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Effects of Service-Learning on Motivation and Socioeducational Commitment in Education and Sports Sciences Degree

Miguel Sánchez-Polán
Universidad Pontificia Comillas, Spain, *mspolan@comillas.edu*

Olga Martín-Carrasquilla
Universidad Pontificia Comillas, Spain, *olmartin@comillas.edu*

Elsa Santaolalla-Pascual
Universidad Pontificia Comillas, Spain, *esantaolalla@comillas.edu*

María Fernández-Rivas
Research group GICAF. Universidad Pontificia Comillas, Spain, *mfrivas@comillas.edu*

This study analyses the effects of a Service-Learning experience in higher education involving students of double degree in Physical Activity and Sport Sciences and Primary Education regarding changes in socioeducational commitment, attitudes toward Mathematics, and motivation toward Physical Education. A quasi-experimental pretest–posttest design was employed with 46 university students participating in interdisciplinary workshops with primary school children. Validated instruments assessed socioeducational commitment, attitudes toward Mathematics, and motivation toward Physical Education. Data were analysed using non-parametric procedures with intention-to-treat and per-protocol approaches. Results showed a significant increase in socioeducational commitment, particularly in social justice awareness and socioeducational action. A significant increase in intrinsic motivation toward Physical Education was observed, whereas attitudes toward Mathematics did not change. Autonomous motivation (intrinsic, integrated, and identified regulation) was positively associated with socioeducational commitment (Rho > 0.5). Higher overall motivation was related to lower social justice awareness (Rho = −0.37). These findings highlight the potential of Service-Learning to enhance civic engagement and professional development contexts.

Keywords: service learning, socioeducational commitment, civic engagement, motivation, physical education, mathematics attitudes

INTRODUCTION

Service-Learning (SL) has been established within the educational context as an active methodology that enables students to take a leading role in their own learning while

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developing social and civic competencies (Blanco & García-Martín, 2021; Furco & Norvell, 2019). At the university level, it is conceptualized as a pedagogical model that links academic institutions with the community, promoting the practical application of curricular content through collaboration with social organizations (Chiva-Bartoll & Fernández-Río, 2021a; García et al., 2019). This approach not only enhances the relevance and contextualization of learning but also facilitates students' engagement with real-world professional environments (Lázaro-Cantabrana et al., 2021). In line with this perspective, the European Observatory of Service-Learning in Higher Education (EOSLHE, 2019) defines Service-Learning in higher education as an experiential pedagogy in which students engage in community service, critically reflect on their experience, and learn from it personal, academic, and social levels. EOSLHE (2019) highlights that Service-Learning is grounded in principles of social justice and sustainable development, it fosters civic responsibility and contributes to community empowerment through reciprocal partnerships among students, faculty, and local organizations, and is formally recognized through European Credit Transfer and Accumulation System (ECTS) accreditation.

Some researches claim the need for innovative and student-centered learning that increases active and practical participation, critical thinking, and collaboration (Ghufron & Ermawati, 2018; Zhenghui et al., 2025). Additionally, the European Higher Education Area (EHEA) supports practical experiences that involve social engagement, for which Service Learning is particularly appropriate, as it combines academic learning with community service (Red de Aprendizaje-Servicio de las Universidades Catalanas, 2019). This fosters the university's role as a space for ethical learning and supports the application of Service Learning.

Contemporary universities must go beyond initial or continuing education; they must aspire to the comprehensive development of students (Mayor, 2020; Ortega Torres et al., 2020). This involves creating collaborative and reflective spaces where theory is linked to practice in real-life contexts, promoting motivation, critical thinking, emotional awareness, and social competence, while strengthening the relationship between universities and communities (Potts and Schlichting, 2011; Warsah et al., 2021). In this context, socio-educational practices emerge as a way of applying the knowledge acquired in social environments. Among the pedagogical strategies used for this purpose, service learning stands out for its relevance in higher education, especially as part of initiatives related to university social responsibility or sustainable universities. It promotes socio-educational engagement and strengthens community cohesion (Asenjo, Santaolalla & Urosa, 2021); Martínez Costa et al., 2018).

Numerous studies have implemented Service-Learning experiences across university programs. Barrón and Muñoz (2015) developed a project in Environmental Sciences, Pedagogy, and Social Education aimed at promoting traditional agricultural knowledge, environmental awareness, and skills such as critical thinking and teamwork. González-Sánchez et al. (2022) applied Service-Learning in a Tourism degree program to address Sustainable Development Goal (SDG) 11, "Sustainable Cities and Communities," showing that it enhanced learning and civic engagement. Similarly, Facal et al. (2024) implemented Service-Learning in Psychology to promote digital skills among older

adults, fostering intergenerational learning and improvements in communication, decision making, and civic responsibility.

