

Article

Toponymic Knowledge and Territorial Literacy in Pre-Service Primary Education Teachers: Effects of a Didactic Intervention in Extremadura and La Rioja

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Abstract

This study analyses the toponymic learning of students enrolled in the Degree in Primary Education programme following a didactic intervention carried out at the Universities of Extremadura and La Rioja. The research was designed as a quasi-experimental study with a pretest and posttest in non-equivalent groups and focused on eight variables related to the identification and location of provincial boundaries, provincial capitals, county seats, and counties. The main objective was to examine the development of toponymic knowledge and to analyse possible differences according to the methodology applied and the group of origin. The results show significant differences between the pretest and posttest in a relevant proportion of the variables analysed, especially in provincial boundaries, provincial capitals, and counties, whereas no significant changes were observed in county seats (i.e., the main towns or functional centres of the Spanish comarcas). In the unadjusted posttest analyses, no statistically significant differences were found between the traditional and interactive methodology; however, exploratory adjusted ANCOVA analyses suggested possible partial methodological tendencies in some specific dimensions, particularly in the identification of counties, although these results should be interpreted cautiously because not all ANCOVA assumptions were met. Likewise, the correlations between identification and location were very high in both phases. Overall, the findings suggest that toponymic tasks based on identification and location can support basic dimensions of territorial literacy in initial teacher education, although they should not be interpreted as a comprehensive assessment of spatial thinking as a whole.

Keywords: toponymy; geography education; initial teacher education; spatial thinking; higher education



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1. Introduction

Initial teacher education for primary education constitutes a decisive stage in the construction of teachers' professional knowledge. At this stage, university students not only acquire teaching strategies and classroom resources but also review and reorganise disciplinary knowledge, prior beliefs, and school memories that shape the way they will later understand and teach school content (Galindo Morales, 2017; Parra & Morote, 2020).

In the field of geography, this issue is especially relevant, since the university preparation of future teachers continues to show weaknesses both in the solidity of geographical knowledge and in its didactic treatment (Martínez, 2017; Calero et al., 2019). This limitation becomes particularly important when considering that these teachers will be the ones introducing primary education pupils to the understanding of territory, maps, and basic spatial relationships.

1.1. Conceptual Framework: Toponymic Knowledge, Territorial Literacy, and Spatial Thinking

Initial teacher education is understood as the university preparation prior to entering the teaching profession (Orland-Barak & Lavrenteva, 2019). Toponymic knowledge, in turn, is conceived as a nominative and spatial form of knowledge that enables individuals to recognise, locate, and interpret basic references of territorial organisation (Ordinas, 2024). From this perspective, toponymy should not be understood as a closed repertoire of names to be memorised but rather as a basis for territorial literacy. Knowing provincial boundaries, provincial capitals, county seats, or counties implies having elementary spatial references for understanding how territory is organised and, consequently, for being able to teach it rigorously at school.

This clarification is important because geographical learning does not end with the verbal recognition of territorial elements. Identifying a reference and locating it correctly on a map are related, but not equivalent, operations. The former refers mainly to the conceptual and denominative differentiation of the element, whereas the latter requires its spatial anchoring within a broader territorial structure. J. Lee and Bednarz (2012), together with the National Research Council (2006), have emphasised that these competences belong to a complex construct made up of spatial concepts, representational tools, and reasoning processes that do not necessarily develop at the same pace. In the specific context of initial teacher education, Jo and Bednarz (2014) further argue that pre-service teachers may successfully recognise a toponym while still struggling to position it accurately in space or connect it to the territorial organisation to which it belongs.

From this perspective, toponymy acquires educational value because it connects name, place, and territorial structure. It does not, of course, encompass geographical education or territorial literacy in their entirety, but it does constitute a necessary foundation for their development. It is difficult to move towards more complex understandings of territory, landscape, or spatial citizenship without first mastering basic references of location and territorial organisation (Morote & Membrado, 2021; Rodríguez et al., 2024). Therefore, working on toponymy at the university level should not be interpreted as a return to a merely rote-based geography but rather as an opportunity to strengthen basic spatial learning on which broader geographical interpretations can later be built.

However, several studies have warned that the geographical knowledge of university students in primary education programmes does not always reach satisfactory levels. Binimelis and Ordinas (2018) identified significant deficiencies in the minimum geographical knowledge of this group, while Gómez-Gonçalves et al. (2021) showed limitations in geo-literacy related to the Spanish territorial division. Along similar lines, Alfonso-Torreño et al. (2024) pointed out that future teachers arrive at university with some familiarity with maps, but with notable difficulties in interpreting them and representing familiar territory spatially. Taken together, these results suggest that prior exposure to geographical content during schooling does not, by itself, guarantee a solid understanding of basic spatial references.

Part of this fragility may be related to the persistence of transmissive, repetition-based teaching approaches, in which geographical content is presented as closed information and the map is reduced to an auxiliary support or a mechanical exercise. In addition,

the school memory of teachers in training continues to have a considerable influence on the way they conceive the teaching of geography (Parra & Morote, 2020). In response, various studies have advocated for active methodologies that engage students in tasks of observation, recognition, spatial relation, representation, and decision-making about territory (De Miguel, 2013; Peralta & Guamán, 2020). In this regard, the use of digital cartography, geographic information systems, and geotechnologies has shown potential to improve spatial reasoning when these tools are integrated into structured teaching sequences and not used merely as technological supports (De Lázaro & González, 2005; Favier & van der Schee, 2014; Bearman et al., 2016).

In initial teacher education, this debate is especially pertinent. The issue is to analyse what kinds of tasks best promote the transition from nominative knowledge to a more consistent territorial understanding and to assess the extent to which different methodologies contribute to this process. The recent literature has also stressed that the development of future teachers' spatial thinking requires not only innovative resources, but also specific pedagogical content knowledge for teaching students to think geographically (Jo & Bednarz, 2014). Therefore, comparing traditional and active methodologies in toponymic content is not a secondary issue but rather an appropriate way of examining how basic territorial competences are developed in those who will later have to teach them.

