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Research article

Strengthening mathematical skills in future teachers through service-learning in a liquid society

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Abstract: This study presents "Aula de Apoyo", a Service-Learning programme in which undergraduate education students provide extracurricular mathematics support to low-achieving Primary learners, particularly those from disadvantaged backgrounds. By applying knowledge from Mathematics Didactics, undergraduates strengthen their teaching skills while helping to reduce educational gaps. A mixed-methods design was used with eight tutor–student pairs. Tutors evaluated their training positively, highlighting the usefulness of the Concrete–Pictorial–Abstract approach, increased responsibility, and the desire for a longer intervention. The findings indicate that Service-Learning supports subject-matter understanding, fosters social engagement, and develops key transversal skills such as empathy and adaptability, thereby contributing to more equitable learning opportunities and aligning with European Higher Education priorities. This study adds to an underexplored line of research by integrating structured extracurricular mathematics support within a Service-Learning framework in initial teacher education. Moreover, the programme helps prepare future teachers to face the challenges of a rapidly changing liquid society, where adaptability and social responsibility are increasingly essential.

Keywords:
service-Learning,
mathematics,
educational support,
primary education,
university degree

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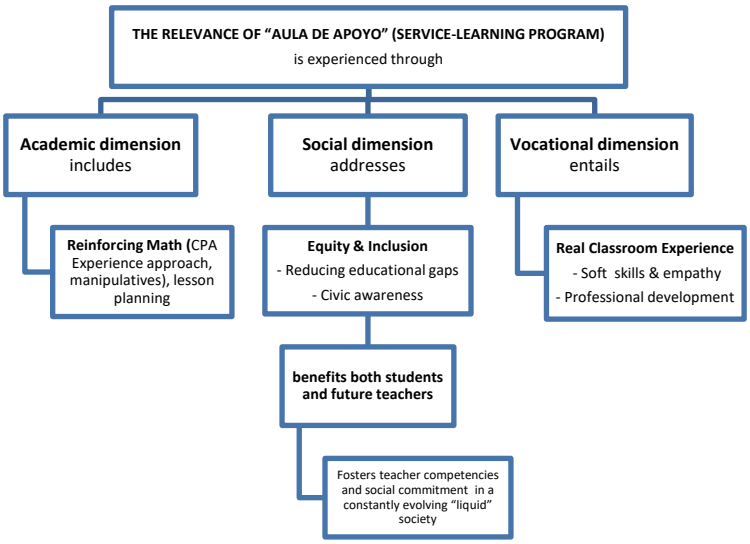

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1 Introduction

In recent years, European Higher Education has experienced a push towards pedagogical renewal, promoting the use of active and participatory methodologies that develop not only academic but also social competencies (McAleese 2013). According to the Delors report (1996), 21st-century education should focus on four fundamental dimensions: learning to know, to do, to live together, and to be. This implies that university teachers face the challenge of designing educational situations that strengthen not only academic but also personal, social, and civic competencies in their students (Ferrández-Berrueco & Sánchez-Tarazaga, 2014; Martínez-Martín & Carreño-Rojas, 2020).

In this context, Service-Learning (SL) emerges as an enriching methodology that integrates academic learning with a more humanistic and critical pedagogical culture (Chiva-Bartoll et al., 2020). This methodology facilitates the acquisition of theoretical knowledge and promotes the development of social, civic, and ethical skills by addressing real-world social issues (Gil-Gómez et al., 2015; Samino, 2023; Weiler et al., 2013). SL contributes to the development of what is commonly referred to as intangible human capital—non-technical skills such as empathy, adaptability or self-assessment—which are increasingly valued in contemporary labour contexts (Goleman, 1995, 1998; Lotti & Betti, 2019; Resch, 2018).

In Spain, SL methodology has gained relevance, as demonstrated by the Organic Law for the Amendment of the Organic Law of Education (LOMLOE, 2020), which encourages the collaboration of educational institutions with community services. This law highlights the transformative potential of SL by integrating it with practical experiences, making learning meaningful and useful for society.

Simultaneously, the demand for extracurricular educational support, especially in critical areas like Mathematics, has grown significantly. Research has shown that non-formal and out-of-school learning environments can broaden students' opportunities for meaningful engagement, complementing and extending what is taught in formal classroom settings (Cabello & Ferk Savec, 2018; Benavent et al., 2020). In response, the "Aula de Apoyo" project represents an innovative initiative that combines SL methodology with extracurricular educational support for Primary Education students. This proposal not only goes beyond the traditional classroom setting but also promotes social engagement by addressing existing educational gaps.

Beyond institutional efforts, research has shown that structured extracurricular academic programmes—such as after-school support or summer learning opportunities—can benefit students in vulnerable contexts. Evidence from meta-analyses indicates that these interventions can contribute to improving academic engagement and reducing educational disparities (Dietrichson et al., 2017; Kremer et al., 2015). In the field of Mathematics, recent findings confirm that providing additional instructional time outside regular school hours, including through summer mathematics programmes, can lead to measurable improvements in achievement (Lynch et al., 2023). However, most extracurricular interventions tend not to incorporate explicit didactic approaches or

community-based components. In this regard, the “Aula de Apoyo” project contributes to an underexplored line of work by combining extracurricular mathematics instruction within a SL model oriented toward equity.

Furthermore, in a society characterized by constant changes and a dynamic social structure (Bauman, 2000), integrating SL into teacher training emerges as a key educational innovation. This methodology not only prepares students to face the challenges of a transforming society but also cultivates the adaptability and resilience needed in the contemporary labour market (Resch, 2018).

