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Mathematics in English? A Pilot Study on the Benefits of an Interdisciplinary Experience in Initial Primary Teacher Education

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Abstract. Although Content Language Integrated Learning (CLIL) is regulated in bilingual education programmes in Spain, the collaboration between mathematics and English as a foreign language (EFL) is generally a controversial topic. This study addresses some of these challenges and analyses the impact of an interdisciplinary experience in preservice primary teacher education, integrating mathematics and English instruction through a collaborative teaching project. The objective is to assess whether this approach influences teacher self-efficacy, perceptions of interdisciplinary teaching, and acceptance of the CLIL approach in mathematics. The research involved 119 preservice teachers in a pre-test-post-test design with non-equivalent experimental (N=59) and control (N=60) groups, using pre- and post-treatment measures with an *ad hoc* questionnaire comprising 17 items grouped into three dimensions: teacher self-efficacy, interdisciplinary teaching, and Maths CLIL. The results show a significant improvement in the experimental group in teacher self-efficacy for both mathematics and English instruction, as well as in the perception of interdisciplinary collaborations between the mathematics and English subjects. However, no significant changes were observed in attitudes toward teaching mathematics in English. The findings suggest that interdisciplinary experiences between mathematics and English can enhance preservice teacher training and recommend integrating collaborative teaching strategies and expanding CLIL training in mathematics to optimize the professional development of future teachers.

Keywords: bilingual education; interdisciplinarity; collaborative teaching; teacher self-efficacy

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1. Introduction

The expansion of bilingual education programmes in Spain over the past two decades has made studying subjects taught in English at the primary and secondary education levels a common experience for many pupils in the public and semi-private school system (Durán-Martínez & Fernández-Costales, 2025). As a result, many teachers make use of Content and Language Integrated Learning (CLIL), an approach that pursues a dual focus on curricular content and language learning (Coyle et al., 2010), to teach subject content in English to learners whose communicative competence in the language may be far from that of native speakers.

However, generally, mathematics is usually excluded from CLIL programmes in Spain, where most regional regulations include the requirement for mathematics to be taught exclusively in Spanish or in co-official languages (Alcaraz-Mármol & Guadamillas, 2019). In the Community of Madrid, which constitutes the context of the present study, current legislation establishes that bilingual schools may offer instruction in English in all areas of the primary education curriculum with the exception of mathematics and Spanish language and literature (Pires et al., 2024). A brief international overview suggests that this restrictive stance is not universal. In some educational systems, such as Singapore (Ministry of Education Singapore, 2025), Finland (Eurydice, 2025b), Canada (Dicks & Genesee, 2016), and Ireland (Department of Education and Youth, 2025), national or local policies explicitly allow the teaching of mathematics through a foreign or second language.

In other contexts, particularly within Europe, the situation is less clear-cut. Countries such as Germany (Eurydice, 2025a) and Slovenia (Eurydice, 2024) tend to maintain restrictive default policies regarding the language of instruction, yet without imposing an explicit legal ban on the use of additional languages to teach mathematics. Outside Europe, neither the United States (Every Student Succeeds Act [ESSA], 2015) nor Australia (Australian Government Department of Education, 2022) issue policy directives that explicitly prohibit the use of languages other than the official national one to teach core subjects; nevertheless, English remains the standard medium of instruction in mainstream schooling.

Considering this international perspective, and the fact that mathematical concepts and forms of reasoning are frequently embedded in other subjects—such as Natural Science—that are taught in English, it appears appropriate to explore the possibility of combining mathematics and English in some form, whether through interdisciplinary collaboration or more integrated approaches. However, implementing such approaches also raises important pedagogical challenges.

Teachers may feel insufficiently prepared to integrate mathematical content with the linguistic demands of English, particularly when their training has focused primarily on disciplinary knowledge rather than bilingual pedagogy. At the same time, pupils may face additional difficulties when engaging with mathematical reasoning through a second language. Although these issues have been discussed

in relation to CLIL in compulsory education, considerably less attention has been paid to how initial teacher education can prepare future teachers to address them. In this context, the aim of this study is to analyse the impact of an interdisciplinary experience that integrates mathematics and English as a foreign language (EFL) within initial primary teacher training. Specifically, we examine whether participation in *MathEnglish*, a collaborative, interdisciplinary project influences preservice teachers' perceived self-efficacy in teaching mathematics, English, and mathematics through English, as well as their perceptions of the educational value of interdisciplinary approaches and their attitudes toward the use of CLIL in mathematics.

By focusing on initial teacher education, this paper seeks to contribute empirical evidence to a research area that has received limited attention to date and to inform the design of training experiences that respond to both the opportunities and challenges associated with integrating mathematics and English in bilingual educational contexts.

2. Theoretical framework

The analysis presented in this study is informed by three theoretical dimensions: teacher self-efficacy, interdisciplinary collaboration in teacher education, and approaches to teaching mathematics through CLIL. These dimensions structure the examination of preservice teachers' perceptions regarding their professional preparation and the integration of mathematics and English.

2.1 Teacher self-efficacy

Teacher self-efficacy refers to individuals' beliefs about their capacity to organize and execute the actions required to achieve desired outcomes (Bandura, 1997). In educational contexts, these beliefs are closely linked to teachers' instructional practices and to pupils' learning goals and outcomes (Skaalvik & Skaalvik, 2014; Tschannen-Moran & Hoy, 2001). In general, there is broad consensus in the literature linking teacher self-efficacy to learners' academic achievement (Klassen & Tze, 2014; Zee & Koomen, 2016).

With regard to the teaching of English, or teaching through English—an aspect of particular relevance in the present study—several studies indicate that a higher level of English proficiency has a positive impact on teacher self-efficacy (Faez et al., 2019; Morton, 2016). In the field of mathematics education, various studies have shown a statistically significant relationship between teachers' self-efficacy interest in mathematics (Hettinger et al., 2023) and achievement in the subject (Perera & John, 2020).