Despite these advances, there are still few studies in the Spanish university context that systematically compare the effects of different methodologies on toponymic learning and analytically distinguish between the identification and location of territorial elements. Likewise, studies exploring this issue across more than one university and in different autonomous regional contexts remain limited. The present research addresses this gap and analyses the toponymic learning of students enrolled in the Degree in Primary Education programme at the universities of Extremadura and La Rioja through a teaching intervention developed with two methodological approaches, one traditional and the other active and interactive. Specifically, the study focuses on the identification and location, on a blank map, of provincial boundaries, provincial capitals, county seats, and counties, which are understood as basic indicators of territorial literacy and spatial thinking.

1.2. Objectives, Research Questions, and Hypotheses

The general objective of this study is to analyse the development of toponymic knowledge among students in the Degree in Primary Education programme following a teaching intervention and to compare the effects of a traditional methodology (TM) and interactive methodology (IM) on the identification and location of different elements of territorial organisation. Based on this general objective, the following specific objectives are proposed:

O1: To evaluate the evolution of students' toponymic learning between the pretest and posttest in the competences of identifying and locating provincial boundaries, provincial capitals, county seats, and counties.

O2: To compare the effects of TM and IM on students' final performance in the variables analysed.

O3: To explore possible differences in toponymic performance according to the group of origin within the two participating universities.

O4: To analyse the association between the identification and location of the different territorial elements at the pretest and posttest stages.

In line with these objectives, the following research questions are formulated:

RQ1: To what extent does students' toponymic knowledge improve after the teaching intervention?

RQ2: Are there significant differences between TM and IM in the development of the toponymic competences analysed?

RQ3: What relationship exists between the identification and location of the different territorial elements?

RQ4: Are there differences in students' final performance according to their group of origin in the participating universities?

These questions are based on a central premise: identification and location constitute two complementary dimensions of geographical learning. The former refers to the conceptual and denominative recognition of the territorial element; the latter, to its representation and placement within an organised spatial framework. Analysing both dimensions jointly makes it possible to assess not only whether students know what a territorial reference is, but also whether they are able to locate it correctly and integrate it into a broader understanding of territory (J. Lee & Bednarz, 2012; National Research Council, 2006).

Based on this theoretical framework, the following working hypotheses are proposed:

H1. *The teaching intervention produces a significant improvement in posttest scores compared with pretest scores in a substantial proportion of the variables analysed.*

H2. *Significant differences are observed between TM and IM in the development of toponymic knowledge, although their intensity varies depending on the territorial dimension considered.*

H3. *Differences are found in at least some of the variables depending on the students' group of origin.*

H4. *The identification and location of territorial elements show positive and significant associations in both the pretest and posttest.*

2. Materials and Methods

2.1. Research Design

The research was conducted using a quantitative approach through a quasi-experimental design with pretest and posttest measures and non-equivalent groups, which is appropriate for real educational contexts in which classes are already formed and it is not feasible to randomly reassign students to different methodological conditions (Capili & Anastasi, 2024; Shadish et al., 2002). This type of design makes it possible to compare the effect of different teaching proposals in authentic instructional settings, although caution is required when making causal interpretations of the results due to the possible existence of initial differences between groups. The study also incorporates an exploratory component, since, in addition to analysing the changes associated with the intervention, it examines possible differences according to students' group of origin and the relationship between identification and location of different territorial elements in an area that remains underexplored in initial teacher education within the Spanish university context.

The study was structured into four stages. First, a pretest was administered to identify students' initial level of toponymic and territorial knowledge. Next, the teaching intervention was carried out in each class, distinguishing between those in which TM was applied and those in which IM was implemented. Subsequently, a posttest, structurally equivalent to the initial test, was administered to assess the changes produced after the intervention. Finally, a perception questionnaire was administered to gather students' evaluations of the methodology used and of their own learning process.

Although this latter instrument formed part of the data collection protocol, the present study focuses on the learning outcomes derived from the toponymic performance tasks.

2.2. Participants and Sampling

The sample consisted of students enrolled in the Degree in Primary Education programme at universities located in the autonomous communities of Extremadura and La

Rioja. The composition of the sample was analysed at two points in the research process, the initial phase or pretest and the final phase or posttest, to examine the distribution of students before and after the teaching intervention.

Extremadura and La Rioja were selected because both universities offered access to comparable groups of students enrolled in the Degree in Primary Education programme and allowed the implementation of the same pretest–posttest design in ordinary classroom contexts. The comparison should therefore be understood as educational and methodological rather than strictly territorial; both contexts involved pre-service primary teachers, similar curricular conditions, and equivalent types of toponymic tasks, although the specific territorial content was adapted to each autonomous community.

Participants were selected through a convenience sampling procedure, inviting all students enrolled in the groups involved in the study to participate. Assignment to the methodological condition was not carried out through random allocation but was instead determined by the pre-existing class groups. This procedure is consistent with the usual organisational constraints of university educational research and with the quasi-experimental design adopted, although it requires cautious interpretation of the results, especially with regard to the initial comparability of the groups and the generalisability of the findings (Ahmed, 2024).

In the initial phase, 268 students participated. Of these, 178 (66.4%) belonged to groups in which an IM was implemented, whereas 90 (33.6%) were part of groups that followed TM.

In Extremadura, the sample was organised into three groups. Groups 1 and 2, both assigned to IM, consisted of 50 students (18.7%) and 55 students (20.5%), respectively. Group 3, in which TM was applied, consisted of 51 students (19.0%).

In La Rioja, the distribution was organised into five groups. In the morning shift, Groups 1, 2, and 3, corresponding to IM, consisted of 27 students (10.1%), 25 students (9.3%), and 21 students (7.8%), respectively. Groups 4 and 5, associated with TM, consisted of 21 students (7.8%) and 18 students (6.7%) (see Table 1).

Table 1. Distribution of the sample in the pretest phase.

Autonomous Community	Group	Frequency	Percentage
Extremadura	Group 1 (IM)	50	18.7%
	Group 2 (IM)	55	20.5%
	Group 3 (TM)	51	19.0%
La Rioja	Group 1 (IM)	27	10.1%
	Group 2 (IM)	25	9.3%
	Group 3 (IM)	21	7.8%
	Group 4 (TM)	21	7.8%
	Group 5 (TM)	18	6.7%
Total		268	100.0%

Note: “TM” = traditional methodology; “IM” = interactive methodology. Source: Prepared by the authors.

