos mejora el desarrollo de la competencia geoespacial en la educación turística. A pesar de algunos desafíos, este enfoque promovió habilidades técnicas, pensamiento crítico y motivación.

Palabras clave: competencia geoespacial; aprendizaje basado en proyectos; educación en SIG

DOI: <https://doi.org/10.29352/mill0230.42013>

INTRODUCTION

In today's interconnected and spatially dynamic world, geospatial competence is fundamental for understanding, managing, and planning tourism development (Maymuna et al., 2025). In both rural and urban contexts, this competence involves knowledge and skills that enable professionals to interpret spatial relationships, analyse resource distribution and visitor flows, and make informed, data-driven decisions. This knowledge and these skills are also essential for addressing key challenges in tourism, such as sustainable development, destination planning, and the assessment of tourism impacts (Šoltésová et al., 2025).

Geospatial Competence and GIS in Tourism Education

In spite of their growing relevance, geospatial tools—particularly geographic information systems (GIS)—are largely absent from the core curricula in tourism higher education. When present, they are frequently limited to optional courses or treated as peripheral components within broader modules, which restricts students' ability to acquire geospatial competence (De Miguel González, 2021). Given the increasing integration of geospatial tools in tourism planning (Waleghwa & Heldt, 2022), this gap is especially striking. Consequently, higher education often fails to produce graduates equipped to address urgent issues related to overtourism and its associated impacts (Meechandee & Meekaew, 2025; Šoltésová et al., 2025)

Recent literature emphasises that the pedagogical value of GIS extends beyond technical skills, playing a key role in the development of spatial thinking skills, which constitute a core component of geospatial competence (Hickman, 2022). Evidence shows a consistent relationship between GIS use and improved spatial thinking performance at the university level (Cao et al., 2023). These cognitive gains are transferable to professional contexts requiring spatial decision-making, such as tourism planning and destination management. Therefore, GIS integration in tourism higher education should be understood as a fundamental pedagogical strategy for fostering geospatial competence demanded by the sector (Bearman et al., 2015; Buzo-Sánchez et al., 2022; Demeuov et al., 2026).

In addition to its cognitive benefits, GIS contributes to fostering a more active and engaged learning environment. Previous studies highlight that GIS-based activities stimulate students' curiosity and promote a supportive and effective classroom atmosphere (Sofias & Pierrakeas, 2023), while recent evidence also shows that the use of GIS enhances students' self-efficacy and motivation to continue learning independently (Cao et al., 2023).

Project-Based Learning (PBL) in GIS Education

Empirical research on effective pedagogical approaches for teaching GIS-related skills in higher education is limited—a gap particularly evident in tourism studies (Nieves, 2024). Project-based learning (PBL) has emerged as a promising pedagogical response to this challenge (Sofias & Pierrakeas, 2023; Žerovnik & Nančovska Šerbec, 2021). By placing students at the centre of the learning process, PBL encourages engagement with real-world, spatially complex problems and promotes the development of both technical skills—including data collection, georeferencing, and spatial analysis—and transferable skills such as spatial thinking and teamwork (Soucy et al., 2025; Umboh et al., 2025).

Within this context, PBL enables the integration of conceptual knowledge, GIS skills, and analytical challenges within a single learning framework. Unlike traditional lecture-based approaches, GIS education requires students to simultaneously understand theoretical concepts and apply them through spatial analysis, which often generates a disconnection between theory and practice in conventional curricula (Bowlick et al., 2015). PBL addresses this limitation by engaging students in research-oriented projects that allow them to work with authentic spatial data, design analytical processes, and produce complete solutions.

Furthermore, PBL promotes learning environments that closely resemble professional GIS practice. Through teamwork, project management and iterative problem-solving, students are exposed to the complexities and uncertainties inherent in real-world experiences (Bowlick et al., 2015). Empirical evidence also indicates that PBL increases student engagement as learners perceive a stronger connection between academic tasks and real-world applications (Blagojević & Sikora, 2017). Consequently, PBL supports the development of geospatial competence by encouraging active learning.