In addition, multiple investigations with preservice teachers have demonstrated a connection between attitudes toward mathematics and teacher self-efficacy in this subject (Schanke, 2023; Segarra & Julià, 2022), pointing to mathematical self-efficacy as a predictive factor of mathematics anxiety (Perry et al., 2023). Taken together, these considerations lead us to include teacher self-efficacy as a variable in the present study, with a special focus on classroom management, learner participation, and teaching strategies (Shafiee & Ghani, 2022).

2.2 Interdisciplinary projects and teacher collaboration

Within higher education, and particularly in initial teacher education, interdisciplinary approaches are widely recognized for their potential to foster the development of professional competences. When well designed, interdisciplinary education proposes integrated activities based on problems, challenges, or guiding questions that allow learners to mobilize knowledge and skills from different disciplines (Lyall et al., 2015). From a constructivist perspective, such approaches enable learners to analyse educational situations from multiple viewpoints, identify connections across domains, and develop a more integrated understanding of teaching and learning (Ashby & Exter, 2019).

To assess the effectiveness of interdisciplinary collaboration, the tripartite model proposed by Boix and Dawes (2007) offers a useful reference framework. According to these authors, interdisciplinary student learning should (a) demonstrate a solid grounding in each of the disciplines involved; (b) show progress in the understanding of a problem or reality that would not have been possible through disciplinary work carried out independently; and (c) display critical awareness of both the purpose of integrating disciplines and the limitations of doing so within a specific activity or project.

However, the implementation and sustainability of interdisciplinary collaborations is not straightforward, whether due to a lack of pedagogical support (Klein, 2004), institutional support (Doig et al., 2019; Pozuelos et al., 2012), or differences between the discourses and methodologies of the disciplines involved (Baker & Däumer, 2015). As a result, and as occurs with other innovative initiatives, interdisciplinary collaborations often suffer from a lack of sustainability.

In the field of initial teacher education, the value of interdisciplinary education is widely recognized; however, despite a growing number of projects that establish connections between different disciplines and areas of knowledge, it has yet to become a consolidated practice (Biseth et al., 2022). In Spain, several universities have implemented interdisciplinary models designed to foster the development of teaching competences and instructional strategies (Arroyo et al., 2020; Jechimer et al., 2024; Pla-Campas et al., 2022; Ugalde et al., 2020).

2.3 Teaching mathematics through CLIL

The integration of mathematics and foreign language instruction through a CLIL approach has attracted growing interest in the research literature (Ruiz-Cecilia et al., 2023), although its implementation remains uneven and, in some contexts, controversial. From a sociocultural perspective, learning is understood as a process mediated by cultural tools, especially language (Vygotsky, 1962). In mathematics, knowledge is constructed through multiple semiotic resources; thus, learning involves using a range of representations beyond vocabulary or formal notation (Moschkovich, 2024).

In this sense, language and thinking processes develop interdependently, and mathematical learning entails participating in specific forms of discourse that enable interpretation, argumentation, and justification (Sfard, 2007). Likewise, the

symbolic and visual features of mathematics may facilitate its integration with an additional language (Prochazkova, 2013). Recent research highlights the role of language in the construction of mathematical meaning, particularly in multilingual contexts (Planas & Morgan, 2024). Within this framework, teaching mathematics through a foreign language may foster pupils' conceptual understanding, cognitive development, and metalinguistic awareness (Bairy & Inamdar, 2025; Surmont et al., 2016; Ter Kuile et al., 2011).

However, the implementation of CLIL in mathematics presents significant challenges. Ruiz-Cecilia et al. (2023) point out that pupils' lack of linguistic competence—particularly in the academic register—and the diversity of proficiency levels within the classroom make it difficult for teachers to balance linguistic development with mathematical content. In addition, multiethnic and multilingual communities pose further challenges. In the early years of primary education, studying mathematics in a second language tends to generate insecurity and negatively affects performance, although these difficulties tend to decrease in later grades. For this reason, the feasibility and educational value of teaching mathematics through CLIL cannot be assumed but rather needs to be examined in relation to specific contexts and forms of implementation.

In the context of initial teacher education, exploring preservice teachers' perceptions of teaching mathematics through CLIL is particularly relevant, as these perceptions are likely to influence their future instructional choices. In this regard, the literature review conducted by Ruiz-Cecilia et al. (2023) shows that, although research on the application of CLIL programmes in the teaching and learning of mathematics has increased notably since 2020, most studies have focused on compulsory education stages, with very little research addressing initial teacher education specifically. Understanding how interdisciplinary and CLIL-oriented experiences affect preservice teachers' confidence and attitudes can therefore contribute to the design of training programmes that respond to both the potential and the challenges of integrating mathematics and English in educational practice.

3. Description of the interdisciplinary experience

MathEnglish, the interdisciplinary experience analysed in this study, was implemented in the Bachelor's degree in Primary Education at a medium-sized Spanish university through collaboration between the professors of the compulsory semester-long courses, Teaching Mathematics and Teaching English as a Foreign Language. The experience was initially implemented as a pilot project during the 2019–2020 academic year and has been consolidated in subsequent years (Jechimer et al., 2024).

The proposal is based on a collection of stories written in English whose themes and narratives intentionally incorporate mathematical content from the primary education curriculum. Previous research has identified storytelling as a didactic resource with the potential to enhance language learning and learner engagement (Kanaan et al., 2025; Xiao et al., 2023), and, in the field of mathematics education, as a means of creating meaningful learning environments (Alsina, 2019) that

facilitate the internalization of mathematical content. In initial teacher education, storytelling has also been considered as an appropriate interdisciplinary resource in bilingual contexts, given its applicability to primary classrooms and its potential to support working on subject content through a foreign language while also fostering motivation, creativity, and cooperative learning dynamics (Alcántara-Manzanares et al., 2022).