In the final phase of the study, corresponding to the posttest, 240 students participated, representing 89.6% of the initial sample. This implies a loss of 28 participants (10.4%) compared with the initial measurement. Of the total valid cases in this second measurement, 161 students (67.1%) belonged to groups that had worked with an IM, whereas 79 (32.9%) were assigned to groups with TM. The descriptive distribution of this phase is shown in Table 2.

In Extremadura, the posttest results were again distributed across three groups. Group 1, with an IM, consisted of 49 students (20.4%). Group 2, also interactive, included 52 students (21.7%). Group 3, corresponding to TM, consisted of 44 students (18.3%).

In La Rioja, the group structure remained unchanged from the initial phase. In the morning shift, the three groups using IM consisted of 23 students (9.6%), 21 students (8.8%),

and 16 students (6.7%), respectively. The groups using TM included 17 students (7.1%) in Group 4 and 18 students (7.5%) in Group 5 (see Table 2).

In general terms, the comparison between the phases shows that the structure of the sample remained relatively stable, although there was a moderate reduction in the number of participants in the posttest. This loss of cases, which is common in research conducted in real educational contexts, does not substantially alter the organisation of the groups or the overall distribution according to the methodology applied. Therefore, the sample retains sufficient internal coherence for comparative analysis between the initial and final phases of the study.

It should be noted, however, that the distribution between methodological conditions was not balanced due to the use of intact classroom groups, with a higher number of students in IM than in TM in both the pretest and posttest. Although this procedure is common in quasi-experimental educational research, it limits the strength of causal interpretations. Consequently, comparisons between TM and IM should be interpreted cautiously and in relation to the specific classroom contexts analysed.

Before conducting the analyses, the database was reviewed to identify unmatched cases between pretest and posttest, incomplete records, and missing values in the performance variables. Only those cases with valid linkage between both measurements and complete information on the relevant variables were retained for the longitudinal and adjusted analyses.

Figure 1 visually summarises the study design, the assignment of groups, and the loss of participants between the pretest and posttest.

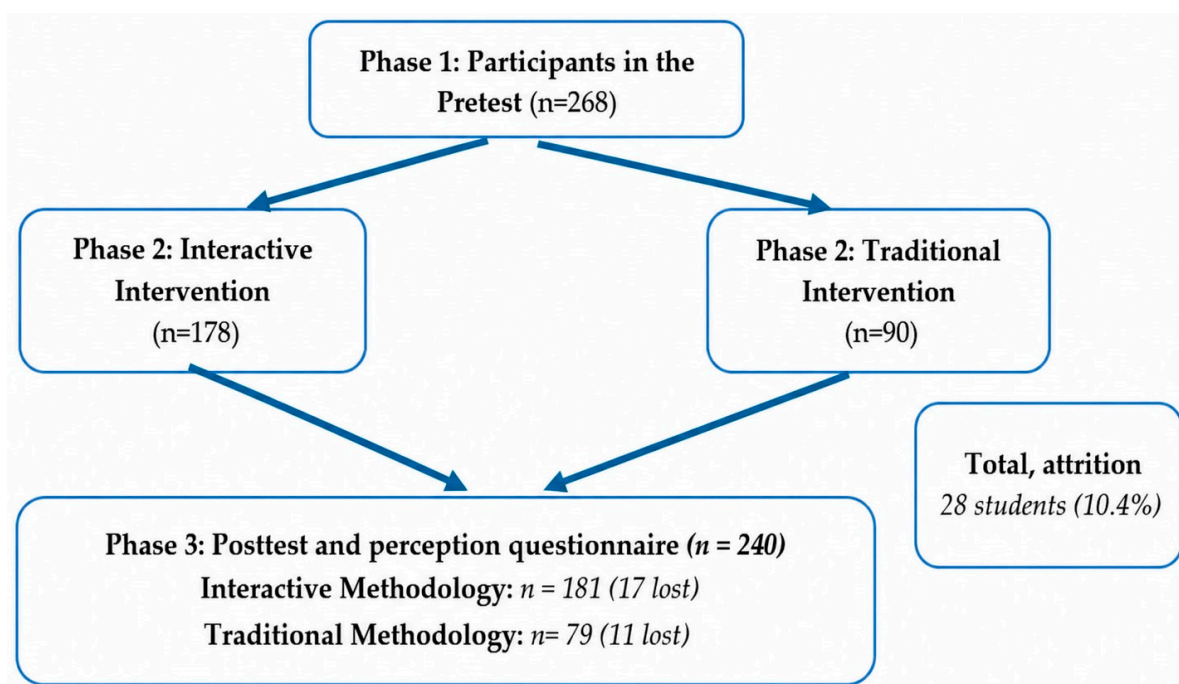


Figure 1. Flowchart of the study design, group assignment, and participant attrition between the pretest and posttest. Source: Prepared by the authors.

Table 2. Distribution of the sample in the posttest phase.

Autonomous Community	Group	Frequency	Percentage
Extremadura	Group 1 (IM)	49	20.4%
	Group 2 (IM)	52	21.7%
	Group 3 (TM)	44	18.3%

Table 2. *Cont.*

Autonomous Community	Group	Frequency	Percentage
La Rioja	Group 1 (IM)	23	9.6%
	Group 2 (IM)	21	8.8%
	Group 3 (IM)	16	6.7%
	Group 4 (TM)	17	7.1%
	Group 5 (TM)	18	7.5%
Total		240	100.0%

Note: “TM” = traditional methodology; “IM” = interactive methodology. Source: Prepared by the authors.

2.3. Teaching Intervention

The teaching intervention was carried out between the administration of the pretest and posttest within the Geography Education course and focused on political geography and toponymic content related to basic territorial elements of Extremadura and La Rioja. In both contexts, the activity started from the need for students to make explicit the knowledge they had about Spanish toponymy and, more specifically, about the autonomous community addressed in each case. To this end, nominative recognition and spatial location tasks based on blank maps were proposed.