Conceptual Framework: The Integrated PBL-GIS Model

This study is built upon a conceptual framework that views the development of geospatial competence not merely as technical proficiency but as the intersection of three pillars: (1) technical GIS skills, including spatial analysis skills (using QGIS and QField), (2) spatial thinking skills, and (3) student engagement (motivation through active learning). In this model, PBL serves as the catalyst that drives these three components simultaneously. By applying this framework, we move beyond passive software instruction toward a holistic development of geospatial competence in the tourism sector.

Applying this conceptual model, this study presents a PBL-based intervention in the third-year course Territorial Planning of Tourism at the University of Zaragoza. Over three weeks, students carried out an applied GIS project using QGIS and QField to investigate two dynamics in Zaragoza's historic centre: the spatial distribution of tourist dwellings and the character of commercial establishments. The project combined classroom instruction with field-based data collection, thus promoting both technical proficiency and spatial reasoning.

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Following the issues outlined above, the general objective of this study is to examine how the combination of project-based learning and mobile and desktop GIS applications (QGIS and QField) supports the development of geospatial competence in tourism students. More specifically, the study investigates how this integrated approach fosters technical skills and spatial thinking skills as well as students' engagement (specifically motivation and active learning). To address this objective, the study is guided by the following research questions:

- RQ1: To what extent does the integration of PBL with GIS tools promote the development of students' technical skills?
- RQ2: In what way does the PBL-GIS approach contribute to the development of students' spatial thinking skills?
- RQ3: To what extent does the PBL-GIS approach promote motivation and engagement?

1. METHODS

This study presents an innovative learning activity designed to develop students' geospatial competence by integrating geographic information systems (QGIS and QField) into a project-based learning model (PBL). The choice of a PBL approach combined with mobile GIS was justified by the need to bridge the gap between theoretical territorial planning and professional field practice. This design enabled a workflow that combined classroom work, field data collection, spatial analysis, and reflective interpretation of spatial patterns and their implications.

The pedagogical design was inspired by prior research (Ruiz et al., 2023; Ruiz et al., 2025), which analysed the tourism orientation and temporal evolution of commercial establishments in Seville's historic centre. Building on these foundations, the activity was adapted to the Zaragoza context and to students' existing GIS knowledge. This adaptation was chosen to allow students to confront real-world data complexities in a familiar local context, thereby fostering a deeper level of spatial thinking skills than traditional classroom exercises. As Zaragoza has the second-largest historic centre in Spain, the fieldwork was limited to its central sector (Figure 1). The educational project unfolded over three main stages, each with specific objectives and tasks.