In Education programs, Early Childhood and Primary, González et al. (2015) developed a children's library with the educational community, while Gregori-Giralt and Menéndez-Varela (2014) implemented Service-Learning in Fine Arts, contributing to SDG 4, "Quality Education." These initiatives showed increased social engagement, motivation, and more positive perceptions of the teaching profession. Likewise, Lázaro-Cantabrana et al. (2021) reported sustained Service-Learning in Education and Psychology degrees focused on digital educational resources, highlighting students' competency development and the project's innovative nature.

With regard to interdisciplinary learning activities, it is worth noting that they are particularly valuable in teacher training, as they reduce the fragmentation of knowledge and foster more integrated, reflective and meaningful learning experiences. Although recent research has documented the pedagogical benefits of integrating Physical Education and Mathematics through specific interventions (Evans et al., 2025; Valentini and Sbarbati, 2024) there is a notable gap in the academic literature regarding the analysis of initial double-degree programmes in these two areas. Whilst authors such as Valentini and Sbarbati (2024) provide systematic reviews of interdisciplinary teaching protocols in primary education, and others such as Evans et al. (2025) examine the impact of experimental programmes such as 'Maths on the Move', research tends to be limited to one-off classroom implementation or to the study of pre-service teachers' attitudes and anxiety towards one of the subjects separately (Perry et al., 2023). There therefore remains a lack of evidence regarding curriculum design, the construction of professional identity, and the institutional challenges specific to dual-degree programmes that aim for a structurally hybrid training model.

For this reason, this study is particularly relevant, as it focuses on the impact of Service-Learning experience based on interdisciplinary proposals on students enrolled in a double degree in Physical Activity and Sports Sciences and Primary Education. Its general objective is to explore the impact of a Service-Learning project by assessing students' self-perception of socioeducational commitment, motivation toward Physical Education (PE) and attitudes toward Mathematics. More specifically, the study aims to: (1) analyze the effect of the project's implementation of the project on socio-educational commitment, as well as on the motivation towards PE and attitude towards Mathematics; and (2) describe the relationship between socio-educational commitment and motivation towards both subject areas. This approach seeks to provide empirical evidence on the benefits of Service-Learning as a transformative strategy in teacher education.

METHOD

This study was developed under a quasi-experimental pre-post design, following the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines (Haynes et al., 2021). This project was designed and carried out under a Service-Learning funded project by "Opening Doors: Service in Action" Ref. 2324-07.

Participants

To carry out this project, two different populations were considered. On the one hand, university members that were students of the 3rd and 4th courses of the Double Degree of Physical Activity and Sports Sciences and Primary Education (N=46) coordinated by professors of each course who conducted the intervention. The applied university subjects in the project were Teaching of Mathematics and Teaching of Physical and Sports Activities.

On other hand, members of the social institution, that is, children of primary school (of 5th and 6th course of primary school of a nearby educational center) in the Community of Madrid. Both populations were selected for convenience with non-equivalent groups based on each class group (Cea D´Ancona, 2010).

Instruments

A Microsoft Forms questionnaire was used for data collection, which was divided into different parts. The first collected sociodemographic data of the university students who participated (age, sex, degree, and course). Subsequently, different questionnaires were included:

- Student Teachers' Socio-Educational Commitment (STSEC). This questionnaire was used to measure the awareness of social justice and the socio-educational commitment of university students, and a Cronbach alpha of $\alpha = 0.931$. The questionnaire was made up of 13 different items scored from 1 (very little/barely capable) to 6 (a lot/very capable). This scale was also divided into two subscales: Awareness of social justice (STSEC 1) with five items and socioeducational action (STSEC 2) with eight items (Asenjo, Santaolalla & Urosa, 2021).
- Students and Teachers' Attitude Towards Mathematics (STATM). Used to measure Attitudes Towards Mathematics, it was chosen to use the reduced scale validated by Fernández Cézar et al. (2016), with a Cronbach alpha of $\alpha = 0.915$, which is based on the original scale published by Auzmendi (1992). On the reduced scale, it is possible to observe a one factor model only involving anxiety questions. This scale has 7 items scored from 1 (completely in disagreement) to 5 (Totally in agreement).
- Perceived Locus of Casuality Scale (PLOC) for PE. This scale was used to measure the perception of Locus of Casuality in students of PE; it was used the version published by Ferriz et al. (2015), which was validated with a Cronbach alpha of $\alpha = 0.93$. This scale has 24 items scored from 1 (Totally in disagreement) to 7 (Totally in agreement) measured before and after intervention, with 6 different dimensions (4 items per dimension): Intrinsic Motivation (PLOC1), Integrated Regulation (PLOC2), Identified Regulation (PLOC3), Introjected Regulation (PLOC4), External Regulation (PLOC5) and Amotivation (PLOC6).