The stories serve as a common thread for both subjects and are used to guide the analysis of mathematical and linguistic content—including the latter's potential obstacles for conceptual understanding (Tayfour & Alabdulaziz, 2025)—the practice of storytelling techniques in English, and the design of didactic workshops supported by manipulative resources. The experience also includes the implementation of the designed activities in a real school setting, allowing preservice teachers to carry out the interdisciplinary proposal with fourth-grade pupils in primary education. In all cases, the mathematics and language university instructors collaborated closely in the planning and implementation of the interdisciplinary learning and assessment tasks (Jechimer et al., 2024).

4. Method

4.1 Research design, objectives and variables

This longitudinal study analyses the impact of an interdisciplinary experience at a university in the Community of Madrid (Spain), which combines the teaching of mathematics and English as a foreign language (EFL), on the perception of students of the Bachelor's degree in Primary Education in three dimensions: teacher self-efficacy, benefits of including interdisciplinary projects that integrate both subjects and the advantages of teaching mathematics through CLIL. In addition, the study compares these averages with a control group before and after the experience.

For triangulation of the quantitative results, the answers to two open-ended questions included at the end of the questionnaire were analysed. These questions asked about the teacher trainees' experience in the interdisciplinary *MathEnglish* project and their impression in relation to the convenience of (1) integrating mathematics and English in interdisciplinary projects and (2) introducing CLIL teaching in mathematics in primary education.

Specifically, the study has the following objectives:

1. To verify the impact of the interdisciplinary experience on preservice teachers' perceptions on the three dimensions: D1 Teacher Self-efficacy; D2 Interdisciplinary Math-English projects; D3 Maths CLIL.
2. To measure preservice teachers' perception of the convenience of integrating mathematics and English in primary education, in the form of interdisciplinary projects to improve the learning of both subjects.
3. To identify the perception of preservice teachers of primary education about the limitations of the current regulations on the teaching of mathematics in English.

The dependent variables (DV) are preservice teachers' perceptions of: DV1. Teacher self-efficacy (items 1 to 12); DV2. Interdisciplinary Math-English projects (items 13 and 14); DV3. Maths CLIL (items 15 to 17).
The main independent variables (IV) are:

- Timepost-test: Measurement before and after in the DV.
- Group: Experimental and control.

4.2 Research hypothesis

The main hypothesis is that the theoretical-practical experience of interdisciplinary training that combines the teaching of mathematics and English (*MathEnglish project*) improves teacher self-efficacy and modifies the perception of the convenience of implementing interdisciplinary projects that integrate the two subjects and the need to teach mathematics through CLIL in students of the Bachelor's degree in Primary Education.

Based on this hypothesis, the following specific working hypotheses (H) have been drafted:

- Dimension 1: Teacher self-efficacy
  H1. Participating in the interdisciplinary experience improves preservice teachers' perceived teaching self-efficacy in the integrated teaching of mathematics and English, specifically: to teach mathematics (H1.1.); to teach English (H1.2.); to teach mathematics in English (H1.3).
- Dimension 2: Interdisciplinary projects
  H2. Participating in the interdisciplinary experience improves preservice primary education teachers' perceptions of how the integration of mathematics and English in interdisciplinary projects contributes to the trainees' learning.
- Dimension 3: Maths CLIL
  H3. Participating in the interdisciplinary experience improves preservice teachers' perceptions of the educational value of teaching mathematics through English as an integrated content and language approach.

4.3 Participants

The sample for the experimental group (EG), chosen by probability sampling for the convenience of the study, is composed of 59 teacher trainees in the third year of the Primary Education degree in the academic years 2021-22, 2022-23 and 2023-24. The participants correspond to different cohorts of preservice teachers enrolled in the same course of the primary Education degree across successive academic years. These trainees take the subjects of Teaching Mathematics and Teaching English as a Foreign Language in the same year. The instructors involved in the study were the lecturers responsible for the courses, who jointly designed and coordinated the two subjects. Both instructors collaborated in the planning of the activities to ensure alignment between the mathematical content and the use of English as the language of instruction.

The control group (CG), 60 preservice teachers took the same subjects without the interdisciplinary *MathEnglish* project, and hence participated in none of the

activities summarized in section 3. Table 1 shows the distribution of the sample and the control group by degree programme and academic year.

Table 1: Distribution of the sample by group, degree programme and academic year

IV	Groups	N EG	N CG	Total
Degree Programme	Primary education	59	-	59
	Early childhood and Primary education	-	34	34
	Sports Sciences and Primary education	-	26	26
TOTAL		59	60	119
Academic year	2021-22	21	27	48
	2022-23	26	33	59
	2023-24	12	-	12
TOTAL		59	60	119

The distribution by gender in the sample is 5.1% men and 94.9% women in the EG, while in the CG the percentages are somewhat more balanced, 35% and 65% respectively. All of them study the specialization in English, which consists of 35 ECTS credits divided into five subjects.

4.4 Instrument

For the quantitative study, an *ad hoc* questionnaire of 17 items was used (see **Appendix 1**). Items 1 to 12 measured teacher self-efficacy; items 13 and 14 measured the perception of the impact of interdisciplinary teaching on the learning in primary education; and items 15 to 17 measured the perception of the convenience of teaching mathematics in English in the current regulatory context in Spain.

For the items that measure teaching self-efficacy (1-12), Prieto's (2007) approach was followed, which addresses both attitudinal issues such as student involvement in learning (items 1 to 3), or interaction and the creation of a positive classroom climate (items 4 to 6), as well as aspects related to teaching preparation and planning (items 7 to 12). Although the questionnaire was administered in the order described above, Table 2 shows the items grouped by dimensions to facilitate the interpretation of the results.