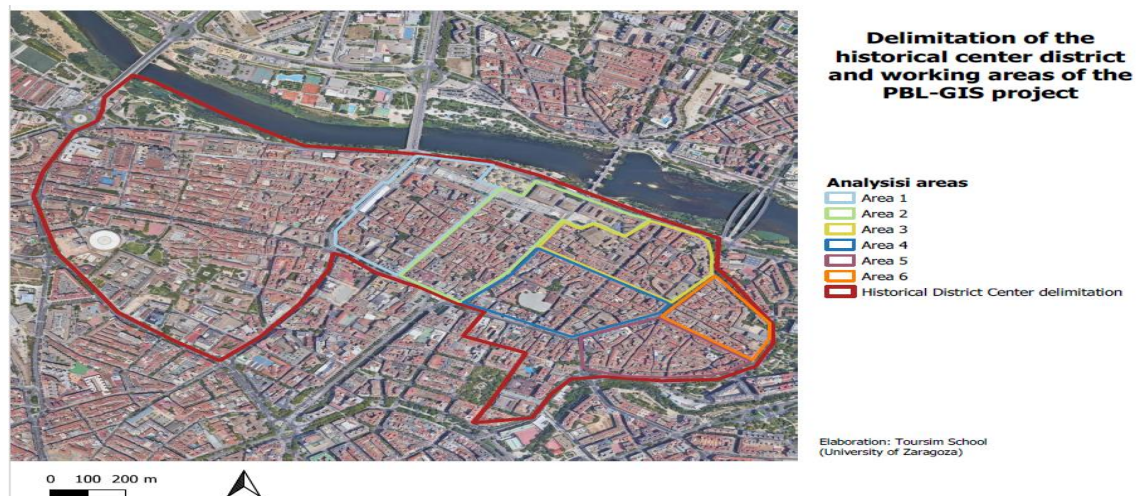


Figure 1 - Historic District Centre and Analysis Areas

In the initial phase, six groups were created and then worked collaboratively to create the GIS project in QGIS for later use in the QField software. Each group developed two spatial data layers in QGIS: one for commercial establishments and one for tourist accommodation. For each layer, they defined a set of attribute fields. In the case of commercial establishments, attributes included the business category (based on CNAE classification) and tourism orientation (low, medium or high), following the methodology by Ruiz et al. (2025). For each tourist accommodation, students identified the type of establishment. In the case of tourist dwellings—residential units rented to visitors—they also recorded the number of such units in each building and the total number of residential dwellings per building (Table 1).

Once the attribute fields had been defined, students converted them into digital forms using QGIS. These forms were then used for structured data entry during fieldwork. At the same time, the study area was divided into six sectors (Figure 1), with each group assigned to one sector to ensure complete spatial coverage and facilitate the fieldwork process.

DOI: <https://doi.org/10.29352/mill0230.42013>

Table 1 - Spatial Data Layers and Their Attribute Fields

Commercial Establishment: Business Category								
Food and Beverage Services	Supermarkets and Variety Stores	Souvenir Retail	Specialized Food Retail	Hairdressing and Beauty services	Home Goods and Furnishing	Medical and Dental Services	Clothing, Footwear and Accessories	Others
Tapas Bars, Restaurants, Cafes, Burger and Pizza Places	Supermarkets and Non-Specialized Retail Stores	Souvenirs and Regional Products Shops	Greengrocers, Butchers, Bakeries, Tobacconists	Hairdressers, Beauty and Tattoo Services	Home Appliances, Furniture, Lighting, Hardware and Related Stores	Medical and Dental Services (including Pharmacies and Opticians)	Clothing, Footwear, Jewelry and Watch Stores	Florists, Newsstands, Stationeries, Bookstores, Real Estates, Laundries, Gambling Venues, Banks
Commercial establishment: Tourism orientation								
High			Medium			Low		
Tourist Accommodation								
Categories		Hotels, Guesthouses, Boarding guesthouses, Hostels, Tourist dwellings and Tourist apartments						
N° of tourist dwellings in the building		This field contains a numerical value indicating the number of dwellings used for tourism purposes within the building.						
N° of dwellings in the building		This field contains a numerical value indicating the total number of dwellings located in the building.						

Source: own elaboration based on Ruiz et al. (2025).

The second stage consisted of eight hours of fieldwork divided into four sessions. During these sessions, students used QField on their mobile devices to geolocate, categorise and record all the information related to the commercial establishment and tourist location shapefiles within their assigned analysis areas. Data collection took place in situ using the forms prepared in QGIS. In the final phase, students returned to the classroom to consolidate their findings. Each group’s layer was merged into a single geospatial database. To address inconsistencies in data entry (use of capital letters, spelling errors, etc.), students engaged in a collaborative data-cleaning process supported by AI tools. Once the database was harmonised, students used QGIS to produce thematic maps that represented the spatial distribution and characteristics of tourism-related commercial activity and accommodations. At the end, each group prepared a report that included cartographic outputs and an integrated analysis of their assigned study area.

1.1 Sample

The activity was conducted with a group of 19 undergraduate students enrolled in the course Territorial Planning of Tourism at the Tourism School of the University of Zaragoza. The group consisted of 9 male and 10 female students, all of whom had previously acquired basic skills in GIS through earlier coursework. For the purposes of the project, the class was divided into six working groups, each of which was responsible for a specific area of the historic centre of Zaragoza (Figure 1).

Regarding the ethical aspects, the study followed the protocols of the University of Zaragoza. While the learning activity was a mandatory component of the course curriculum, students were informed that the use of their data for research purposes was voluntary. All participants provided informed consent for their outputs and questionnaire responses to be analysed for this study. To protect participant privacy, all data were anonymised. Students were explicitly informed that their consent to participate in the research would have no impact on their academic grades or the evaluation of the mandatory coursework.