The intervention was structured around eight dimensions of analysis: identification of provincial boundaries, location of provincial boundaries, identification of provincial capitals, location of provincial capitals, identification of county seats, location of county seats, identification of counties, and location of counties. These tasks made it possible to assess, in a differentiated way, both the verbal recognition of territorial references and their correct spatial placement on the map.

In the groups assigned to TM, teaching was organised through a predominantly expository approach, based on the teacher’s explanations and on guided activities aimed at reviewing and consolidating the content. In the groups linked to IM, by contrast, the same content was addressed through a practical and collaborative activity in which students, working in small groups, were required to produce digital cartographic materials using Canva. More specifically, each group had to design several maps of the corresponding autonomous community focusing on provincial boundaries, provincial capitals, counties, and county seats, incorporating labels, colours, lines, icons, and other visual resources to support the identification and location of these elements. In addition, students had to create a presentation in Canva, drawing on the platform’s design features and AI-assisted tools to organise and present the results of their work to the rest of the class. According to the activity guidelines, the teacher provided initial instructions, basic templates, and supporting resources (see Appendix A.1 for the teacher’s activity description), and the final products had to be shared afterwards for assessment (see Appendix A.2 for an example of student work).

The comparison between TM and IM should be understood as a comparison between two instructional approaches rather than as the isolated effect of a single methodological component. The IM condition combined collaborative work, visual representation, digital cartographic production, active engagement, and different presentation formats. Therefore, the design does not allow us to determine which specific component of the interactive condition was responsible for the observed effects.

The intervention was implemented over one session of approximately 120 min. The pretest was administered before the intervention, and the posttest was administered after the completion of the teaching sequence. All groups worked on the same type of territorial content and completed equivalent identification and location tasks adapted to the autonomous community addressed in each university.

Not all groups were taught by the same instructor. However, the instructors followed a common instructional protocol, worked with the same type of territorial content, and used equivalent assessment criteria across groups (See Figure 2).

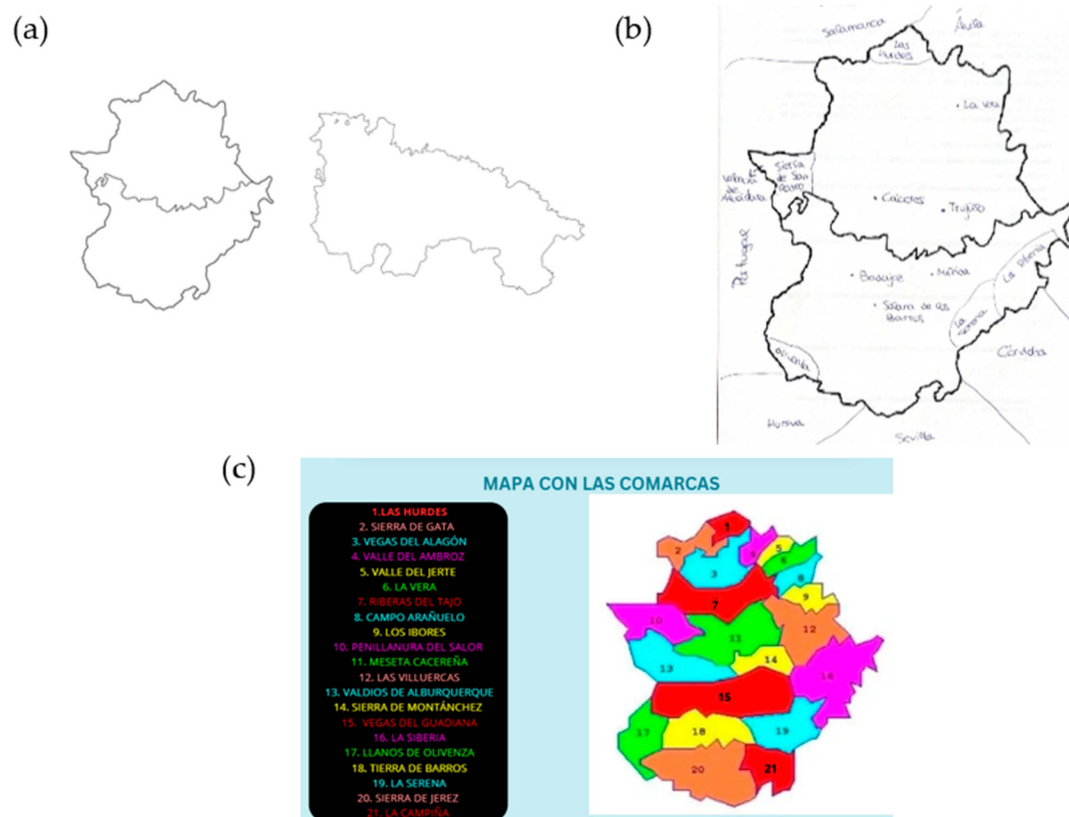


Figure 2. Examples of the toponym-related tasks carried out during the intervention and used in the final assessment: (a) blank map used as the working base; (b) example of identification and location of provincial boundaries, provincial capitals, county seats, and counties; and (c) screenshot of the interactive activity created in Canva. Source: Prepared by the authors.

2.4. Instrument

Data were collected using an ad hoc protocol composed of four complementary sections. Its development involved review by specialists in social sciences education, physical geography, and human geography, to ensure that the content was aligned with the objectives of the research and with the dimensions of territorial knowledge to be assessed. In addition, the study was conducted in accordance with the protocol established by the Ethics Committee and received the corresponding favourable approval (Code: 275/2025).

The first section consisted of a sociodemographic questionnaire aimed at gathering basic information about the participating students. The second section involved an initial self-assessment by the students of their level of competence in several school subjects. The third section constituted the core of the study and consisted of a practical task involving the identification and cartographic location of different elements of territorial organisation. The fourth section collected students' perceptions of the methodology used, their previous experiences in teaching geography, and their overall evaluation of the learning experience.

In the identification tasks, students were asked to name the territorial element represented or marked on a blank map. In the location tasks, students were asked to place or mark the corresponding territorial element on a blank map of the autonomous community studied. Thus, the instrument distinguished between denominative recognition and spatial placement. Examples of the activity and student work are provided in Appendix A.