Additionally, SL strengthens the connection between higher education institutions and local communities, thus contributing to a more integrated and socially responsible educational structure (Butin, 2010). This approach not only enriches students' educational experience but also promotes community development and social cohesion.

In summary, integrating SL in higher education represents a forward-looking strategy to equip students with the competencies necessary to thrive in a dynamic global environment. By fostering academic excellence, civic responsibility, and practical skills, SL ensures that future teachers not only master their field of study but also become agents of change capable of positively influencing a constantly evolving society. This educational approach not only addresses educational disparities but also significantly contributes to social cohesion in a complex and ever-changing world.

1.1 Service-Learning

SL is a pedagogical approach based on social justice and the promotion of inclusion (Martínez-Usarralde & Chiva-Bartoll, 2020), aiming to develop both academic and personal skills in participating students while addressing a social need. Students enrich their learning by applying knowledge in a real context, providing community service to address an identified need (Puig et al., 2007; Tapia, 2010). Through this experiential educational method, students engage in activities that address human, social, or environmental needs, combining community service with the curriculum to enhance learning in any discipline and academic programme while instilling civic responsibility through action and reflective analysis. Moreover, students participating in SL programmes undertake practices outside their comfort zone, which is a valuable component of their education (Chambers & Lavery, 2022). Ultimately, SL provides a transformative educational experience that combines theoretical and practical learning.

Due to the dual nature of SL methodology, three basic elements define an SL project: 1) students play a central role in the learning process and in participating in solidarity activities; 2) there must be a clear intention to address real problems; and 3) it must be integrated with the curriculum and competencies of the study programme (Puig et al., 2007; Tapia, 2010).

Recently, the Organic Law for the Amendment of the Organic Law of Education (LOMLOE) has endorsed the SL philosophy: "To the compulsory subjects, the possibility of offering optional subjects is added, with the novelty that they can be configured as a

monographic project or a collaboration with a community service" (LOMLOE, 2020, p. 9). The practical nature of SL makes it particularly appealing in the training of future teachers. Cámara et al. (2017) support this idea, indicating that often, undergraduate students design activities and resources, but these are not usually implemented. SL allows students to experience learning through implementation and contextualization, reinforcing their education and facilitating a greater connection between theory and practice.

With SL in teacher training, the aim is to carry out practices in an unfamiliar context to improve their classroom skills and develop the “readiness” to teach (Salter & Halbert, 2019). Numerous studies highlight the benefits of SL in initial teacher training, including interventions with people with functional diversity (Case et al., 2020; Maravé-Vivas et al., 2022b), older adults (Ruiz-Montero et al., 2019), in contexts of social exclusion (Giles et al., 2019; Capella-Peris et al., 2019), and immigrants or refugees (Hawkins & Kaplan, 2016; Samino, 2023).

Research on the use of this methodology in this context has demonstrated numerous benefits, such as strengthening professional competence related to teacher identity, teacher motivation, pedagogical knowledge, professional culture, and awareness (Carrington et al., 2015; Dvir & Avissar, 2014; He & Prater, 2014; Ramsaroop & Petersen, 2020), as well as improvements in self-efficacy (Hollingsworth & Knight-McKenna, 2018). Finally, SL seems to impact the critical thinking ability of future teachers (Chiva-Bartoll et al., 2020; García-Rico et al., 2021; Nelson, 2021), cultural understanding (Daum et al., 2021), civic skills and attitudes (Maravé-Vivas et al., 2022a), the practice and acquisition of values (Iyer et al., 2018; Samino, 2023), and awareness of social justice (Adarlo & Pelias, 2021).

1.2 Educational Support

According to the Organization for Economic Cooperation and Development (OECD), around 23% of 15-year-old students perform poorly in Mathematics (Ministry of Education and Vocational Training, 2020), highlighting the need for support in this subject during the Compulsory Secondary Education stage, as well as in earlier stages.

In the Spanish educational context relevant to this study, the Ministry of Education launched in 2011 the Reinforcement, Guidance, and Support Plan (PROA) to improve educational actions in schools (Ministry of Education, 2011). This national programme provides additional support to students with academic difficulties through reinforcement in key subjects, academic and vocational guidance, and support in the acquisition of basic competences. Initially targeted at Primary and Secondary Education, the programme has since evolved into PROA+ (Ministry of Education and Vocational Training, 2023), expanding support for vulnerable students and reinforcing actions aimed at reducing dropout and early school leaving.

In addition to this national initiative, some autonomous communities have developed their own complementary measures. In Castilla-La Mancha—the region in which this

study is situated—such measures form part of the VI Plan for Educational Success and include actions focused on reinforcing basic skills and supporting students with specific educational needs. These regional initiatives share the common aim of providing additional learning opportunities beyond regular school hours, although their design and implementation vary across territories.

As previously mentioned, SL offers undergraduate students the opportunity to engage directly with authentic educational contexts, which makes it especially relevant in teacher education. Several academic works describe in-school SL actions carried out during regular school hours (Gómezescobar & Fernández-Cézar, 2020; Lamoneda, 2018; Mayor & Rodríguez, 2015; Rodríguez, 2014; Vázquez et al., 2017). Building on this experience, an emerging line of research explores how SL can extend beyond the classroom by providing educational reinforcement outside school hours, thus enriching the learning opportunities of both undergraduate tutors and the Primary students they support. This idea resonates with initiatives such as "Let's Teach English" (Zerbikas, 2018), where students offer instructional support to younger peers in their local community.