1.2 Data collection instruments

To address the above-mentioned research questions, two sources of data were used: final group reports (including maps and written analyses) and a post-project questionnaire with 12 closed-ended items. The maps and reports were evaluated with two rubrics: one for cartographic quality, which measured thematic accuracy, symbology, layout, and completeness, and another for spatial thinking skills, focusing on analytical depth and the link to tourism dynamics (Table 2).

The questionnaire used a 5-point Likert scale (Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, and Strongly Disagree) to capture students' subjective perceptions of their skill development and motivation. To ensure the content validity of this instrument, it was reviewed by an expert in Geography Education to verify the clarity and relevance of the items. While the written

DOI: <https://doi.org/10.29352/mill0230.42013>

analyses were summarised, the questionnaire results were analysed using descriptive statistics to provide a comprehensive view of students’ learning outcomes, both in terms of observable performance and subjective experience.

Table 2 - Criteria of the Implemented Rubrics for Assessing Student Outputs

Rubric 1. Cartographic Quality					
Criteria	0	1	2	3	4
Thematic Accuracy	No map submitted	Incoherent or irrelevant content	Partially accurate	Mostly accurate and relevant	Fully accurate and consistent
Symbology and layout	Not present	Poor or missing Symbology/layout	Basic but unclear layout	Clear and legible layout	Professional, well-structured and visually coherent
Completeness	Missing key elements (title, legend, etc.)	Several required elements missing	Includes essential components	Almost complete	Fully complete, including advanced cartographic elements
Rubric 2. Spatial Thinking Skills					
Criteria	0	1	2	3	4
Analytical depth	No analysis	Descriptive only	Limited interpretation	Coherent spatial reflection	Deep and critical geospatial insight
Link to tourism dynamics	Not addressed	Weak or inaccurate connection	Basic tourism implications identified	Clear and relevant connections	Strong linkage to urban tourism theory and spatial processes

1.3 Statistical Analysis

A mixed-method approach was used to assess student learning outcomes through both performance-based and perception-based measures. The evaluation rubric and the post-project questionnaire addressed largely overlapping dimensions, including the development of technical skills and spatial thinking. In addition, the questionnaire included items related to student engagement and motivation.

The rubric served as an external assessment tool for evaluating students’ skill development based on the quality of their outputs, while the questionnaire captured students’ subjective perceptions. Quantitative data from the 5-point Likert scale were analysed using descriptive statistics, specifically focusing on percentage distributions for each response category to identify trends in student perception. The analysis was structured to directly respond to the three research questions outlined in the introduction, which addressed: (1) the effectiveness of the activity in developing technical skills, (2) the effectiveness of the activity in enhancing spatial thinking skills and (3) the project’s impact on engagement and motivation.

2. RESULTS

The results are structured according to the three research questions. The first two questions are addressed through both students’ perceptions and the analysis of their final deliverables. The third question is only addressed through the students’ perception.

2.1. Students’ Perception

RQ1: Development of Technical Skills

A key indicator of students’ technical learning is their ability to understand the role of GIS tools in tourism planning. A majority of students (61%) agreed or strongly agreed that the activity increased their understanding while only 8% disagreed, and none expressed strong disagreement. Although 31% remained neutral, the results indicate that the project provided a clear conceptual basis and practical application. It enabled students to relate GIS tools to real-world tourism planning processes.

In addition to recognising the role of GIS in tourism territorial planning, students evaluated their acquisition of technical skills required to design and conduct a geospatial project. As shown in Figure 2, most agreed or strongly agreed that they had developed the necessary skills to create and manage layers in QGIS, design tourism maps, set up a base using aerial imagery and build and edit attribute tables. However, a considerable proportion (25% to 30%) selected neutral responses, particularly in relation to layer creation and management in QGIS, base setup with aerial imagery and attribute table editing.