Procedure

This project emerged in response to the strategic need of a Secondary Education institution in Madrid (Spain) to attract students from nearby Primary Education schools. The centre serves a highly diverse student population, characterized by significant interculturality and heterogeneity in academic levels, which has led to the prioritisation

of innovative, student-centred methodologies within its Educational Project. In this context, the institution organises three annual Open Days to present its educational approach, facilities, and resources to prospective students and families. To enhance these events, the centre collaborated with a university in the design and implementation of the Open Days, establishing a Service-Learning partnership that enabled university students to apply curricular knowledge in an authentic socioeducational setting while supporting student recruitment.

University students were required to design and deliver active, innovative, and interdisciplinary workshops aligned with the sixth-grade Primary Education curriculum of three degree-related subjects. The workshops aimed to engage pupils from nearby schools and communicate the philosophy of the host Secondary Education institution. Activities were developed in groups of 4–5 university students, with 10–15 Primary pupils per workshop. As three subjects participated, three interventions with the same design and population were conducted on different days. The interventions were focused on subject contents, and on three different days during the academic course, participants developed the mentioned workshops, each one lasting approximately 3 to 4 hours. During the interventions, the participants carried out specific activities with regards to the subject contents of about 15 – 20 minutes of duration, with a set schedule where the children, in groups, participate in each activity, and with the aim of improving the assimilation of concepts from a practical, collaborative and fun approach. Participation formed part of the assessment of each subject and was eligible for academic recognition. Data were collected anonymously at two time points (pre- and post-intervention) under informed consent, following strict response-time criteria, and the study was approved by the university's Ethics Committee (006/24-25).

Statistical analysis

SPSS for Windows (version 28.0.1.1; IBM Corporation, Armonk, NY, USA) was used for statistical analyses. Continuous variables were expressed as mean and standard deviation or, when non-normality was observed, as median and interquartile range (IQR). Data normality was assessed using the Shapiro–Wilk test. It was opted to perform an Intention-to-treat (ITT) and Per-Protocol (PP) analyses to avoid response bias, due to there were 5 participants (13,89%) that completed the questionnaires unusually quickly (under 3 minutes and 30 seconds in total), potentially meaning low attention or careless answer. Pre–post intervention comparisons were performed using paired-samples t-tests or the Wilcoxon signed-rank test when normality was not met. Post-intervention associations were examined using Spearman correlation matrices for both ITT and PP analyses.

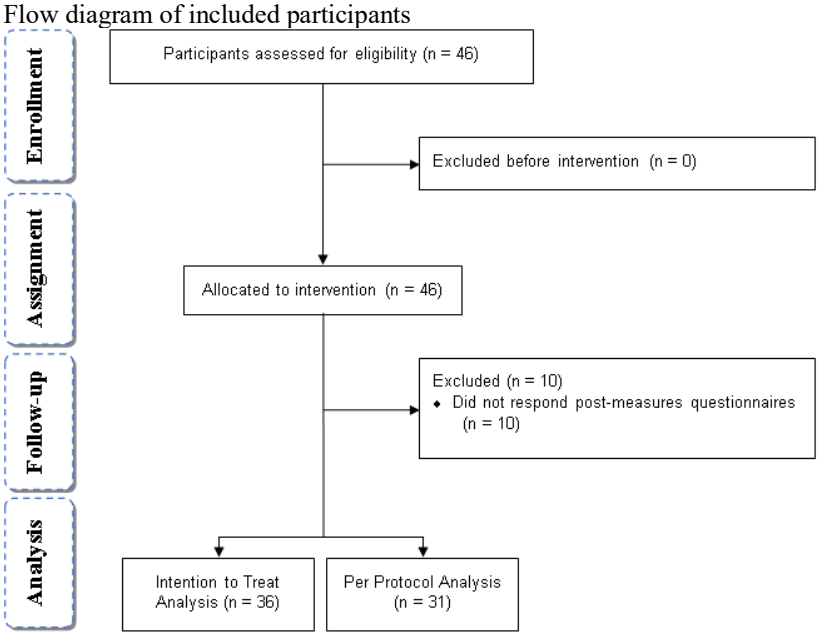
Consistency of all scales and questionnaires in the Per Protocol analysis was assessed using Cronbach's alpha (α) having into account the next cutoffs: $\alpha \geq 0.90$ = excellent, 0.80-0.89 = good, 0.70-0.79 = acceptable, 0.60-0.69 = questionable, and <0.60 = poor (Nunnally & Bernstein, 1994). When analysis revealed conflictive items with improvement of the scales by removing them, it was prioritized the integrity of subscales by assuming that with less than 3 items scale integrity could be harmed (Oviedo & Campo-Arias, 2005; Streiner, 1994). Effect sizes were reported as Cohen's d (d), Spearman's Rho (Rho) and eta squared (η2) interpreted with conventional Cohen's