2 Objectives and Research Questions

This case study aims to present the "Aula de Apoyo" project and analyze the impact of Service-Learning (SL) on the students participating in this initiative. The specific objectives and research questions are detailed below.

Objectives:

O1: Analyse the design and implementation of the "Aula de Apoyo" intervention as a SL experience aimed at providing extracurricular mathematics support.
O2: Evaluate the effect of SL on the academic and personal development of participating students, as well as on the strengthening of human capital skills such as communication and empathy.

Research Questions:

RQ1: What are the perceptions of students reflecting on their experience in SL?
RQ2: What specific experiences provide valuable learning in terms of the personal, civic, and social commitment of students?

By addressing these questions and objectives, this study aims not only to evaluate the educational benefits of SL but also to highlight its potential to foster a more inclusive and equitable education aligned with the demands of a constantly changing liquid society.

3 Methods

3.1 Design

A mixed-method methodology was used, which is widely used in educational research in general (Johnson & Christensen, 2008) and in SL research in particular (Gil-Gómez et al., 2015). This case study integrates qualitative and quantitative methods (Creswell & Plano Clark, 2017) divided into two phases. First, a Likert questionnaire by León-Carrascosa et al. (2020) was administered, evaluating three dimensions: Formative (as an end), Learning (as a means), and Service (as personal, civic, and social commitment). After each block, open-ended questions were included to collect qualitative data. This questionnaire was completed after participation in the SL programme. Table 1 outlines the process.

Table 1. Sequential explanatory design of the study. Self-elaboration.

Phases	**Phase 1**	**Phase 2**
Variables	Formative, Learning, and Service	Reflective Perception
Methodological Approach	Quantitative: Test at the end of the SL programme	Qualitative: Small group interviews at the beginning and end of each session. Deductive content analysis based on open-ended questions from the questionnaire
Instrument	Questionnaire by León-Carrascosa et al. (2020)	Open-ended questions in the questionnaire reflecting on the three variables
Research Questions	*No research questions addressed in this phase*	RQ1. What are the perceptions of students when reflecting on their SL experience? RQ2. What experiences provide valuable learning related to students' personal, civic, and social commitment?

Note. This table outlines the sequential explanatory design used in the study, detailing each phase, variables measured (formative, learning, and service dimensions), methodological approach (quantitative and qualitative), and instruments employed (questionnaires and open-ended reflections).

3.2 Participants

The SL project “Aula de Apoyo” involved a total of eight students from the Degree in Primary Education at the Faculty of Education in Toledo (UCLM) and eight Primary Education students from CEIP Santa Teresa in Toledo. Seven of the university students were enrolled in the second year, and one student was in the third year.

Regarding the Primary Education students, two were in the 2nd year, two in the 3rd year (although they were at the 1st and 2nd-year levels, respectively), one student was in the 4th year, two in the 5th year, and one in the 6th year of Primary Education. The requirement for participation in the programme was to have a failing grade in

Mathematics. A preference criterion for entering the programme was belonging to a group of social exclusion.

3.3 Intervention Design

In the "Aula de Apoyo" programme, undergraduate students provide educational support to Primary Education students who face difficulties in Mathematics.

Academically, the programme addresses the need to develop the transversal competencies of the degree in Primary Education through innovative methodologies applied to real contexts, expanding what is learned in classes, specifically in Mathematics Didactics (Vázquez-Toledo et al., 2017). The "Aula de Apoyo" project works on all competencies outlined in the degree described on its website (UCLM, n.d.):

- Design teaching-learning processes tailored to different curricular areas of primary education using various methodologies while addressing cultural, linguistic, and social integration diversity, making the necessary curricular adaptations and optimizing available resources (both internal and external to their educational centre).
- Develop essential values such as democratic coexistence, equity, gender equality, responsibility, ethical commitment, critical spirit, etc., enhancing classroom coexistence.
- Collaborate with different sectors of the educational community and the social environment, promoting individual and collective responsibility to achieve a sustainable future.
- Be critical of their teaching role to improve and adapt to scientific, pedagogical, and social changes throughout their lives.
- Understand the role, possibilities, and limitations of education in today's society and the fundamental competencies affecting primary education schools and their professionals.
- Know models of quality improvement applicable to educational centres.