Toponymic performance was analysed on the basis of eight dependent variables; namely, identification and location of provincial boundaries, provincial capitals, county seats, and counties. These variables were constructed by distinguishing between a nominative dimension, referring to the ability to recognise or correctly name a territorial element, and a spatial dimension, referring to the ability to locate it correctly on the map. This distinction is conceptually relevant because it allows the conceptual recognition of territorial references and their spatial location to be analysed separately, although in a complementary manner. These are two closely related dimensions of geographical learning and territorial literacy (Kriewaldt et al., 2023; J. Lee & Bednarz, 2012; National Research Council, 2006).

The cartographic task was administered in both the pretest and posttest, maintaining the same structure and scoring criteria at both stages. To this end, versions adapted to the territorial contexts addressed at each university were used. This decision made it possible to align the assessment with the content actually covered during the intervention, although it requires direct comparisons between university contexts to be interpreted with caution, since the tests were not strictly equivalent in content or difficulty.

The choice of a specific instrument responded to the need to assess highly specific territorial content that is difficult to address through general standardised tests. The ad hoc design made it possible to tailor data collection to the aims of the study and to distinguish clearly between different dimensions of toponymic and territorial knowledge.

2.5. Validity and Reliability

The content validity of the instrument was established through expert judgement and estimated using the Content Validity Index (CVI), following standard criteria for this type of procedure (Polit & Beck, 2006). This process made it possible to verify the relevance of the items and tasks in relation to the objectives of the study and the dimensions of territorial knowledge assessed.

With regard to internal reliability, Cronbach's alpha and McDonald's total omega were used as complementary indicators of internal consistency, particularly appropriate in educational research contexts and for scales with a brief or heterogeneous structure (Malkewitz et al., 2023; Taber, 2018). Based on the posttest data, the dimension related to the evaluation of school subjects presented a value of $\omega = 0.60$, whereas the dimension referring to territorial toponymic knowledge assessed through identification and location tasks reached values of $\alpha = 0.757$ and $\omega = 0.77$. Taken together, these results support the conclusion that the instrument shows adequate levels of internal consistency for the purposes of the study.

It should be noted, however, that the value of $\omega = 0.60$ should be interpreted cautiously, as it corresponds to a brief and heterogeneous dimension. Nevertheless, the main dimension directly related to territorial toponymic knowledge showed more adequate internal consistency values, with $\alpha = 0.757$ and $\omega = 0.77$.

2.6. Data Analysis Procedure

The analytical strategy was structured at two complementary levels. First, non-parametric procedures were used as the main analytical framework, since the distribution of the scores did not allow the assumption of normality. Second, analysis of covariance (ANCOVA) was incorporated as an adjusted procedure to examine whether the differences observed in the posttest remained once students' initial level had been controlled for.

To analyse changes between the pretest and posttest, the Wilcoxon signed-rank test for related samples was applied to test H1, which referred to a significant improvement in performance following the teaching intervention. To examine differences in students' final performance according to the methodology used, the Mann-Whitney U test was employed

as an initial test of H2, concerning the existence of differences between TM and IM. Possible differences according to group of origin were analysed using the Kruskal–Wallis H test, which was used to test H3, referring to the presence of differences in at least some variables depending on the participating group.

The relationship between the nominative dimension and the spatial dimension of toponymic knowledge was examined using Spearman's rho coefficient, which is appropriate for ordinal or non-normally distributed data. This analysis made it possible to test H4, according to which the identification and location of territorial elements would show positive and significant associations in both the pretest and posttest. In interpreting the magnitude of the correlations, the criteria proposed by Schober et al. (2018) were followed, according to which values between 0.50 and 0.69 indicate moderate associations, values between 0.70 and 0.89 indicate high associations, and values equal to or greater than 0.90 indicate very high associations.

Finally, the possible influence of methodology on students' final performance was explored through ANCOVA models, incorporating the equivalent pretest score as a covariate in each model. This procedure was used only as a complementary adjusted analysis of H2, because assignment to methodological conditions was not random. Before interpreting these models, diagnostic checks of the main ANCOVA assumptions were conducted. These checks indicated that not all assumptions were satisfied across the eight models, especially regarding the homogeneity of regression slopes in some variables. Consequently, ANCOVA was not treated as a confirmatory test of methodological effects, but as an exploratory procedure for identifying possible adjusted tendencies after controlling for baseline performance. Greater interpretative weight was therefore given to the non-parametric analyses, and all ANCOVA results were interpreted with caution (Van Breukelen, 2006).

In addition to significance testing, effect sizes were reported to assess the practical relevance of the findings. For the Wilcoxon signed-rank test and the Mann–Whitney U test, the effect size r was calculated from the standardised Z value using the formula $r = |Z| / \sqrt{N}$. For the Wilcoxon test, N refers to the number of valid paired observations, whereas for the Mann–Whitney U test, N refers to the total number of participants in both groups. For the Kruskal–Wallis test, epsilon squared (ϵ^2) was calculated using the formula $\epsilon^2 = (H - k + 1) / (N - k)$, where H is the Kruskal–Wallis statistic, k is the number of groups, and N is the total sample size. For ANCOVA models, partial eta squared (ηp^2) was used as an indicator of effect size.

3. Results

3.1. Changes Between Pretest and Posttest

To analyse the development of students' toponymic knowledge following the intervention, the scores obtained in the pretest and posttest were compared using the Wilcoxon test. As shown in Table 3, statistically significant differences were found in six of the eight variables analysed: identification and location of provincial boundaries, identification and location of provincial capitals, and identification and location of counties. By contrast, no statistically significant differences were observed in either the identification or the location of county seats. These results therefore indicate that the intervention was associated with changes in a substantial number of the dimensions assessed, although this pattern was not homogeneous across all territorial contents.

With regard to H1, these results provide general support for the expectation of improvement following the intervention, although such improvement was not confirmed for all of the variables analysed.

The Wilcoxon signed-rank test showed statistically significant pretest–posttest differences in six of the eight variables analysed. The effect sizes were small for provincial boundaries

and provincial capitals, negligible for county seats, and large for counties. No statistically significant differences were observed in the identification or location of county seats.

Table 3. Results of the Wilcoxon test in the comparison between pretest and posttest.