threshold: small (d = 0.2; Rho = 0.1; η2 = 0.01), moderate (d = 0.5; Rho = 0.3; η2 = 0.06) and large (d = 0.8; Rho = 0.5; η2 = 0.14) (Cohen, 1988). Statistical significance was set at α = 0.05.

FINDINGS

In this study, 46 students who were in the double undergraduate program in physical activity and sports sciences and primary education (32 men and 14 women), none of them excluded prior to the intervention. Subsequently, 10 participants were excluded because they did not respond to the questionnaires at the end of the study, finally analyzing 36 students (Intention to Treat analysis), as shown in Figure 1, who were in the third and fourth course of the double undergrad (25 men and 11 women, 21 of them in the third and 15 in fourth courses), with a mean age of 21.53 ± 1.52 years. Then 5 students were excluded (per protocol analysis) due to their answers to the questionnaires that ended with 31 participants (21.71 ± 1.55 years).

Figure 1
Flow diagram of included participants



Reliability of the questionnaires in the involved sample

After performing a reliability test of used questionnaires along the interventions (Per Protocol analysis), these questionnaires and subscales demonstrated very good internal consistency, with Cronbach's alpha exceeding 0.83 in mostly all the cases (excepting cases with > 0.74, and one with poor consistency with 0.586).

Cronbach's alpha was poor in the after-intervention measure of PLOC5. Also, in the measure of PLOC3 and PLOC5 before the intervention the result showed a significant improvement by removing item 21 and 23 respectively.

Additionally, after intervention, in the global result of PLOC questionnaire it was observed that 4 items reported low item-total correlations (r = -0.195 to 0.200) likely reflecting intervention effects rather than measurement error. As the questionnaire was originally validated for ≤ 19 years and it was used with participants of 21.71 ± 1.55 years of mean, it was decided to remove 2 items with r < 0.2 while preserving all subscales ≥3 items (23 and 24). Results are displayed in Table 1.

Table 1
Reliability of used questionnaires

Questionnaire subscale	Time	Items	Cronbach α	Corrected item-total range	Observations
ST1	BI	5	0.883	0.61 – 0.78	Good
	AI	5	0.933	0.76 – 0.89	Excellent
ST2	BI	8	0.912	0.59 – 0.76	Excellent *Improvement (not significant) to α = 0.913 removing item 1.
	AI	8	0.947	0.71 – 0.87	Excellent
STT	BI	13	0.944	0.60 – 0.80	Excellent
	AI	13	0.965	0.73 – 0.90	Excellent
ATM	BI	7	0.904	0.56 – 0.86	Excellent
	AI	7	0.895	0.45 – 0.82	Good *Improvement (not significant) to α = 0.906 removing item 3.
PL1	BI	4	0.848	0.63 – 0.77	Good
	AI	4	0.806	0.55 – 0.75	Good
PL2	BI	4	0.932	0.77 – 0.92	Excellent *Improvement (not significant) to α = 0.934 removing item 20.
	AI	4	0.915	0.73 – 0.88	Excellent *Improvement (not significant) to α = 0.917 removing item 2.
PL3	BI	4	0.868	0.55 – 0.84	Excellent *Significant improvement to α = 0.906 removing item 21.
	AI	4	0.838	0.60 – 0.79	Good
PL4	BI	4	0.831	0.60 – 0.81	Good
	AI	4	0.743	0.46 – 0.62	Acceptable
PL5	BI	4	0.844	0.49 – 0.80	Good *Significant improvement to α = 0.874 removing item 23.
	AI	4	0.586	0.29 – 0.48	Poor
PL6	BI	4	0.797	0.57 – 0.70	Acceptable
	AI	4	0.704	0.34 – 0.64	Acceptable *Improvement (not significant) to α = 0.726 removing item 24.
PLT	BI	24	0.928	0.30 – 0.80	Excellent *Improvement (not significant) to α = 0.929 removing item 6.
	AI	24	0.884	-0.20 – 0.75	Good *Significant improvement to α = 0.885, 0.887, 0.888 and 0.89 removing items 18, 12, 23 and 24, respectively.