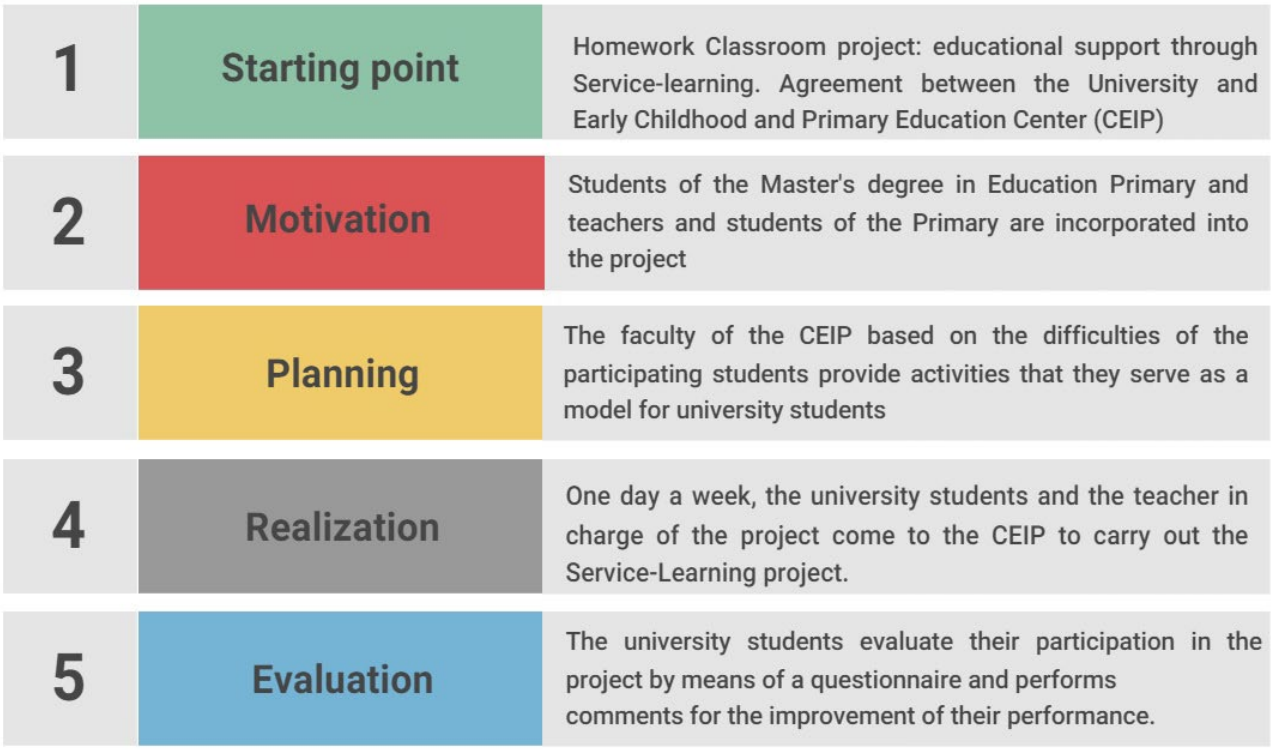
Furthermore, the project's approach promotes the acquisition of new knowledge and competencies that are difficult to achieve solely within the university classroom, such as how to communicate with Primary Education students, which mathematical terms to use, and how to manage their emotions.

In terms of service, the goal is to contribute to the achievement of Sustainable Development Goal 4: "Ensure inclusive, equitable quality education and promote lifelong learning opportunities for all" (United Nations, n.d.). The "Aula de Apoyo" programme aims for Primary Education students to receive educational support, contributing to not increasing the educational gap and thereby guaranteeing the principles of non-discrimination and equality in education by applying and formulating specific strategies for vulnerable and excluded groups. It also aims to eliminate barriers that prevent access to quality education for youth, girls, and boys in vulnerable situations. The university

refers to its Social Responsibility to address this specific need in the community in which it is immersed (Alonso-Sáez et al., 2015); thus, this project responds to a real social need.

To implement the project, the five phases proposed by Uruñuela (2015), a recognized author of the State Network of SL, are followed, which undergraduate students and future teachers could join in their professional future. These five phases are summarized in Figure 1 and are explained in detail below:

Figure 1. Phases of the project



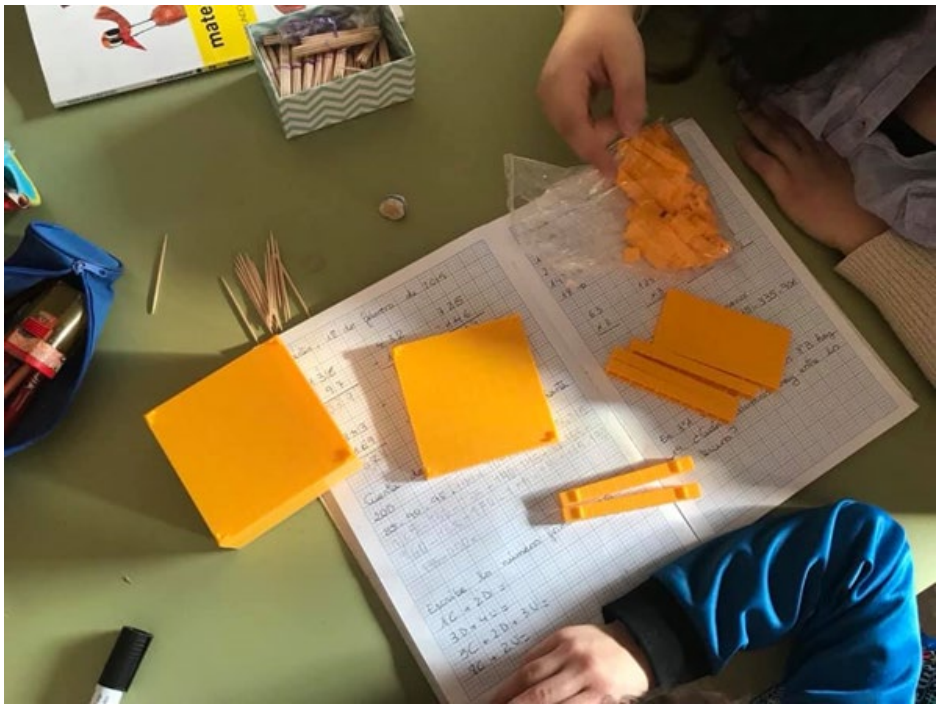
Note. Diagram illustrating the five phases of the "Aula de Apoyo" initiative—identification of needs, motivation, planning, implementation, and evaluation. Each phase is shown in sequence to highlight the iterative nature of Service-Learning and how undergraduates and primary students' progress through the programme.