Table 2: Order of the 17 items grouped for analysis

Dimension	Hypothesis	Items
D1. Teacher self-efficacy	H1.1. Teaching mathematics	1 – 4 – 7 – 10
	H1.2. Teaching English	2 – 5 – 8 – 11
	H.1.3. Teaching Maths CLIL	3 – 6 – 9 – 12
D2. Interdisciplinary teaching	H2. Beneficial in primary education	13 – 14
D3 Maths CLIL	H3. Convenience of Maths CLIL	15 –16 –17

All 17 items are measured with a Likert scale of 1-4, in which 1 means not at all and 4 to a great extent. At the end of the questionnaire, three criterion items (IC) were included.

4.5 Data collection and analysis

Data for the quantitative analysis were collected during three academic years (2021-22; 2022-23; 2023-24) before and after participation in the *MathEnglish* interdisciplinary project that ran from January to April. In all cases, the sample responded to the same version of the 17-item questionnaire. The data collected were analysed with the IBM SPSS 29 application. As descriptive statistics, the means (M) and their standard deviation (SD) were analysed.

To assess the significance of the differences in the means (MD), Student's *t*-tests for independent and paired samples were conducted, along with one-way ANOVA followed by Tukey's for the subsequent contrasts of the groups. The statistical analyses were conducted by testing the corresponding null hypotheses (H_0) of mean equality between the compared groups or measurement moments. Rejection of the null hypothesis ($p<.05$) was interpreted as evidence supporting the research hypotheses formulated in the study.

For both statistics, the effect size was calculated, which was interpreted according to Cohen's (1988) criteria: $d \geq 0.20$ small; $d \geq 0.50$ median; $d \geq 0.80$ large. Cronbach's alpha was used to measure the degree of reliability and internal consistency of the questionnaire. The interpretation of the reliability coefficients followed commonly accepted thresholds in the literature ($\alpha \geq .90$ excellent; $.80 \leq \alpha < .90$ good; $.70 \leq \alpha < .80$ acceptable). The Kolmogorov-Smirnov test was used for decision on the normality assumption. Finally, an analysis of the convergent validity of the instrument and its dimensions (Pearson correlations) was performed.

The qualitative data in the open-ended responses were analysed using an inductive approach (Holliday, 2010). Initial open coding was conducted to identify recurring ideas and topics in participants' responses, and then then examined for patterns and relationships. This analysis was supported by the use of NVivo 14 software. In addition, relevant textual quotations were selected to enrich the analysis. Participation in the study was voluntary. Participants were informed about the objectives of the research and gave their informed consent before completing the questionnaire. The anonymity and confidentiality of the collected data were guaranteed throughout the research process.

5. Results and Findings

5.1 Questionnaire reliability and validity analysis

The results of Cronbach's Alpha are close to excellent in the pre-test of the EG (0.856) and excellent in the CG (0.915). In the post-test the values are also very good, 0.871 (EG) and 0.878 (CG). Normality tests also indicated significance values of the Kolmogorov-Smirnov statistic greater than .05 in both groups in both pre- and post-test. Figures 1 and 2 show the normal Q-Q graphs for both groups before and after the experience.

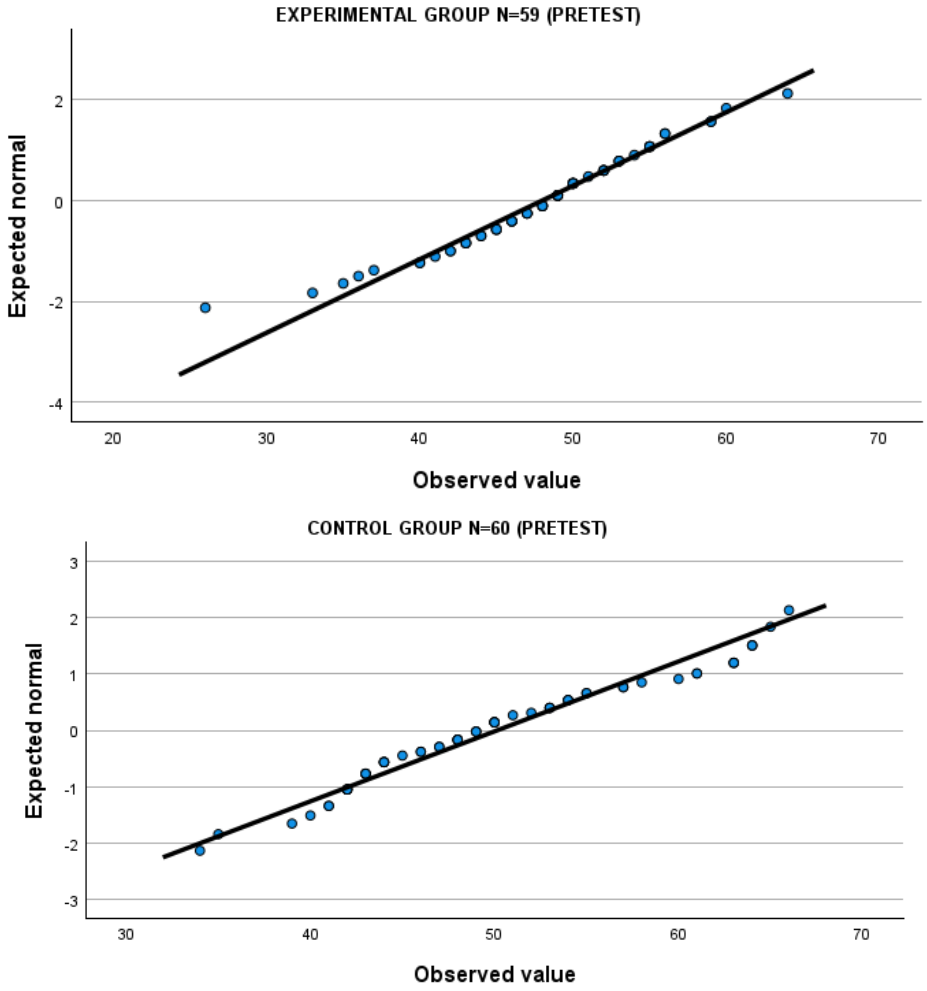
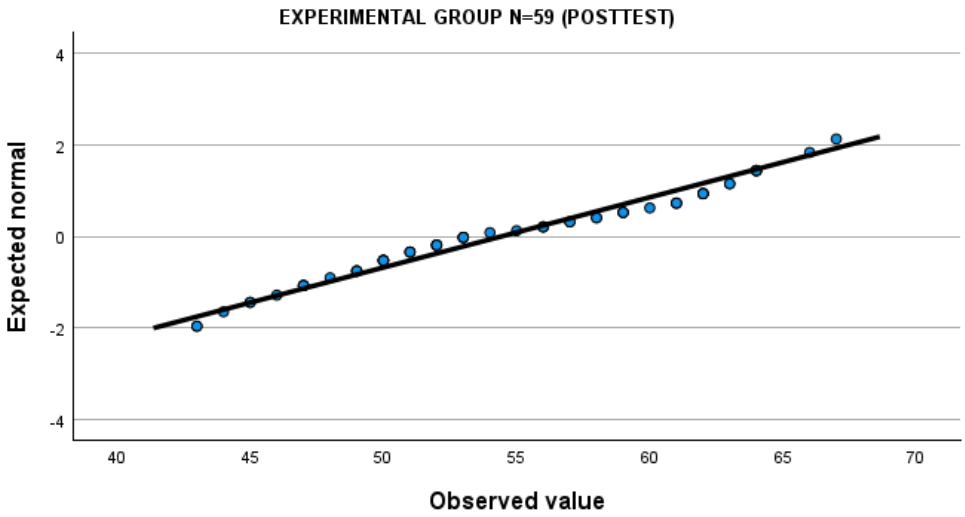