In one area that requires more advanced skills—the integration of QGIS and QField—the results were more mixed. While over 60% of students reported being capable of integrating QGIS and QField, nearly 20% expressed disagreement. Finally, the use of AI tools to support project development received a highly favourable evaluation, with more than 80% of students agreeing or strongly agreeing. These results suggest growing confidence in the use of these applications, although some students still encountered difficulties when combining desktop-based tasks with fieldwork.

DOI: <https://doi.org/10.29352/mill0230.42013>

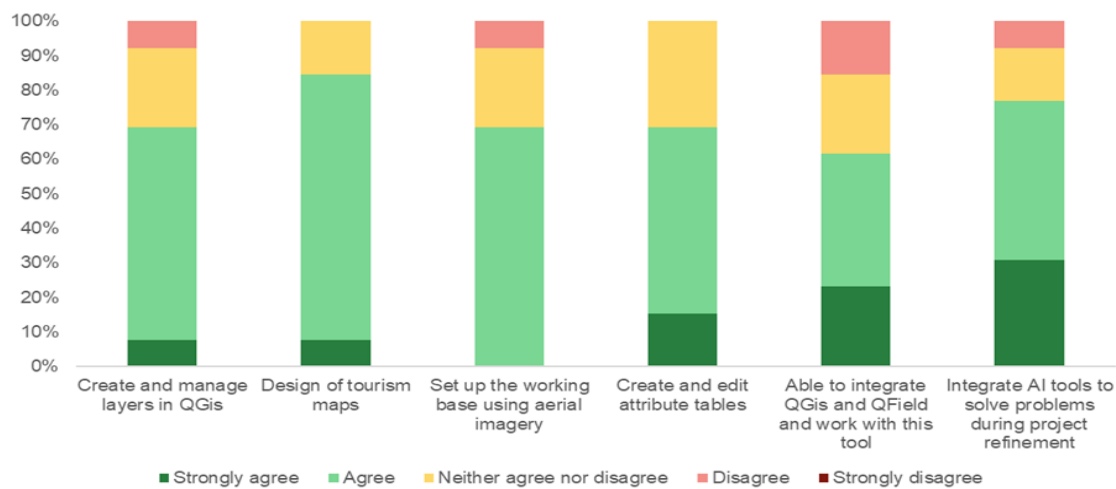


Figure 2 - Students' Self-Assessment of Technical Skills in GIS-Based Territorial Planning

RQ2: Development of Spatial Thinking Skills

Regarding students' ability to understand and interpret tourism-related spatial patterns—and thus develop spatial thinking skills—the results reveal a generally positive level of perceived learning. As illustrated in Figure 3, over 80% of respondents agreed or strongly agreed that the project helped them understand the spatial structure and tourism function of Zaragoza's historic centre. This suggests that the vast majority of students were able to recognise key spatial patterns in the urban environment. Nonetheless, the ability to interpret these patterns critically or connect them with broader socio-spatial processes received a more moderate evaluation. While most participants stated that they had acquired analytical skills for interpreting spatial information in the context of tourism, nearly 30% selected a neutral option and a small minority expressed strong disagreement. Similarly, although more than 60% of students stated that they had reflected on the sustainability of urban tourism through cartographic analysis, a significant proportion either disagreed or expressed uncertainty.

These findings demonstrate that the shift from technical proficiency to deep spatial thinking remains incomplete. Most students feel confident using GIS tools for spatial analysis, but not all are able to apply critical thinking skills to spatial patterns or sustainability issues. This highlights the need to strengthen pedagogical strategies that link technical tasks with analytical and reflective learning.



Figure 3 - Students' Perceived Ability to Analyse Tourism Dynamics and Apply Critical Spatial Thinking Skills

DOI: <https://doi.org/10.29352/mill0230.42013>

RQ3: Promotion of Motivation and Overall Engagement

The results show a high level of student motivation: 69% agreed or strongly agreed that the activity was motivating while 31% responded neutrally (Figure 5). This positive reception highlights that the combination of QField-based fieldwork and the autonomy of the project-based approach fostered sustained engagement.