Variable	Z	p	Effect Size r
Identification of provincial boundaries	−2.217	0.027	0.143
Location of provincial boundaries	−2.083	0.037	0.134
Identification of provincial capitals	−3.076	0.002	0.199
Location of provincial capitals	−2.174	0.030	0.140
Identification of county seats	−0.024	0.981	0.002
Location of county seats	−0.688	0.492	0.044
Identification of counties	−9.974	<0.001	0.644
Location of counties	−9.867	<0.001	0.637

Note. Wilcoxon signed-rank test for related samples. Effect size r was calculated as $|Z|/\sqrt{N}$, where N refers to the number of valid paired observations. Source: Prepared by the authors.

3.2. Differences According to the Methodology Applied

To examine whether students' final performance varied according to the methodology implemented during the intervention, posttest scores were compared using the Mann–Whitney U test. In this comparison, the posttest methodological grouping consisted of 79 students in TM and 161 in IM, in line with the descriptive distribution presented in Table 2. As shown in Table 4, no statistically significant differences were found in any of the eight variables analysed. The comparisons closest to significance were observed for the identification and location of counties, as well as for the location of provincial capitals. These results do not support conclusive differences in students' final performance according to the methodology applied.

In terms of the hypotheses, the results of the unadjusted analysis do not support H2, since no statistically significant differences were found between methodologies in any of the variables considered.

Table 4. Results of the Mann–Whitney U test according to the methodology applied in the posttest.

Variable	N (TM)	N (IM)	U	Z	p	Effect Size r
Identification of provincial boundaries	79	161	6065.00	−0.660	0.509	0.043
Location of provincial boundaries	79	161	6016.50	−0.778	0.436	0.050
Identification of provincial capitals	79	161	5761.50	−1.369	0.171	0.088
Location of provincial capitals	79	161	5593.00	−1.728	0.084	0.112
Identification of county seats	79	161	5974.50	−0.764	0.445	0.049
Location of county seats	79	161	6232.50	−0.251	0.802	0.016
Identification of counties	79	161	5421.50	−1.890	0.059	0.122
Location of counties	79	161	5422.50	−1.889	0.059	0.122

Note. Mann–Whitney U test. “TM” = traditional methodology; “IM” = interactive methodology. Effect size r was calculated as $|Z|/\sqrt{N}$, with $N = 240$. Source: Prepared by the authors.

3.3. Differences According to Group of Origin

Possible differences in students' final performance according to group of origin were analysed using the Kruskal–Wallis H test. As shown in Table 5, statistically significant differences were observed in all the variables considered, indicating that students' performance was not

homogeneous across the different participating groups. These results reveal the existence of intergroup heterogeneity in the posttest and suggest that, in addition to methodology, other factors associated with the specific context of each group may have been involved. However, since this test only indicates the overall existence of differences, these results do not by themselves identify between which specific groups such differences occurred.

Table 5. Results of the Kruskal–Wallis H test according to group of origin (posttest).

Variable	χ^2	gl	<i>p</i>	ϵ^2
Identification of provincial boundaries	71.660	7	<0.001	0.279
Location of provincial boundaries	67.246	7	<0.001	0.260
Identification of provincial capitals	195.222	7	<0.001	0.811
Location of provincial capitals	154.786	7	<0.001	0.637
Identification of county seats	44.040	7	<0.001	0.160
Location of county seats	55.543	7	<0.001	0.209
Identification of counties	53.477	7	<0.001	0.200
Location of counties	50.059	7	<0.001	0.186

Note. Kruskal–Wallis H test. “TM” = traditional methodology; “IM” = interactive methodology. Source: Prepared by the authors.

These findings clearly support H3, as they show significant differences between groups in all posttest variables.

3.4. Association Between Identification and Location of Territorial Elements

To examine the relationship between the nominative dimension and the spatial dimension of toponymic knowledge, correlations were calculated between the identification and location of the different territorial elements in the pretest and posttest. As shown in Table 6, all associations were positive, statistically significant, and of very high magnitude at both stages of the study. In the pretest, the coefficients ranged from 0.906 to 0.994, whereas in the posttest, they ranged from 0.925 to 0.977. These results indicate that students who were better able to identify the different territorial elements also tended to locate them more accurately on the map, thus confirming the close relationship between both dimensions of toponymic learning.

Table 6. Correlations between identification and location of territorial elements in the pretest and posttest.

Phase	Variable	Spearman’s ρ	<i>p</i>	N
PRETEST	Provincial boundaries	0.994	<0.001	268
	Provincial capitals	0.906	<0.001	268
	County seats	0.935	<0.001	268
	Counties	0.949	<0.001	268
POSTTEST	Provincial boundaries	0.968	<0.001	240
	Provincial capitals	0.925	<0.001	240
	County seats	0.957	<0.001	240
	Counties	0.977	<0.001	240

Note. Spearman’s rho coefficient between the identification and location variables corresponding to each territorial dimension in the pretest and posttest phases. Source: Prepared by the authors.

Accordingly, the results confirm H4, showing positive, significant, and high-magnitude associations between identification and location in both phases of the study.

3.5. Exploratory Adjusted Results Through ANCOVA

Not all the ANCOVA assumptions were satisfied across all models; therefore, the associated results should be considered exploratory. Table 7 reports the results obtained.

Table 7. Exploratory ANCOVA models for posttest performance.

Dependent Variable (Posttest)	Model F	Model p	Model ηp^2	Covariate p	Methodology p
Identification of provincial boundaries	1.666	0.191	0.014	0.072	0.625
Location of provincial boundaries	1.584	0.207	0.013	0.078	0.630
Identification of provincial capitals	130.566	<0.001	0.524	<0.001	0.310
Location of provincial capitals	47.191	<0.001	0.285	<0.001	0.744
Identification of county seats	1.044	0.354	0.009	0.468	0.198
Location of county seats	2.465	0.087	0.020	0.421	0.038
Identification of counties	4.149	0.017	0.034	0.418	0.010
Location of counties	2.635	0.074	0.022	0.440	0.049

Note. ANCOVA = analysis of covariance. Fixed factor: methodology applied. Covariate: equivalent score in the pretest. ηp^2 = partial eta squared for the corrected model. Since not all ANCOVA assumptions were met across the set of models, these analyses were treated as complementary exploratory adjusted models and should be interpreted with caution. Source: Prepared by the authors.