Figure 1: Normal Q-Q graphs before the experience for both groups (E/C)



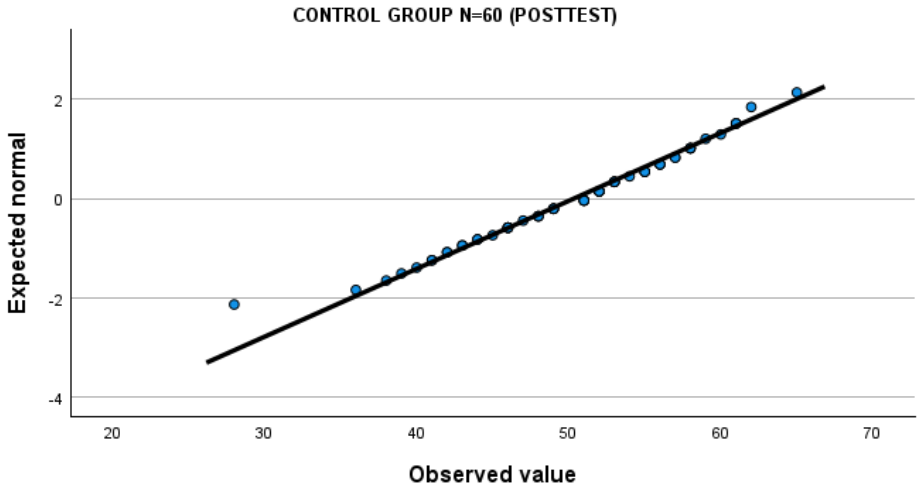


Figure 2: Normal Q-Q graphs after the experience for both groups (E/C)

In the last two years of the project, three criterion items (IC) were added to the questionnaire. In the experimental group (N=38), the result of the Pearson-type correlations of the questionnaire with the three criterion items shows a statistically significant linear correlation between the total score in the pre-test and the IC2 (R=0.446 and p=.005) and IC3 (R=0.359 and p=.027). The correlations between the post-test score and the three criterion items are all significant with a p-value ≤ .01.

5.2 Descriptive analysis

Considering the minimum and maximum possible values for each measure were 17 to 68, in the experimental group, a notable difference in means was observed with a similar standard deviation at both times. However, in the control group the means are similar, but the standard deviation is lower in the pos—test. The histograms in Figure 3 and Figure 4 illustrate this distribution.

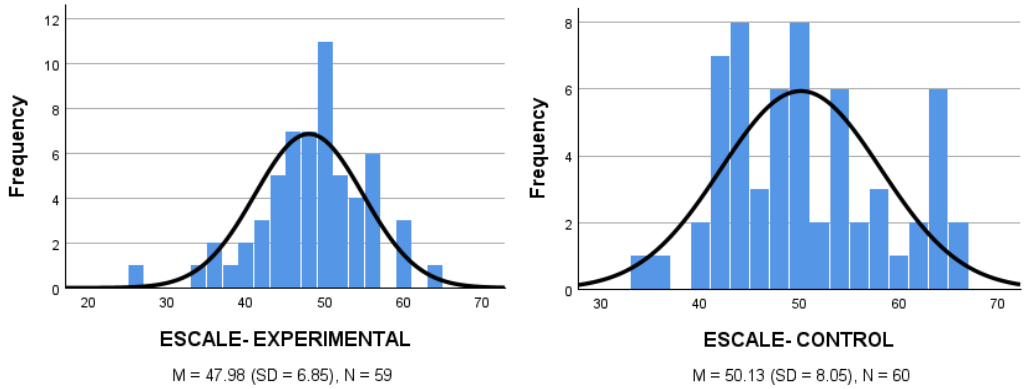


Figure 3: Distribution of the main DV in the pre-test by groups (E/C)