Furthermore, the results indicate that this motivation is closely linked to the opportunity to engage directly with the real world in situ. This out-of-class activity not only enhanced their understanding of the study area but also allowed them to observe and interpret territorial dynamics and highlight patterns and relationships that are difficult to grasp through theoretical instruction alone.

2.2. Evaluation of Student Outputs: Cartographic and Analytical Deliverables

RQ1: Technical Skills in Cartographic Outputs

Students' ability to represent spatial data was evaluated using rubric 1 (Table 2). Among the submitted maps, two examples were selected: one showing the tourist orientation of commercial establishments and another depicting the concentration of tourist dwellings.

Figure 4 presents the map by group 2 on the tourist orientation of commercial establishments. It includes all essential cartographic elements—title, legend, north arrow and scale bar—and applies a clear, consistent colour scheme to indicate low, medium and high tourism orientation. The layout is well-structured and visually balanced, reflecting strong command of symbology and thematic mapping.

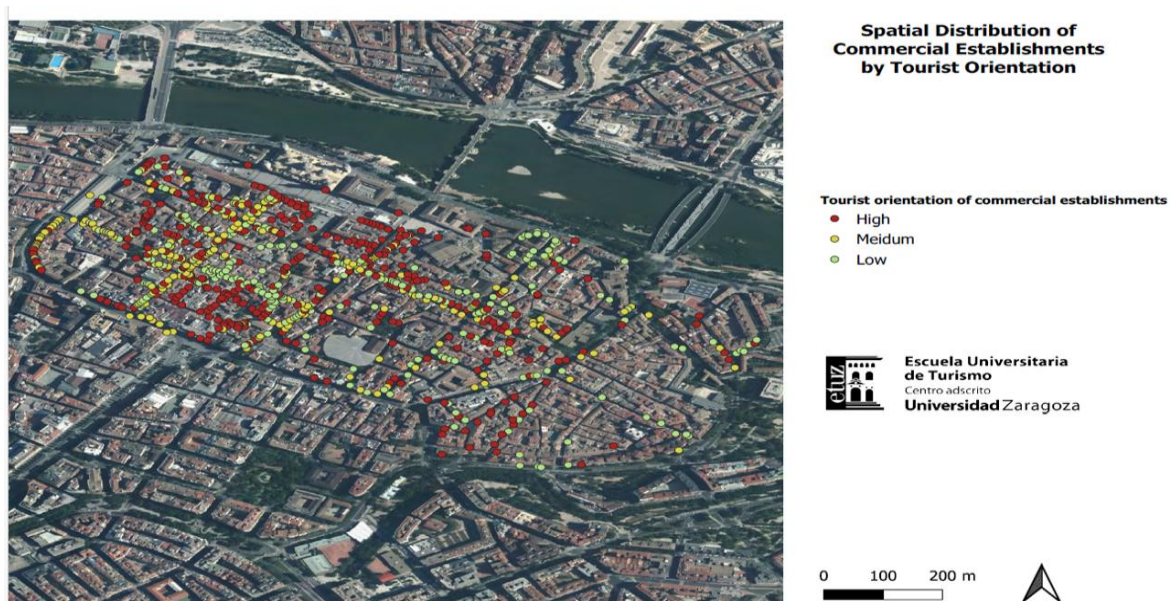


Figure 4 - Spatial Distribution of Commercial Establishments by Tourist Orientation

Despite these strengths, a couple of groups faced difficulties with symbology. Two maps used unclear or inconsistent colour schemes, which reduced visual clarity. A more severe problem appeared in the geolocation process. In area 5, students did not complete the fieldwork, which caused a failure that resulted in dataset gaps and limited the analytical value of the results. Although a collaborative review corrected some classification errors, it did not resolve the problems caused by the lack of data.

Figure 5 shows a map of the spatial concentration of tourist dwellings. Four groups used proportional point symbols to indicate the number of units per building, while the other groups (groups 2 and 5) applied more advanced techniques such as heatmaps. This method improved readability and allowed a clear identification of high-density areas. This cartographic solution demonstrates students' ability to select and apply appropriate visualisation methods to represent spatial patterns in urban tourism.