Note. BI, Before the intervention; AI, After the intervention; ST1, STSEC-1 (Awareness of social justice); ST2, STSEC-2 (Socio-educational action); STT, STSEC T (Total sum of STSEC dimensions); ATM (Students and Teachers' Attitude Towards Mathematics); A PL1, PLOC1 (Intrinsic Motivation); PL2, PLOC2 (Integrated Regulation); PL3, PLOC3 (Identified Regulation STAT, STATM (Students and Teachers' Attitude Towards Mathematics Anxiety); PL1, PLOC1 (Intrinsic Motivation); PL2, PLOC2 (Integrated Regulation); PL3, PLOC3 (Identified Regulation); PL4, PLOC4 (Introjected Regulation); PL5, PLOC5 (External Regulation); PL6, PLOC6 (Amotivation); PLT, PLOCTOTAL. Values are represented as the Spearman correlation coefficient (Rho).

After removing the two items from the PLOC questionnaire, the updated reliability results are displayed in Table 2. Despite there were results indicating that by removing some items the reliability could improve, it was opted to not remove more items since subscale integrity could be altered (Oviedo & Campo-Arias, 2005; Streiner, 1994).

Table 2
Reliability of sample adapted PLOC questionnaire and subscales

Questionnaire/ subscale	Time	Items	Cronbach α	Corrected item-total range	Observation
PL5	BI	3	0.761	0.47 – 0.68	Acceptable *Significant improvement to α = 0.802 removing item 11.
	AI	3	0.583	0.34 – 0.52	Poor *Improvement (not significant) to α = 0.585 removing item 5.
PL6	BI	3	0.781	0.59 – 0.64	Acceptable
	AI	3	0.726	0.47 – 0.69	Acceptable *Significant improvement to α = 0.782 removing item 6.
PLT	BI	22	0.922	0.25 – 0.81	Excellent *Improvement (not significant) to α = 0.923 and 0.924 removing items 12 and 6, respectively.
	AI	22	0.894	0.17 – 0.76	Good *Improvement (not significant) to α = 0.896 and 0.899 removing items 12 and 18, respectively.

Note. BI, Before the intervention; AI, After the intervention; PL1, PLOC1 (Intrinsic Motivation); PL2, PLOC2 (Integrated Regulation); PL3, PLOC3 (Identified Regulation STAT, STATM (Students and Teachers' Attitude Towards Mathematics Anxiety); PL1, PLOC1 (Intrinsic Motivation); PL2, PLOC2 (Integrated Regulation); PL3, PLOC3 (Identified Regulation); PL4, PLOC4 (Introjected Regulation); PL5, PLOC5 (External Regulation); PL6, PLOC6 (Amotivation); PLT, PLOCTOTAL. Values are represented as the Spearman correlation coefficient (Rho).

Student Teachers' Socio-Educational Commitment (STSEC) and Students and Teachers' Attitude Towards Mathematics (STATM) performance

When comparing both measures of the STSEC questionnaire (before and after the intervention), significant differences ($p < 0.05$) were observed after the intervention in the ITT analysis showing a significant improvement with moderate effect sizes in both dimensions, 'Awareness of social justice' ($Z = -2.79$; $p = 0.005$; $\eta 2 = 0.11$) and 'Socio-educational action' ($t_{35} = -3.79$; $d = -0.63$; $p < 0.001$), as well as in the total sum of the questionnaire ($t_{35} = -3.67$; $d = -0.61$; $p < 0.001$), showed in Table 1.

Similarly, significant differences were observed after the intervention in the PP analysis in the two dimensions of the STSEC questionnaire, awareness of social justice with small effect sizes ($t_{30} = -2.44$; $d = -0.44$; $p = 0.011$) and socioeducational action ($t_{30} = -3.04$; $d = -0.55$; $p = 0.002$), and in the total sum of both dimensions ($t_{30} = -2.91$; $d = -0.52$; $p = 0.003$) with moderate effect sizes, shown in Table 1. However, no significant differences were observed in the STATM questionnaire in the ITT and PP analysis ($p > 0.05$). Additionally, a significant increase was reported in the dimension of PLOC1 after intervention in the ITT analysis ($p = 0.046$).