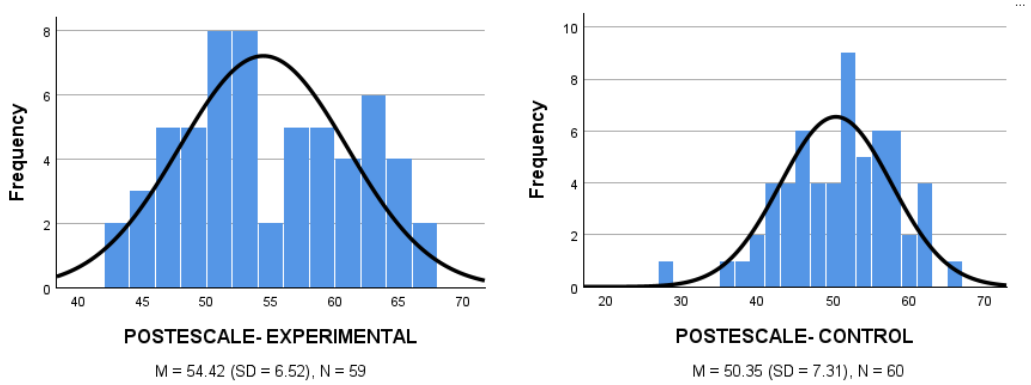


Figure 4: Distribution of the main DV in the post-test by groups (E/C)

5.3 Differential analysis

The result of comparing the means of the experimental group in the three dimensions of the questionnaire before and after participating in the interdisciplinary project is shown in Table 3.

Table 3: Mean difference in the specific DV grouped by dimensions according to the pre/post-test

Null hypothesis (mean equality)		Item variable	Post-test M	Pre-test M	SD	*t*	One-factor *p*	*d*
D1	H1.1	Pair 1	3.54	3.25	0.29	3.962	<.001	.52
		Pair 4	3.51	3.25	0.25	3.231	.001	.42
		Pair 7	3.47	3.27	0.20	2.451	.009	.32
		Pair10	3.69	3.29	0.41	4.646	<.001	.61
	H1.2	Pair 2	3.20	2.88	0.32	3.938	<.001	.52
		Pair 5	3.36	3.07	0.29	3.585	<.001	.47
		Pair 8	3.32	2.97	0.36	3.969	<.001	.52
		Pair 11	3.54	3.14	0.41	3.848	<.001	.50
	H1.3	Pair 3	2.68	2.17	0.51	4.907	<.001	.64
		Pair 6	3.00	2.41	0.59	4.712	<.001	.61
		Pair 9	2.98	2.20	0.78	5.525	<.001	.72
		Pair 12	3.17	2.37	0.80	6.252	<.001	.81
D2	H2	Pair 13	3.54	3.15	0.39	3.909	<.001	.51
		Pair 14	3.29	2.73	0.56	4.796	<.001	.62
D3	H3	Pair 15	2.17	2.17	0.00	0.000	.500	.00
		Pair 16	3.22	3.00	0.22	2.035	.023	.27
		Pair 17	2.73	2.66	0.07	0.456	.325	.06

The results support hypotheses H1.1, H1.2, H1.3, and H2, as statistically significant differences between pre-test and post-test scores were found in all corresponding items ($p<.05$). Hypothesis H3 was only partially supported, since significant differences were observed only in item 16.

Table 4 presents the comparison between the experimental group (EG) and the control group (CG) in relation to the null hypothesis of mean equality before and after the interdisciplinary experience *MathEnglish* project.

The results show that no statistically significant differences were found between the groups in the pre-test ($p=.120$), indicating that both groups started from a comparable baseline. However, statistically significant differences were observed in the post-test ($p=.002$), with higher mean scores in the experimental group ($M=54.42$) compared to the control group ($M=50.35$). These results suggest that the interdisciplinary experience had a positive effect on the dependent variable, with a moderate effect size ($d=.57$). For all outcomes, equality of variances is assumed.

Table 4: Mean difference in the DV according to the IV Group (E/C), before and after

Null hypothesis (mean equality)	EG (N=59) M	CG (N=60) M	SD	*t*	Two-factor *p*	*d*
Differences in the DV before the experience between the groups	47.98	50.13	-2.15	-1.57	.120	-.29
Differences in the DV after experience between the groups	54.42	50.35	4.07	3.20	.002	.57

5.4 Results of the qualitative analysis

The research team identified nine codes that reflect the most frequent recurring ideas identified in the responses to the two open-ended questions answered by the three cohorts included in the sample. As the questions were optional, not all participants provided responses. Table 5 shows the frequency and coverage of each code.

Table 5: Codes used and frequency of each code

Code	Frequency	Percent (%)
Challenge for preservice teachers	12	20.34
Change in perspective on interdisciplinary teaching	10	16.95
Subject integration	7	11.86
Implementation in a primary school	6	10.17
Perceived challenge for primary pupils	6	10.17
Application to their future teaching practice	5	8.47
Motivation	5	8.47
Learning context	4	6.78
Activity design	4	6.78

The most frequent response referred to the perception of the project as a challenge for both preservice teachers and primary pupils. Many participants reported having overcome this challenge, noting that teaching mathematical content in a foreign language requires a much deeper understanding of the subject matter. One teacher trainee stated:

> *"It forced me to master both subjects, and since I was not teaching in my mother tongue, I had to learn the mathematical content properly."*

Regarding the perceived challenge for primary school pupils, several responses indicated that children's English level is perceived as a difficulty for the accurate understanding of mathematical content, as well as the possibility that its benefits for English learning may outweigh those for mathematics. The following statement by one of the participants underscored this idea:

> *"I felt that the benefits for English learning seemed greater than those for mathematics."*

A change in perspective regarding interdisciplinary teaching also appeared frequently in the responses. In this case, all comments reflected a positive shift, often starting from a rather negative opinion prior to participating in the project. The two following testimonies from preservice teachers illustrated this change:

> *"I totally disagreed when the project was first proposed […] My opinion has completely changed."*

> *"I have proven to myself that I can be competent in this area, which I doubted before. I have changed my opinion about teaching mathematics in English."*

This shift in perspective occurred once the project had been completed and results were observed, generating a sense of having overcome the challenge. That is, participants did not consider interdisciplinary teaching of mathematics in English to be inappropriate *per se*, but rather very complex and demanding in terms of effort. In addition, participants highlighted the importance of subject integration in primary education teaching and, in most cases, perceived it as positive, as it requires deeper understanding to ensure effective integration.