1. The project starts from the need for educational support in Mathematics due to the difficulties inherent in its teaching-learning process. We believe that offering educational support from education faculties can benefit both the Primary students receiving the educational support and the university students who have the opportunity to apply what they learned in theoretical classes. As previously stated, the project is framed within an R&D agreement between UCLM and the centre.
2. Motivating the Group: The project is proposed to undergraduate students, and a total of 8 students from the Degree in Primary Education express interest in it, so the school is offered 8 places for Primary students, since the idea is to provide individualized reinforcement in Mathematics.

3. Planning: Primary Education teachers are asked to provide a brief report on each student participating in the programme, as well as model activities that need to be worked on. These activities will serve as a guide for the trainee teachers to carry out the educational support outside the classroom. Students visited the centre weekly for two months, in sessions scheduled after lunch and before other extracurricular activities
4. Project Implementation: Once a week, the 8 undergraduate students and the university professor responsible for the project carry out the "Aula de Apoyo". The sessions typically focused on numerical understanding with decompositions and subsequent operations. Problem-solving was also addressed.
5. Evaluation, Celebration, and Improvement: As established by Ruiz-Corbella and García-Gutiérrez (2019), formative and collaborative evaluation during the process allows for aligning students' learning with the actions carried out within the SL framework. In this sense, an initial tutorial is proposed in which teachers and undergraduate students analyze the reports and the model activities provided by the teachers. Moments for reflection on the adequacy of the support measures being implemented are also proposed before and after the reinforcement classes. Finally, the project is evaluated through the instrument detailed in the next section.

Figure 2 shows an image of the project's implementation and part of the materials used.

Figure 2. Project Implementation



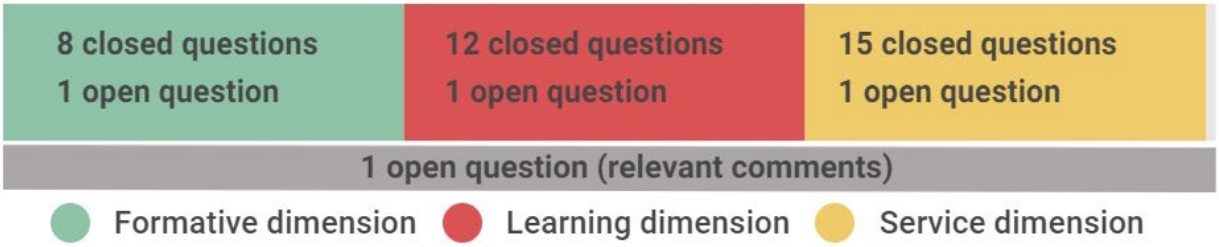
Note. Visual depiction of the actual implementation of "Aula de Apoyo" where undergraduates provide weekly math support to primary students. Materials such as multibase blocks or other manipulatives are showcased, along with the roles of both tutors and tutees during the sessions.

3.4 Instrument

For the quantitative part, a measurement instrument for evaluating SL programmes in the university context, designed and validated by León-Carrascosa et al. (2020), was used. This instrument, in the form of a questionnaire, encompasses three dimensions: Formative (as an end), Learning (as a means), and Service (as a personal, civic, and social commitment). The items are rated on a Likert scale from 1 to 5, which can be consulted in the Results section.

For the qualitative component, open-ended questions were used to encourage reflection after each dimension, as reflection is a widely utilized practice in teacher training (Baldwin et al., 2007). Finally, an open question is included to allow for relevant comments.

Figure 3. Structure of the instrument for data collection



Note. Diagram illustrating the structure of the instrument for data collection, which is divided into three dimensions: formative, learning and service. In each one there are linker scale questions and an open question.

Although the sample size of this case study is intentionally small due to the 1:1 pairing between undergraduate tutors and Primary pupils, the use of a Likert-type instrument is methodologically appropriate. In studies with reduced samples, structured scales are commonly used to complement qualitative evidence and to organise participants' perceptions across predefined dimensions (Hernández-Sampieri et al., 2014). In this study, the questionnaire does not aim to support inferential analysis but to provide descriptive information that triangulates the qualitative reflections, thereby strengthening the internal coherence of the mixed-methods design.

4 Results

The results of the study are presented below, organised according to the three dimensions of the instrument: formative, learning and service. Tables 2, 3, and 4 present the means and standard deviations for the items corresponding to the three dimensions evaluated by the questionnaire: formative, learning, and service.

The scores in Table 2 present the formative dimension, whose average score is 4.58; these scores are higher than those reported in the study by Severino-González et al. (2023), in which students from public and private universities in Peru rated their participation in various SL projects. Otero-Escobar et al. (2022) evaluated the same scale in an educational experience seeking student participation, identifying the most appropriate technology to address real problems in organizations; the results are shown as percentages for the Likert scale, making direct comparison difficult. Nevertheless, the authors highlight, as does this study, the students' perception of the relationship between content and the SL experience which enhances their performance in their future profession.

Table 2. Means and standard deviations M (SD) for the items corresponding to the formative dimension.

Formative dimension	**M (SD)**
F1. The service is related to the contents of the subject (or subjects taken during the degree).	4.75 (0.71)
F2. The service is related to the curricular contents of my future profession.	4.75 (0.46)
F3. The service is linked to learning at university.	4.38 (1.06)
F4. The learning achieved is useful for my training as a professional.	4.88 (0.35)
F5. The learning achieved is useful for my personal training.	4.63 (0.52)
F6. I have received training materials for my individual training (self-training).	4.00 (1.20)
F7. I have acquired practical knowledge through the experience.	4.63 (0.52)
F8. I have developed the ability to learn in new contexts.	4.63 (0.52)

Note. This table shows descriptive statistics (mean and standard deviation) for the eight items in the formative dimension of the Service-Learning evaluation questionnaire. Participants rated each item on a five-point Likert scale, reflecting how the service experience contributed to their professional and personal training in mathematics didactics.