Table 3
Results of the STSEC, STATM and PLOC questionnaire

Variable	Intention to treat analysis (n = 36)			Per protocol analysis (n = 31)		
	BI	AI	*p*	BI	AI	*p*
STSEC-1	21.19 ± 4.69	25 (7.75)	0.005*	21.55 ± 4.60	24.03 ± 4.39	0.011*
STSEC-2	32.19 ± 6.70	38.56 ± 6.47	<0.001*	32.74 ± 6.99	38.13 ± 6.07	0.002*
STSEC T	53.39 ± 10.78	62.86 ± 10.65	<0.001*	54.29 ± 11.14	62.16 ± 10.13	0.003*
ATM	22.08 ± 6.35	21.86 ± 6.07	0.370	22.68 ± 6.43	22.32 ± 6.42	0.299
PLOC1	23 (3.75)	26 (5.75)	0.046*	23 (3)	26 (6)	0.073
PLOC2	25 (7)	27 (4.75)	0.132	25 (6)	27 (4)	0.091
PLOC3	24 (6)	26 (5)	0.289	24 (6)	26 (5)	0.483
PLOC4	16.47 ± 5.95	17.25 ± 6.40	0.264	16.55 ± 6.02	15.97 ± 5.78	0.319
PLOC5	8.5 (7.5)	7.5 (6.5)	0.588	7 (7)	7 (5)	0.473
PLOC6	5 (4.75)	5 (6.75)	0.278	5 (4)	4 (5)	0.794

*Note. *p<0.05. BI, Before the intervention; AI, After the intervention; STSEC-1, Awareness of social justice; STSEC-2, Socio-educational action; STSEC T, Total sum of STSEC dimensions; ATM, Student and Teachers' Attitude Towards Mathematics; PLOC1 (Intrinsic Motivation);PLOC2 (Integrated Regulation); PLOC3 (Identified Regulation);PLOC4 (Introjected Regulation);PLOC5 (External Regulation);PLOC6 (Amotivation) Values are presented as mean ± standard deviation or median (IQR).*

Relationship between results (ITT analysis)

The results between STSEC and the PLOC questionnaire after intervention in the ITT analysis revealed (and excluded evident correlations between the dimensions of the same questionnaire) significant positive associations with moderate correlations between the dimensions of PLOC1, 2 and 3 dimensions with STSEC1 (Rho > 0.45), with STSEC2 (with two strong associations, Rho > 0.5), and with the total sum of items in the STSEC items (with also two strong associations, Rho > 0.5).

In the end, significant positive correlation was observed between PLOC 5 and PLOC 6 (Rho = 0.73), represented in Table 4.

Table 4
Spearman correlation matrix of measured questionnaires and dimensions after intervention with ITT analysis (n = 36)

Var	ST1	ST2	STT	ATM	PL1	PL2	PL3	PL4	PL5	PL6
ST1	1									
ST2	0.89*	1								
STT	0.95*	0.98*	1							
ATM	0.05	-0.00	0.01	1						
PL1	0.49*	0.53*	0.55*	-0.14	1					
PL2	0.46*	0.50*	0.51*	-0.06	0.87*	1				
PL3	0.45*	0.48*	0.49*	-0.12	0.89*	0.87*	1			
PL4	0.33	0.27	0.30	-0.18	0.45*	0.41*	0.42*	1		
PL5	0.20	0.20	0.22	-0.11	0.21	0.17	0.15	0.04	1	
PL6	0.25	0.14	0.19	0.07	0.04	0.02	0.01	0.08	0.73*	1

*Note. *p<0.05. Var, Variable; ST1, STSEC-1 (Awareness of social justice); ST2, STSEC-2 (Socio-educational action); STT, STSEC T (Total sum of STSEC dimensions); ATM (Students and Teachers' Attitude Towards Mathematics); A PL1, PLOC1 (Intrinsic Motivation); PL2, PLOC2 (Integrated Regulation); PL3, PLOC3 (Identified Regulation); PL4, PLOC4 (Introjected*

Regulation); PL5, PLOC5 (External Regulation); PL6, PLOC6 (Amotivation). Values are represented as the Spearman correlation coefficient (Rho).

Relationship between outcomes (PP analysis)

When comparing the correlations with the variables recorded at the end of the intervention, and between the ITT and PP analyzes, it is possible to distinguish lower correlation coefficients in the matrix of the PP analysis compared to the ITT one. However, it was possible to observe a significant positive association between PLOC5 and PLOC6 (Rho = 0.58) that was not reported in Table 2, that weren't observed in Table 3, with also less significant correlations in Table 5.

Table 5
Spearman correlation matrix of measured questionnaires and dimensions after intervention with PP analysis (n = 31).