In some cases, participants even suggested extending the proposal to other subjects, such as Science. Several responses indicated that working in an interdisciplinary way is something participants are likely to do in their future teaching practice, as they have observed its benefits both in terms of content acquisition and increased motivation among primary school pupils. In this regard, participants reported increased self-confidence and the positive impact that overcoming the challenge had on their teaching self-efficacy, even stating that:

> *"You lose the fear of speaking in English while also working on mathematics."*

Moreover, preservice teachers stated that interdisciplinary proposals such as the one experienced constitute an effective context for designing learning activities and emphasize their effectiveness in helping learners internalize the contents of

both subjects. Likewise, they identified the stories used as a powerful learning tool:

> *"Above all, I have learned to recognise the many possibilities a simple story offers."*

Finally, respondents evaluated the implementation of the project in a real classroom very positively, as it allowed them to verify the effectiveness of the planned activities. Even mistakes and difficulties were interpreted as opportunities for improvement rather than as negative aspects.

6. Discussion

The findings show that participation in the interdisciplinary experience produced a statistically significant improvement in preservice teachers' perceived teaching self-efficacy for teaching mathematics (H1.1), English (H1.2), and mathematics through English (H1.3), both in the experimental group before and after the experience and between the experimental and control groups. Likewise, significant improvements were observed in future teachers' perceptions of the contribution that interdisciplinary mathematics–English projects can make to primary pupils' learning (H2). However, the experience did not significantly modify attitudes toward CLIL teaching in mathematics (H3). The following section discusses these results in relation to previous literature and points to some of their possible implications.

The increase in teaching self-efficacy supports the idea that applied interdisciplinary experiences can strengthen teachers' self-efficacy (Hettinger et al., 2023; Lazarides et al., 2021; Ugalde et al., 2020). In the case of mathematics, the statistically significant improvement in teaching self-efficacy may be explained by the requirement to design open mathematical tasks involving the use of manipulative materials (Moore & Lorenzo, 2015; Schanke, 2023). The improvement was more pronounced for teaching English than for teaching mathematics, suggesting that the experience enhanced preservice teachers' confidence in using English as a language of instruction to a greater extent. This result may be explained by the nature of the activities, which were built around storytelling and facilitated spontaneous use of English in a narrative and communicative context.

In this regard, previous research has shown that storytelling constitutes an appropriate resource in initial teacher education for teaching content through English, both because of its usefulness for subject learning and its future applicability in primary classrooms (Alcántara-Manzanares et al., 2022). Moreover, constant interaction in English with peers and with children in the classroom may have reduced perceived difficulty in the language, reinforcing self-efficacy (Faez et al., 2019). By contrast, and as the literature suggests (Ruiz-Cecilia et al., 2023), sustained and effective teaching of mathematics through English poses specific challenges, particularly when preservice teachers have not received extensive training in the CLIL approach.

Similarly, the improvement in perceptions of interdisciplinarity suggests that participants developed a better understanding of its educational potential after this collaborative teaching experience. The integrated teaching of mathematics and English was positively valued, with moderate effect sizes, indicating a meaningful shift in preservice teachers' views toward this approach. In our data, initial scepticism about the feasibility of interdisciplinary teaching often gave way to a more favourable appraisal once the experience had been completed and its outcomes had been observed.

From this perspective, the results indicate that the intervention constituted an effective interdisciplinary experience as, in line with the model proposed by Boix and Dawes (2007), participants worked from the specific didactics of mathematics and English, ensuring a solid grounding in both areas. In addition, the significant improvement in perceptions of interdisciplinarity suggests that future teachers recognized that integrating both subjects facilitated a better understanding of the content and its application in the classroom. This interpretation is also consistent with the constructivist view according to which interdisciplinary learning allows learners to analyse educational situations from multiple perspectives and to establish connections across domains (Ashby & Exter, 2019).

The open-ended responses help explain why the collaborative teaching experience enhanced perceptions of interdisciplinarity but did not change attitudes toward teaching mathematics in English. Several participants reported that their initial view of interdisciplinary teaching was negative, but that practice within the project helped them overcome their doubts. The opportunity to experience the methodology directly in a primary school appears to have been key for perceiving it as feasible in practice. By contrast, perceptions of CLIL in mathematics did not change, which may be related to the preliminary training participants had received in this approach.

Although basic notions of CLIL were introduced within the project, the training focused on the linguistic analysis of mathematical content (language demands analysis) and on strategies to scaffold content understanding and linguistic output. In this sense, it appears likely that this initial training was not sufficient for participants to fully understand how to integrate CLIL into mathematics teaching or to perceive its feasibility in the classroom. Previous research suggests that more in-depth CLIL training—including practical application and the development of specific strategies for teaching content through a foreign language—is key for preservice teachers to adopt a positive attitude toward this model (Ruiz-Cecilia et al., 2023).

Another key factor in explaining this result may be that many participants perceived teaching mathematics in English as an obstacle to content understanding. In the open-ended responses, several noted that with projects like this one, English learning may benefit more than mathematics learning, suggesting that they perceive a potential imbalance between the two areas. Others considered that children's English level may be a barrier to understanding mathematical concepts, reinforcing the idea that CLIL in mathematics requires

specific conditions for success. This is consistent with previous studies indicating that learning mathematics through a foreign language can generate additional difficulties in the early years of schooling, especially when pupils have not yet developed sufficient command of the academic register (Surmont et al., 2016; Ter Kuile et al., 2011).

Overall, however, the results suggest that future primary teachers do not categorically reject teaching mathematics in English, but rather view it as an option that must be implemented carefully so as not to affect the acquisition of mathematical content. While interdisciplinarity is perceived as enriching and feasible in practice, teaching mathematics through English is perceived as more demanding and as involving potential barriers to implementation.