DOI: <https://doi.org/10.29352/mill0230.42013>

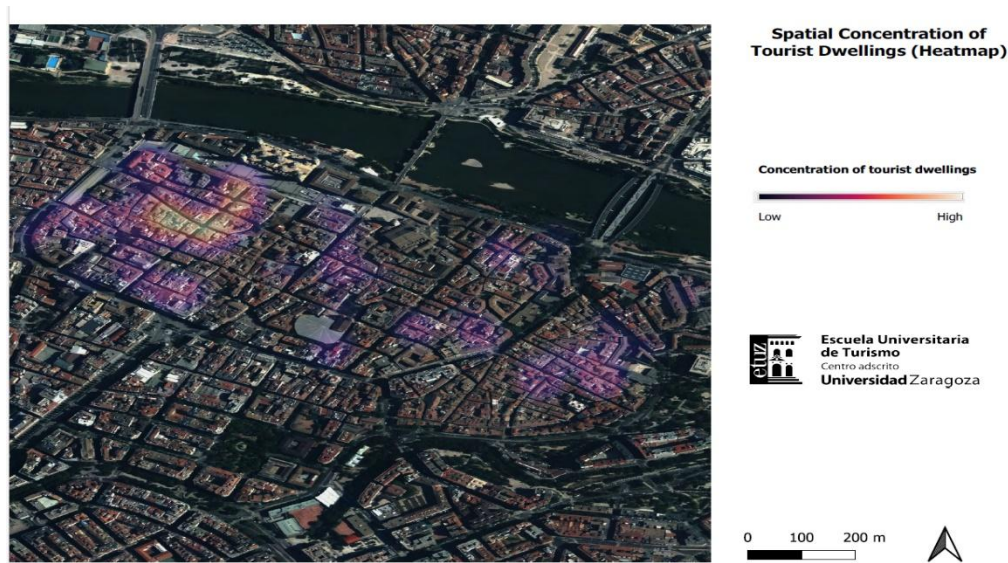


Figure 5 - Spatial Concentration of Tourist Dwellings

In general, this use of cartographic techniques shows that students have, for the most part, developed the technical skills needed to effectively visualise spatial data although inconsistencies in data quality and symbol application occasionally limited the clarity and analytical potential of their maps.

RQ2: Critical Spatial Thinking Skills in Analytical Reports

The reports submitted were assessed using rubric 2. The evaluation focused on the analytical depth of spatial interpretation and the students' ability to relate observed patterns to broader tourism dynamics. The results were mixed. Some students demonstrated a capacity for critical reflection on the spatial factors and consequences of their findings, while others remained at a descriptive level.

In some cases, students articulated thoughtful interpretations that linked spatial concentration to underlying urban processes. One group, for example, wrote: "The high concentration of tourist-oriented retail businesses along Calle Alfonso suggests a process of commercial specialization that caters more to short-term visitors than to local residents. This raises questions about the long-term sustainability of the commercial services in the historic centre." This kind of reflection goes beyond pattern identification to consider socio-economic consequences and tensions associated with tourism-led urban change.

Other reports, however, offered much more limited commentary, as in the following example: "Most shops in this area are of medium tourist orientation. There are also some supermarkets and souvenir stores." While such observations are factually correct, they do not demonstrate interpretive engagement or an effort to situate the spatial data within a broader analytical framework. These disparities point to differing levels of engagement with the reflective dimension of the task. They also suggest that while the technical use of GIS tools is a necessary condition for the development of the first dimension of geospatial competence, it does not automatically lead to the acquisition of critical spatial thinking skills. Targeted pedagogical strategies are needed to help students move from mapping to meaningful spatial analysis and from observation to interpretation.

3. DISCUSSION

The analysis offers several insights relevant to the existing literature, particularly regarding the multidimensional nature of geospatial competence. First, the integration of GIS tools into a project-based activity yielded clear pedagogical benefits. Students acquired technical skills in map creation and maintained strong engagement throughout the activity. These results support earlier research that links hands-on, project-based learning to higher motivation and more effective outcomes in GIS education (Kerski, 2021; Sofias & Pierrakeas, 2023). However, the uneven quality of field data from some groups shows that PBL alone does not resolve all instructional challenges. Students with limited field experience often failed to design coherent data collection strategies, which highlights a need for structured scaffolding during the initial planning phase to ensure that difficulties in data acquisition do not hinder the subsequent execution of spatial analysis (Berendsen et al., 2006).