Var	ST1	ST2	STT	ATM	PL1	PL2	PL3	PL4	PL5	PL6
ST1	1									
ST2	0.85*	1								
STT	0.94*	0.98*	1							
ATM	0.12	0.07	0.08	1						
PL1	0.41*	0.44*	0.45*	-0.12	1					
PL2	0.39*	0.42*	0.44*	-0.07	0.88*	1				
PL3	0.34	0.36*	0.36*	-0.13	0.89*	0.85*	1			
PL4	0.25	0.14	0.18	-0.04	0.44*	0.47*	0.45*	1		
PL5	-0.20	-0.13	-0.13	0.21	-0.12	0.02	-0.06	-0.22	1	
PL6	0.01	-0.01	0.04	0.25	-0.05	0.02	0.02	0.04	0.58*	1

Note. Var, Variable; ST1, STSEC-1 (Awareness of social justice); ST2, STSEC-2 (Socio-educational action); STT, STSEC T (Total sum of STSEC dimensions); ATM (Students and Teachers' Attitude Towards Mathematics); A PL1, PLOC1 (Intrinsic Motivation); PL2, PLOC2 (Integrated Regulation); PL3, PLOC3 (Identified Regulation STAT, STATM (Students and Teachers' Attitude Towards Mathematics Anxiety); PL1, PLOC1 (Intrinsic Motivation); PL2, PLOC2 (Integrated Regulation); PL3, PLOC3 (Identified Regulation); PL4, PLOC4 (Introjected Regulation); PL5, PLOC5 (External Regulation); PL6, PLOC6 (Amotivation). Values are represented as the Spearman correlation coefficient (Rho).

DISCUSSION

Firstly, this study aims to analyze the effect of the implementation of the project on socio-educational commitment, as well as on motivation towards PE and attitude towards Mathematics. Thus, with respect to whether the implementation of a University Service-Learning experience has an impact on the awareness of social justice and the socioeducational action of the university students involved, it is observed that, after the intervention, these variables have increased significantly. Specifically, statistically significant differences are observed both in the partial dimensions (awareness of social justice and socio-educational action) and in the total measure of the socio-educational commitment scale, which demonstrates the positive effect of Service-Learning on this variable. In this sense, there are numerous studies that support these results, such as the studies by Luna et al. (2024), Mayor and Guillén-Gámez (2021) and Meyer et al., (2019) who show that Service-Learning favors active student participation and enhances key competencies related to social commitment. Along the same lines, studies such as

that of Asenjo, Santaolalla & Urosa (2021), García-Gutiérrez and Corrales (2021) and Saavedra et al. (2022) point out that this methodology promotes a critical attitude and greater socio-educational participation in future teachers, positively favoring awareness of social justice and encouraging civic engagement in relation to inequalities, demonstrating, mainly, greater impact on socio-educational action. In addition, the work of Do et al. (2024) demonstrates that these experiences not only reinforce commitment to the community, but also strengthen personal and academic development, especially when apply with vulnerable groups.

Furthermore, this study aimed to know if this Service-Learning experience increased the motivation of students towards PE and attitude towards Mathematics, noting that there are no significant differences after the intervention in terms of the attitude towards mathematics, although there were with respect to motivation towards PE, specifically, with respect to their intrinsic motivation.

The increase in intrinsic motivation for PE aligns with the findings of de Lobo-de-Diego et al. (2024), who emphasize that Service-Learning projects in PE foster meaningful learning by connecting academic content with real-life social contexts (Sumarmi et al., 2020). Their study highlights how students experience satisfaction and personal growth when engaging in physical activity with vulnerable populations, which in turn enhances their civic participation and intrinsic motivation. The emphasis on movement and embodied learning in all workshops, as noted in this study, likely contributed to this motivational boost. In addition, Lamoneda et al. (2019) also implemented a Service-Learning programme in PE with secondary school students and observed evidence of statistically significant improvement in the development of participants' prosocial attitudes but no changes in attitudes towards immigration.

With regard to attitudes towards mathematics, these are shaped through students' diverse experiences with the subject and directly influence their disposition to approach it with confidence or, conversely, with resistance (Auzmendi, 1992; Fernández Cézar et al., 2016). These attitudes significantly affect teaching and learning processes, primarily due to their strong association with academic achievement in mathematics—both among primary and secondary school students (Hwang & Son, 2020) and among preservice teachers (Edo et al., 2024). In this context, it is possible to identify several methods for improving mathematical attitudes, confidence, and achievement, highlighting among them active methodologies such as Service-Learning, which has proven to be an effective approach for enhancing student motivation and engagement across educational stages (Gómez-Escobar & Simón-Medina, 2022).