Regarding the open-ended question about the formative dimension, all students referred to content covered in subjects related to Mathematics Didactics regarding the structure of numeration and its operations, specifically composition and decomposition of numbers to facilitate understanding and operations such as addition, multiplication tables, two-digit multiplication, and single-digit division with decimals.

In the Mathematics Didactics courses, the importance of following the CPA (Concrete-Pictorial-Abstract) approach in the teaching-learning of Mathematics is emphasized. This involves working on the concept through material in the concrete or manipulative phase, then representing that concept/operation pictorially or graphically, and finally evolving to abstraction, where representation occurs with mathematical symbols. The contributions from students to this question demonstrate an internalization of this approach, which

involves moving from the manipulative to the symbolic in Mathematics. Some comments made by these students can be highlighted:

> "...homework consisted of exercises from the textbook, and other exercises were proposed using multibase blocks. In practice, a greater understanding of the concept of decimal numbers was observed when manipulating the blocks compared to mechanically doing the exercises from the textbook" (Student 5).

> "In my case, the child had great difficulties understanding the decomposition of the number into thousands, hundreds, tens, and units. For his explanation, we used the resource of the multibase blocks and at the same time a template that he had to fill in according to the decomposition of the number. When I presented the practice at home, it seemed easy and adapted to his level, but when I took it to the classroom, the child struggled to reflect the multibase blocks (the manipulative phase) in the template (the symbolic phase)" (Student 8).

All results for the items in Table 3 on the learning dimension exceed a score of 4, reaching an average of 4.47 for this dimension, indicating students' positive perception regarding the learning obtained through the "Aula de Apoyo" programme. In this dimension, the scores are also higher than those of the study by Severino-González et al. (2023), except for item A8: Teamwork has helped me create knowledge networks. This may be due to the fact that students focused on the learning problems of their assigned Primary student and, although they occasionally collaborated with each other, providing various resources and strategies in the final meetings of each session, they did not feel the need to broaden their network for the development of the experience. In the study by Otero-Escobar et al. (2022), with which these results are compared, values such as social responsibility and personal growth are highlighted. Additionally, our students highly value the organization and planning of time in searching for resources to meet the educational needs of their tutored student, as well as the social reflection or necessary linkage of social reality with the university.

Table 3. Means and standard deviations M (SD) for the items corresponding to the learning dimension.

Learning dimension	M (SD)
A1. I have felt responsible for my actions.	4.88 (0.35)
A2. I believe I have acquired greater responsibility for my professional performance.	4.63 (0.52)
A3. I have grown personally during the service development.	4.50 (0.76)
A4. I have developed the ability to organize and plan my time.	4.50 (1.07)
A5. The Service-Learning methodology has helped me obtain tools for my future profession.	4.38 (0.74)
A6. The experience has provided me with greater social reflection linked to my future professional practice.	4.50 (0.76)
A7. I have shared reflections with different people about the practice of Service-Learning.	4.00 (0.93)
A8. Teamwork has helped me create knowledge networks.	3.75 (1.16)
A9. My communication skills have improved.	4.13 (0.83)
A10. I understand the meaning of the service performed as help to others.	4.75 (0.46)
A11. I have been aware of the need to link the reality of society with the university.	4.88 (0.35)
A12. The experience has increased my social sensitivity.	4.75 (0.71)

Note. This table presents the mean scores and standard deviations for the items related to the learning dimension of the Service-Learning questionnaire. Each statement was rated on a five-point scale, capturing how undergraduates perceived their personal growth, sense of responsibility, organizational skills, and improved communication resulting from the tutoring sessions.

Regarding the open-ended question about the learning dimension, all responses refer to the search for resources to better address the learning deficiencies that undergraduate students noticed in Primary students. These deficiencies were mainly related to understanding numbers and operations, specifically with understanding units, tens, and hundreds, as well as multiplication and division.

Generally, students refer to the use of manipulable materials to compensate for these gaps in the understanding of numbers and their operations:

> "...in the first session, I could see the difficulties my student had in learning on a superficial level, and that helped me prepare different manipulable materials for the next session, allowing me to create a learning environment in which he could construct his own understanding using the resources I had developed. We used Cuisenaire rods, number decomposition houses, the ABN method..." (Student 8).

Table 4 shows the scores assigned to the service dimension. This dimension presents the lowest overall average of the three at 4.11, but still remains close to 5. In this case, half of the items are still above the work of Severino-González et al. (2023), but the other half

are below. These items have an average score below 4, changing the overall trend, and are related to the organization and development of the project, the distribution of tasks, or the coordination of activities. This is coherent since students have been more involved in the execution of the project than in its planning, as it was an initiative aimed at the supplementary training of university students. The item with the lowest score (2.63) refers to the duration of the service; thus, it is interpreted that students would have preferred the "Aula de Apoyo" to be extended over time. This coincides with comments received from families and the teachers of Primary students.

Table 4. Means and standard deviations M (SD) for the items corresponding to the service dimension.