Second, some groups moved beyond conventional symbology and adopted more advanced visual strategies to represent tourism-related spatial trends. By moving beyond simple point-plotting, these students were able to quantify spatial clusters and identify correlations that were invisible in the raw database. These results are consistent with Bondarenko's (2025) findings, which emphasise that advanced cartographic practices act as a bridge through which design proficiency transforms raw data into interpretable spatial patterns.

DOI: <https://doi.org/10.29352/mill0230.42013>

Third, the analysis showed wide variation in students' ability to interpret spatial data. While some groups offered deep insights into tourism-related urban change, others limited their work to description. This contrast reflects a broader issue in GIS education. As Bednarz and Lee (2011) noted, technical GIS proficiency does not ensure the development of higher-order spatial thinking. Our findings suggest that analytical reasoning is a distinct competency that requires students to connect the what and where of their spatial analysis with the why of broader socio-spatial processes. Consequently, educators who aim to promote analytical reasoning—and, by extension, comprehensive geospatial competence—must provide targeted instructional support to help students transition from technical description to critical thinking (Kholoshyn et al., 2021).

Finally, the project revealed several methodological limitations. Incomplete or inconsistent geolocation activities affected the reliability of some maps. These outcomes confirm earlier observations by Goodchild (2007), who pointed out that errors in GIS projects often result from flaws in data collection or processing. To improve the reliability of future implementations, instructors should provide clearer protocols for fieldwork, introduce regular feedback opportunities and allocate more time for supervised data acquisition. Moreover, the small sample size ($N=19$) and the specific focus on third-year students at a single institution limit the statistical generalisability of the findings. While this allowed for a deep, qualitative assessment of the PBL process, the results represent an exploratory case study rather than a universal trend in tourism education.

CONCLUSION

This study demonstrates that integrating geographic information systems with project-based learning enhances pedagogical effectiveness and supports the development of geospatial competence in tourism education. The project engaged students in the entire geospatial process—from map creation to fieldwork and spatial thinking—resulting in the promotion of technical skills, critical engagement with real urban dynamics, and increased autonomy and motivation.

By combining GIS and PBL in tourism education, the study provides a clear example of how practical training can foster geospatial competence. Although it does not present a formal model, the research introduces an empirical framework that links PBL with the development of GIS skills and learner motivation, illustrating a positive correlation between the instructional approach and these outcomes. This result aligns with Kerski (2021), who emphasises that active learning environments foster GIS skills and student engagement more effectively than traditional teacher-centred approaches.

This notwithstanding, the project also revealed two pedagogical challenges. First, the variation in field data quality suggests that a lack of field experience can lead to methodological inconsistency. Second, students' limited capacity for critical spatial interpretation shows that technical mastery does not automatically translate into spatial reasoning (Bednarz & Lee, 2011). This highlights the necessity of structured scaffolding during the data collection and analysis phases.

Despite these challenges, the results remain encouraging. With adequate guidance, students produced meaningful maps and offered thoughtful insights into spatial changes. These results suggest that GIS instruction should extend beyond technical training to foster critical spatial thinking skills. To realise this potential, future iterations of the project should strengthen preparatory training and increase opportunities for guided interpretation and discussion. Only by bridging the gap between data handling and critical spatial reasoning can educators prepare future tourism professionals to address the territorial, environmental, and social challenges shaping the field.

AUTHORS' CONTRIBUTION

Conceptualization, A.A., R.J. and M.E.; data curation, A.A.; investigation, A.A. and M.E.; methodology, A.A., R.J. and M.E.; project administration, M.E.; resources, A.A.; software, A.A.; supervision, R.J. and M.E.; validation, R.J. and M.E.; visualization, A.A. and R.J.; writing – original draft, R.J.; writing – review & editing, M.E.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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