The models were statistically significant for the identification and location of provincial capitals and for the identification of counties. In the two variables related to provincial capitals, the pretest covariate was significant, whereas methodology was not, suggesting that final performance was more strongly associated with students' initial level than with the methodology applied. Methodology reached statistical significance in the location of county seats, the identification of counties, and the location of counties. However, in the location of county seats and the location of counties, the overall models were not statistically significant. The identification of counties was the most consistent adjusted tendency, as both the overall model and the methodology factor were statistically significant.

4. Discussion

4.1. Effects of the Intervention on Toponymic Learning

The results indicate that the didactic intervention produced significant improvements in six of the eight variables analysed. Improvements were observed in the identification and location of provincial boundaries, provincial capitals, and counties, whereas no significant changes were found in the identification or location of county seats. Therefore, the intervention had a positive but uneven effect on students' toponymic learning, depending on the territorial element assessed, providing general support for H1. The pattern of improvement suggests that toponymic learning did not evolve uniformly but rather varied according to the type of territorial reference addressed, its prior familiarity, and the spatial complexity involved in its recognition and location. In this regard, [Bendl et al. \(2025\)](#), [Kriewaldt et al. \(2023\)](#), [J. Lee and Bednarz \(2012\)](#), and the [National Research Council \(2006\)](#) agree in understanding geographical thinking and spatial thinking as multidimensional constructs composed of concepts, representations, and reasoning processes that do not necessarily progress at the same pace.

The improvement observed in provincial boundaries, provincial capitals, and counties reinforces the idea that toponymy should not be understood as strictly rote content, but rather as a foundation for territorial literacy. [Morote and Membrado \(2021\)](#) had already

emphasised the didactic value of toponymy in linking name, place, and spatial organisation. Along similar lines, [Rodríguez et al. \(2024\)](#) argue that geographical education needs to move from the recognition of specific elements toward broader forms of territorial and landscape understanding, without dispensing with the basic knowledge that makes such progression possible. To this may be added the contribution of [Ordinas \(2024\)](#), who insists that place names constitute a particularly fertile resource for connecting spatial knowledge, territorial experience, and teaching practice.

The absence of significant changes in county seats, however, introduces an important nuance. This result suggests that not all toponymic contents present the same degree of cognitive accessibility or respond in the same way to a brief intervention. In this case, county seats require a more complex relationship between denomination, territorial hierarchy, and cartographic location. Once again, [Bendl et al. \(2025\)](#) and [Kriewaldt et al. \(2023\)](#) are useful for interpreting this finding, as they stress the importance of task sequencing, conceptual explicitness, and teacher guidance when working with more complex spatial content.

4.2. Methodological Effects: Traditional and Interactive Methodology

With regard to methodology, the results paint a more nuanced picture than is often assumed in didactic debates. In the unadjusted posttest analyses, no statistically significant differences were detected between TM and IM in any of the eight variables analysed, although some comparisons approached significance, particularly in variables related to counties and in the location of provincial capitals. Therefore, the data do not support an interpretation of final performance based solely on methodological condition, nor do they justify a general claim about the superiority of one methodology over the other.

The exploratory ANCOVA analyses were conducted to examine whether this pattern changed after accounting for students' initial levels. Overall, these adjusted analyses did not provide evidence of a general methodological effect. Methodology did not show significant adjusted effects on provincial boundaries or provincial capitals; in the latter case, the pretest covariate accounted for the main explanatory weight, indicating that students' starting levels remained the strongest predictor of final performance. Some isolated adjusted tendencies were observed in the location of county seats and in the variables concerning counties. However, these results should be interpreted with particular caution, as they emerged only after adjustment, some overall ANCOVA models were not statistically significant, and the assumptions of ANCOVA were not fully met across all models. Consequently, these findings should be regarded as exploratory signals rather than robust evidence of methodological superiority. Taken together, the results do not support the general superiority of one methodology over the other, but suggest, at most, partial and content-dependent methodological tendencies. H2 therefore receives only tentative partial support: no general and stable superiority of IM is observed in the unadjusted analysis, while the exploratory ANCOVA models suggest possible adjusted tendencies in some specific dimensions, especially in the identification of counties. However, these adjusted results should be interpreted cautiously because not all ANCOVA assumptions were met.

Recent studies on active methodologies and geographical education support this interpretation. [Bearman et al. \(2016\)](#) and [Favier and van der Schee \(2014\)](#) had already shown that the value of active approaches and geotechnologies depends less on the tool itself than on the pedagogical design that organises it. Along similar lines, [Muntaner et al. \(2020\)](#) warn that the impact of active methodologies on academic achievement should not be taken for granted but rather empirically examined according to the content, the context, and the mode of implementation. In the field of initial teacher education, [D.-M. Lee \(2020\)](#) also shows that the use of Story Maps can foster a more reflective geographical awareness, although their benefits depend on sustained didactic integration rather than

mere technological incorporation. [Cabanillas-García \(2025\)](#) expands this idea by pointing out that the implementation of these methodologies continues to be conditioned by teacher training, student acceptance, and the real transfer of these proposals into classroom practice.

In the more specific field of digital cartography, [De Lázaro and González \(2005\)](#) previously pointed to the usefulness of these tools for geographical education, although their benefits depend on consistent didactic integration. From a more recent perspective, [D.-M. Lee \(2020\)](#) showed how the use of Story Maps can strengthen the geographical awareness of initial teacher education, while [Vojteková et al. \(2022\)](#) highlighted their potential to improve the spatial and narrative work of future geography teachers. These contributions help to explain why IM may be associated with possible partial adjusted tendencies in some dimensions without necessarily translating into an overall advantage across all variables.