7. Conclusions

This study analyses the impact of an interdisciplinary experience combining the teaching of mathematics and English as a foreign language (EFL) on teachers' self-efficacy, perceptions of interdisciplinary teaching, and acceptance of the CLIL approach in mathematics. It responds to the need identified by Ruiz-Cecilia et al. (2023) for further research on the application of CLIL programmes to the teaching and learning of mathematics in teacher education. From a theoretical perspective, the findings contribute to the limited body of research on the integration of mathematics and English within initial teacher education and provide empirical support for the role of interdisciplinary experiences in strengthening preservice teachers' perceived teaching self-efficacy.

This study also suggests several lines of action, of interest to teacher educators and programme designers, to improve teacher education in interdisciplinary approaches and in the teaching of mathematics through English. First, it would be advisable to strengthen interdisciplinary teaching collaboration within initial teacher education, through more experiences such as the one described here, given their potential to model future professional practice.

The results also highlight the importance of providing preservice teachers with more opportunities for practical teaching in real educational contexts, where interdisciplinary and bilingual methodologies can be applied directly, thereby contributing to a stronger consolidation of teaching self-efficacy. Finally, although the results of this study do not allow for a general recommendation regarding whether bilingual education programmes should allow or promote the teaching of mathematics in English, they do suggest that the widespread rejection of combining both curricular areas may be disproportionate, and that such integration deserves more attention within teacher education.

With regard to the limitations of this study, the sample analysed is relatively small and homogeneous, as all participants belong to the same university and are enrolled in the English specialization track, which may influence their perceptions of bilingual teaching and interdisciplinarity. Furthermore, the questionnaire used does not allow for a precise attribution of the observed gains in teaching self-efficacy: in the case of mathematics, the improvement may be partly attributable

to the nature of the mathematical tasks involved—such as open problems, modelling activities, and manipulative materials—rather than exclusively to the interdisciplinary or bilingual dimension of the experience. Hence, it would be of interest to replicate this study with a more diverse sample, as well as employing more precise instruments that allow for a clearer distinction between the effects of task design, interdisciplinarity, and bilingual instruction on preservice teachers' self-efficacy.

8. Conflict of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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Appendix 1. Questionnaire

Perception of preservice primary education teachers regarding the benefits of interdisciplinary teaching combining mathematics and English as a Foreign Language.

ACTIVE VARIABLES OF THE STUDY				
Please indicate the extent to which you agree with the following statements, or the degree to which you feel capable of performing the actions described below. **1. Not at all / 2. Slightly / 3. Moderately / 4. To a great extent**	Circle the appropriate option			
1. I feel capable of actively engaging children in learning activities carried out in a mathematics class.	**1**	**2**	**3**	**4**
2. I feel capable of actively engaging children in learning activities carried out in an English language class.	**1**	**2**	**3**	**4**
3. I feel capable of actively engaging children in learning activities carried out in a mathematics class taught in English.	**1**	**2**	**3**	**4**
4. I feel capable of fostering positive attitudes in children towards learning mathematics.	**1**	**2**	**3**	**4**
5. I feel capable of fostering positive attitudes in children towards learning English.	**1**	**2**	**3**	**4**
6. I feel capable of fostering positive attitudes in children towards learning mathematics in English.	**1**	**2**	**3**	**4**
7. I feel capable of designing the structure and content of a mathematics session or lesson.	**1**	**2**	**3**	**4**
8. I feel capable of designing the structure and content of an English language session or lesson.	**1**	**2**	**3**	**4**
9. I feel capable of designing the structure and content of a mathematics session or lesson taught in English.	**1**	**2**	**3**	**4**
10. I feel capable of preparing the materials I will use in a mathematics class in Primary Education.	**1**	**2**	**3**	**4**
11. I feel capable of preparing the materials I will use in an English language class in Primary Education.	**1**	**2**	**3**	**4**
12. I feel capable of preparing the materials I will use in a mathematics class taught in English in Primary Education.	**1**	**2**	**3**	**4**
13. Carrying out interdisciplinary collaborations between mathematics and English in Primary Education can contribute to improving English language learning.	**1**	**2**	**3**	**4**
14. Carrying out interdisciplinary collaborations between mathematics and English in Primary Education can contribute to improving mathematics learning.	**1**	**2**	**3**	**4**
15. Despite the fact that current regulations (Order 5958/2010) in the Community of Madrid do not allow bilingual schools to teach mathematics in English, either fully or partially, I believe that in bilingual schools it should be compulsory to teach mathematics in English in Primary Education.	**1**	**2**	**3**	**4**
16. Despite the fact that current regulations (Order 5958/2010) in the Community of Madrid do not allow bilingual schools to teach mathematics in English, either fully or partially, I believe that those bilingual schools that request it should be allowed to teach mathematics in English.	**1**	**2**	**3**	**4**

17. Despite the fact that current regulations (Order 5958/2010) in the Community of Madrid do not allow bilingual schools to teach mathematics in English, either fully or partially, I believe that it would be a good option to teach mathematics in Primary Education by combining both languages: English and Spanish.	**1**	**2**	**3**	**4**
OTHER PERCEPTIONS				
1. Learning how to teach a foreign language and mathematics in an interdisciplinary way can improve my teaching competence.	**1**	**2**	**3**	**4**
2. Learning mathematics in English makes it possible to enrich learning in both areas of knowledge.	**1**	**2**	**3**	**4**
3. In the future, I would like to be able to teach mathematical content in English in Primary Education.	**1**	**2**	**3**	**4**

Tell us what you think of the interdisciplinary *MathEnglish* project itself. Which of its features should be maintained next academic year? What could we do to improve it?

Give us your opinion about the convenience of integrating mathematics and English in primary education, either through interdisciplinary projects or through CLIL teaching (mathematics in English).