Service dimension	**M (SD)**
S1. When necessary, I have made decisions for the proper functioning of the service.	4.13 (0.83)
S2. I have taken the initiative to propose different viewpoints to organize the sessions.	4.00 (0.93)
S3. Overall, the service (project programme) has met my expectations.	4.50 (0.53)
S4. My service has responded to the needs of the institution/entity where the service is performed.	4.38 (0.74)
S5. I have felt committed to the project.	5.00 (0.00)
S6. The learning environment has benefited group work.	4.63 (0.74)
S7. I have carried out activities addressing the needs of the participants in the project.	4.75 (0.46)
S8. The resources of the centre have been sufficient.	4.13 (1.13)
S9. The duration of the service has been adequate.	2.63 (1.30)
S10. The distribution of tasks has been adequate.	3.88 (0.64)
S11. The project has been evaluated throughout its process.	3.88 (0.83)
S12. My participation has been recognized.	4.13 (0.83)
S13. I have participated in the organization and development of the project.	3.75 (1.04)
S14. I have participated in the coordination of activities during the service.	3.75 (1.04)
S15. My participation has satisfactorily responded to the needs of the institution/entity where the service is performed.	4.13 (0.83)

Note. This table displays the mean scores and standard deviations for 15 items in the service dimension of the questionnaire. Rated on a five-point scale, these items assess how well the project met community needs, participants' commitment, the adequacy of resources, and the overall organization of the "Aula de Apoyo" programme.

In the open-ended question of the service dimension, most students mentioned the importance of educational support for students at risk of social exclusion, highlighting aspects related to language:

> "It has been positive to be able to offer a service to children who do not have the economic resources to have a private tutor. It is also positive that foreign children, who may lag due to language or cultural changes, can receive this type of reinforcement to equalize their level with that of their peers and enhance their education. I found this to be a very rewarding experience." (Student 8).

They also emphasized the importance of these actions to decrease the educational gap for students with fewer economic resources, thereby ensuring a quality and equitable education that promotes a fairer society.

Finally, in the open-ended question inviting any relevant contributions, the opportunity to interact with Primary Education students was highlighted, as the curriculum does not propose practicums until the end of the third year of study (UCLM, n.d.):

> "...these workshops are very good because they help us grow as future teachers, in addition to allowing us to be with students and work with them, as we had never had the opportunity to teach/help until then." (Student 2)

> "...the sessions we held at the centre were quite enriching. I find it a very innovative and motivating idea for university students because practical implementation in our training is very important..." (Student 6)

> "...seeing how the children wanted to learn and enjoyed what we were going to teach them, and how gradually they were understanding it was a very exciting experience for me. I wish we could have extended it over time. Thank you for this opportunity." (Student 8)

5 Discussion

The "Aula de Apoyo" project is based on the Service-Learning (SL) methodology, where students from the Degree in Primary Education provide educational support in Mathematics to Primary Education students with difficulties in the subject, preferably coming from vulnerable families. This approach not only strengthens the learning related to Mathematics Didactics but also fulfills a crucial service to society by reducing the educational gap in this student segment.

The results also reinforce the relevance of providing structured extracurricular support in Mathematics. As noted in the introduction, previous meta-analyses show that additional learning time outside regular school hours—whether through after-school programmes or summer learning opportunities—can improve mathematical engagement and achievement (Dietrichson et al., 2017; Kremer et al., 2015; Lynch et al., 2023). Unlike most of these interventions, which do not incorporate didactic frameworks or community-based components, the "Aula de Apoyo" project integrates mathematics reinforcement within a SL approach, addressing an underexplored intersection in the literature.

The results obtained, both qualitative and quantitative, are consistent with previous research showing that SL can foster civic attitudes and social skills in participating students (Bringle et al., 2019; Maravé-Vivas et al., 2019; Maravé-Vivas et al., 2022a; Samino, 2023). In terms of learning, the programme has impacted key competencies such as designing teaching–learning processes in Mathematics and effective collaboration with the educational community.

The reflections of the students highlight this transformation. One student expressed: "In practice, a greater understanding of the concept of decimal numbers was observed when manipulating the blocks compared to mechanically doing the exercises from the textbook." This comment underscores the importance of active learning and manipulation, aligning with the CPA approach that is fundamental in Mathematics Didactics.

The use of manipulable materials reflects the internalization of this essential approach both in the teaching of mathematics and in the development of the teaching identity of participating students (Domínguez & López, 2016). Students have emphasized the importance of these resources to address difficulties in understanding mathematical concepts. One student pointed out: “We used Cuisenaire rods, number decomposition houses, the ABN method…” evidencing the effective implementation of this approach in practice.

Furthermore, students have demonstrated notable empathy towards the recipient students, feeling valued and appreciated. This phenomenon has been observed in previous projects (Giles et al., 2019). One student shared: “Seeing how the children wanted to learn and enjoyed what we were going to teach them… was a very exciting experience for me.” This testimony illustrates both the didactic impact of the intervention and the personal development experienced by future teachers. This emotional bond directly relates to Daniel Goleman’s theory of emotional intelligence (1995), which emphasizes the importance of emotional skills such as empathy for professional and personal success. The statement “it was a very exciting experience for me” highlights how these interactions enriched their overall development, strengthening both their pedagogical competencies and their ability to connect emotionally with students.

The analysis indicates clear evidence of personal growth and an increase in social responsibility among the participants, fundamental aspects highlighted in previous studies (Capella-Peris et al., 2019; Maravé-Vivas et al., 2022a; Samino, 2023). Interaction with Primary students not only reinforces their teaching skills but also allows them to better understand the difficulties their future students face. As one student expressed: “These workshops are very good because they help us grow as future teachers”, emphasizing the relevance of the programme in their comprehensive training.