The differences detected between groups through the Kruskal–Wallis test must also be considered. The fact that significant differences appeared in all variables indicates that performance was not homogeneous among the different participating groups. This result points to the possible influence of additional contextual factors, such as students' territorial familiarity, their prior educational experiences, the composition of each group, or the specific way in which the intervention was implemented in each context. In the Spanish context, [García-González et al. \(2023\)](#) also showed, based on the analysis of mental maps in university students in teacher education, that geographical literacy presents significant inequalities and that initial territorial knowledge is not always homogeneous among future teachers. About this issue, both [Binimelis and Ordinas \(2018\)](#) and [Gómez-Gonçalves et al. \(2021\)](#) had already warned that university students' geographical knowledge presents deficiencies and inequalities that cannot be explained solely by a specific intervention. To this must be added the reflection of [Jo and Bednarz \(2014\)](#), who stress that the development of spatial thinking in initial teacher education requires specific pedagogical knowledge, not merely exposure to innovative resources. Hypothesis 3 is, therefore, supported.

4.3. Identification and Location as Related Dimension

One of the most robust findings of the study appears in the correlations between identification and location. In both the pretest and posttest, positive, very high, and statistically significant associations were recorded in all dimensions, confirming H4.

This result indicates that students who are better able to identify a territorial element also tend to locate it more accurately, a fact that is theoretically relevant because it shows that the nominative dimension and the spatial dimension of toponymic knowledge do not act as isolated processes but rather as closely related components of the same geographical competence. At the same time, the results themselves show that both dimensions may respond differently depending on the content addressed and the type of intervention, which justifies keeping them analytically separate. At this point, the proposal of [J. Lee and Bednarz \(2012\)](#), as well as the perspective of the [National Research Council \(2006\)](#), remain especially useful.

4.4. Didactic Implications and Limitations

From a didactic perspective, the results suggest that toponymic learning should not be reduced to the memorisation of place names. Identification and location tasks can be used as starting points for broader geographical activities involving map reading, territorial comparison, interpretation of spatial relationships, and discussion of how administrative and functional territories are organised. This is especially relevant in initial teacher education, as future teachers need to transform basic territorial knowledge into meaningful classroom activities for primary education pupils. Therefore, toponymy should be integrated into map-based, interpretive, and contextualised tasks rather than taught as an isolated list of names.

5. Conclusions

The results show that the didactic intervention was associated with significant improvements in six of the eight variables analysed. Specifically, statistically significant differences between the pretest and posttest were found in the identification and location of provincial boundaries, provincial capitals, and counties. By contrast, no significant changes were observed in the identification or location of county seats. Therefore, the intervention appears to have had a positive but uneven effect on students' toponymic learning, depending on the territorial element assessed.

Second, the influence of methodology was partial and should be interpreted cautiously. In the unadjusted posttest analyses, no statistically significant differences were detected between TM and IM in the eight variables analysed. The exploratory ANCOVA models suggested possible adjusted tendencies in some specific dimensions, especially in the identification of counties. However, these results cannot be considered conclusive because not all ANCOVA assumptions were met across the models and some overall models were not statistically significant. Consequently, the study does not support a general superiority of IM over TM; rather, it points to the need to assess the fit between task type, content addressed, student context, and instructional design.

Third, the study confirms the close relationship between identifying and locating. The very high correlations observed in both the pretest and posttest indicate that both dimensions form part of an integrated territorial competence. Consequently, toponymic knowledge cannot be understood solely as the nominal recognition of places, but also as the ability to situate them correctly in space and relate them to a given territorial structure.

Fourth, the differences between groups show that the learning of toponymic knowledge was also conditioned by the context of origin and by the specific conditions under which the intervention was implemented. This result reinforces the need to interpret methodological performance by taking into account the group, students' initial level, and the type of task proposed.

In conclusion, the study shows that toponymy constitutes a relevant content area for initial teacher education, not only as specific geographical knowledge, but also as a basis for developing basic dimensions of territorial literacy. However, the findings should not be interpreted as evidence of the full development of spatial thinking, since the study focused specifically on identification and location tasks. From this perspective, the educational value of toponymy lies in connecting place names with maps, territorial organisation, and spatial relationships, thereby providing future teachers with basic references for teaching geography more rigorously in primary education.

Regarding the limitations of the study, the quasi-experimental design with natural groups requires the results to be interpreted cautiously, especially with regard to the specific effect of methodology. The unequal distribution between TM and IM groups, the absence of random assignment, and the use of context-adapted instruments limit the possibility of making strong causal and comparative claims. In addition, the distinction between TM and IM involved several simultaneous instructional differences, including collaboration, visual representation, digital tools, and activation level; therefore, the design does not allow the effect of each component to be isolated. Finally, the study assessed identification and location tasks, which are basic dimensions of territorial literacy, but not a comprehensive measure of spatial thinking as a whole. Future research should include delayed posttests, more balanced group designs, standardised instruments across contexts, and tasks assessing broader geographical reasoning.

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Appendix A.

Appendix A.1. Activity Introduced by the Instructor as Part of the Interactive Methodology

Actividad: Mapas con Topónimos de carácter Administrativo



Objetivo

Los alumnos crearán mapas detallados en la aplicación Canva, identificando:

1. Límites provinciales.
2. Capitales de provincia.
3. Comarcas.
4. Cabeceras comarcales.

Desarrollo de la Actividad

1. Preparar varios mapas de la Comunidad en Canva
2. Dividir la clase en grupos
3. Cada grupo debe realizar estos 4 mapas:
 - Mapa con los Límites provinciales.
 - Mapa con las capitales de provincia.
 - Mapa con las Comarcas
 - Mapa con las Cabeceras Comarcales
4. Tienen que ser mapas interactivos, con el uso de la aplicación Canva
5. Cada grupo expondrá los diferentes mapas a los compañeros

Elementos Clave

- Límites provinciales bien definidos
- Iconos y nombres de las capitales de provincia
- Etiquetas para cada cabecera comarcal
- Comarcas señaladas con diferentes colores

Recursos Sugeridos

- Mapas en blanco de la Comunidad extraídos de Google
- Herramientas en Canva (líneas, iconos, etiquetas, colores).
- Plantillas base, con los contenidos a exponer en la actividad, compartidas por el docente.
 - Mapa de las comarcas <https://redes.org/informacion-territorial>
 - Información de las poblaciones de las comarcas <https://conoceextremadura.com/comarcas/>
- Mapas interactivos (Google maps): https://www.youtube.com/watch?v=M_JQ0XcpQZM

Appendix A.2. Example of Student Work



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