This broader interpretation gains additional significance when viewed through Bauman’s (2000) idea of a liquid society, where rapid social transformations generate new forms of uncertainty and vulnerability. The combination of SL and extracurricular mathematics support appears particularly suited to these conditions, as it promotes

adaptability, relational skills and civic responsibility—competencies that become essential for future teachers operating in fluid and constantly changing environments.

Regarding the service provided, families and teachers have shown their gratitude and support for the "Aula de Apoyo" project, suggesting its prolongation over time. However, a limitation of this study is that systematic written feedback from Primary teachers was not collected; incorporating this perspective in future iterations would offer a more complete picture of pupils' academic progress and classroom impact. This feedback validates the effectiveness of SL in improving civic attitudes and social commitment (Maravé-Vivas et al., 2022a) and highlights the impact on intangible human capital, such as trust and community connection among students (Lotti & Betti, 2019). As Goleman (1995) notes, developing emotional intelligence in future teachers not only enables them to manage their emotions but also allows them to connect more deeply with their students—an aspect evidenced in the experiences of the participants.

Butin (2010) argues that SL is more than an educational practice; it is an opportunity for future educators to develop a sense of social responsibility and civic commitment. This is reflected in the testimonies of students who emphasize the value of providing support to students at risk of social exclusion and the positive impact their intervention can have on these communities.

The "Aula de Apoyo" programme has not only benefited the students involved but has also positively contributed to their employability, as evidenced by cases where families have requested to continue receiving educational support from undergraduate students outside the initial project. This approach responds to the demands of a liquid society in constant change where adaptation and empathy are essential to navigate uncertainties in the social and educational environment. Additionally, it promotes a more inclusive and equitable education aligned with the United Nations Sustainable Development Goals.

Overall, the "Aula de Apoyo" has proven to be a successful pilot project that could be expanded to more subjects and education faculties, extending its benefits to both participating students and local educational communities. This model not only strengthens the intangible human capital of students but also promotes collaboration among different institutions to address common educational challenges and advance towards a more integrative and sustainable educational future.

Conclusions

Service-Learning promotes a more inclusive and equitable education by providing additional support to vulnerable students and fostering social commitment among future teachers. It contributes to reducing educational gaps and strengthens social cohesion, preparing students to navigate the uncertainties inherent in contemporary society. Moreover, the project strengthens the intangible human capital of future teachers by fostering empathy, adaptability and interpersonal skills—elements increasingly valued in modern educational and professional contexts. The "Aula de Apoyo" illustrates how universities can

contribute to addressing educational inequalities while preparing future teachers to respond to the complexities of a liquid society. Finally, by combining extracurricular mathematics support with this pedagogical approach, the programme offers a community-oriented model that remains scarce in current educational literature.

The purpose of this work is to present and analyze the impact of the "Aula de Apoyo" project, an educational intervention that combines the SL methodology with extracurricular educational support in Mathematics aimed at Primary Education students with academic difficulties. The study focuses on evaluating how this combination of pedagogical approaches contributes to the academic, personal, social, and civic development of both undergraduate students in the Primary Education degree and the Primary students receiving support. Additionally, it seeks to highlight the potential of SL to foster inclusive, equitable education adapted to the demands of a constantly changing society.

In the "Aula de Apoyo" undergraduate students from the Degree in Primary Education provide extracurricular educational support in Mathematics to students with failing grades, prioritizing access for students in disadvantaged situations. Undergraduate students reinforce content obtained in subjects related to Mathematics Didactics while providing a social service aimed at preventing a potential educational gap among Primary students. The self-perception of undergraduate students regarding the formative, learning, and service dimensions is evaluated.

Although the study was conducted with a small sample size and in a single educational centre, this does not detract from the value of the findings obtained, as it allows for a more in-depth and detailed approach to the dynamics of the project in a specific context. In addition, the small sample and the post-only design did not allow for inferential statistical analyses, so the quantitative findings are interpreted descriptively and in close connection with the qualitative evidence. While this limitation may affect the generalization of the results, the follow-up focused on a short period, providing an opportunity for more extensive analyses in the future to capture all long-term effects of the programme.

Despite these considerations, the procedure followed is reproducible and establishes the foundations for future studies to confirm and expand upon the observed benefits. The evidence suggests that although the primary focus is educational support, the "Aula de Apoyo" also contributes additionally to the development of human capital skills such as communication and empathy, which are essential for the comprehensive training of future educators. The programme could serve as a model for other institutions and could be integrated into additional areas of the curriculum, thereby contributing to improved educational opportunities in vulnerable contexts.

Research ethics

Author contributions

A.GE.C., E.L.-I., M.T.S. and M.S.-V.: Conceptualization, design, data acquisition and analysis, drafting manuscript and critical revision of manuscript.

Artificial intelligence

No generative AI or AI-supported technologies were used.

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Institutional review board statement

All relevant ethical guidelines and principles were carefully considered during the preparation of this article. The participants were voluntary, and informed consent was obtained from all participants. Ethical review and approval were required by University Jaume I (CEISH/31/2022).

Informed consent statement

Informed consent was obtained from all research participants.

Data availability statement

The data collected in this research is not publicly accessible due to strict privacy protection measures, particularly as the participants are minors. In compliance with current data protection regulations, special care has been taken in handling personal information of underage subjects. Informed consent was obtained from parents or legal guardians for participants under 14, while appropriate consent protocols were followed for those aged 14-18. These measures have been implemented to safeguard the privacy and rights of minor participants, adhering to ethical and legal obligations in educational research.

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Conflicts of interest

The authors have declared no potential conflicts of interest regarding the research, authorship, and/or publication of this article.

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