Although several studies have reported that Service-Learning can positively influence students' attitudes in general (Andrade-Zapata & López-Vélez, 2023; Martínez-Usarralde et al., 2024), and specifically in the domain of mathematics (Anderson et al, 2016; Santaolalla, Martín-Carrasquilla & Urosa, 2025; Wilkerson, 2020), the present study did not reveal a significant change in students' attitudes toward mathematics. This outcome may be attributed to the specific characteristics of the intervention. On the one hand, this may be attributed to the fact that the Service-Learning experience has been implemented through an interdisciplinary approach in which Mathematics has been

integrated with Physical Education; in such cases, authors such as Honey et al. (2014) point out that, in general, there is less evidence of a positive impact of interdisciplinary integration on mathematics outcomes than on those of other disciplines. Furthermore, this was a one-off initiative carried out over the course of a single academic year and, although there is evidence of improved attitudes towards mathematics in interdisciplinary experiences between these two subjects (Valentini & Sbarbati, 2024). Within the field of mathematics education, previous research has shown that substantial changes in beliefs and attitudes often require time, continuity, and stable pedagogical relationships (Stipek et al., 2001). Finally, in other cases, statistically significant improvements have been observed among preservice teachers when engaged in open-ended mathematical tasks that involve the use and design of manipulatives and modeling tools (Schanke, 2022). This has not been the case here due to the nature of the interdisciplinary collaboration between Mathematics and Physical Education. These findings underscore the need for mathematics teaching not to shy away from approaches that offer students in general, and future teachers in particular, the opportunity to engage continuously in competence-based and context-based learning (Simarro & Couso, 2018), through approaches that move away from those in which the pedagogical focus is based on excessive control in the classroom (Perry et al., 2023).

Studies such as Meyer et al. (2019) suggest that the nature of service activities and student characteristics can influence Service-Learning outcomes. In this study, it is likely that the interdisciplinary design of the Mathematics and PE workshops, combined with the fact that the preservice teachers were specializing in Physical Education, led to a lower integration on the mathematical component into the movement-based activities, which may explain their lower level of engagement and emotional impact compared to PE. These findings highlight the importance of discipline-specific design and careful implementation in Service-Learning to effectively enhance students' attitudes and motivation (Ortega-Ruipérez & Correa-Gorospe, 2024). Furthermore, studies such as that conducted by Evans et al. (2025) highlight the value and potential of integrating physical education and mathematics through a teacher-centered approach and emphasize the need to further develop strategies aimed at improving the effectiveness of interdisciplinary education.

Secondly, the study aimed to explore the relationship between socioeducational commitment and students' motivation toward PE and attitudes toward Mathematics. The findings revealed a positive association between autonomous motivation (intrinsic, integrated and identified regulation) and socioeducational commitment, particularly in the dimensions of social justice awareness and socio-educational action. On the contrary, higher levels of motivation were linked to lower awareness of social justice.

These results align with existing literature highlighting the transformative potential of Service-Learning in fostering ethical reflection and civic engagement (Blanco & García-Martín, 2021; Furco & Norvell, 2019; Garbarino & Lewis, 2020). Specifically, Chiva-Bartoll et al. (2022) emphasize that Service-Learning experiences in PE contexts enhance not only professional competencies, but also a deeper understanding of social responsibility and justice. Similarly, Ruiz-Montero et al. (2022) found that students involved in Service-Learning projects with vulnerable populations developed stronger

socioeducational values and intrinsic motivation, suggesting that meaningful engagement supports both personal and academic growth.

In this regard, the study by Wong et al. (2023) introduces the Student Voice for Social Justice (SVSJ) methodology, which shares conceptual ground with Service-Learning through its commitment to active, co-constructed pedagogies grounded in Nancy Fraser's social justice dimensions (redistribution, recognition, and representation). Though developed in the context of online participatory action research in Hong Kong, the findings demonstrate similar outcomes, such as critical engagement, voice empowerment, and increased civic awareness, supporting the idea that centering students as agents of change can deepen both academic and socioeducational learning.

The positive correlation between autonomous motivation and socioeducational commitment may be explained through the lens of self-determination theory (Ryan & Deci, 2017). When students perceive their actions as self-directed and socially meaningful, they are more likely to experience intrinsic satisfaction and a sense of purpose. This is supported by de Lobo-de-Diego et al. (2024), who reported that PE students participating in Service-Learning initiatives demonstrated greater motivation and ethical awareness, particularly when the activities were embedded in real-world social contexts.

CONCLUSION

This study examined the impact of a university Service-Learning experience on students' socio-educational commitment of students and their attitude and motivation toward PE and Mathematics. The findings indicate that the Service-Learning intervention positively influenced students' awareness of social justice and their engagement in socioeducational action. Furthermore, a significant increase in intrinsic motivation toward PE was observed, while no significant changes were found in students' attitudes mathematics towards mathematics. The study also revealed a positive relationship between autonomous motivation (intrinsic, integrated and identified regulation) and socioeducational commitment, particularly in the dimensions of social justice awareness and socio-educational action. On the contrary, higher levels of motivation were associated with lower awareness of social justice, and a negative relationship was found between externally regulated motivation towards PE and students' attitudes toward Mathematics.

Finally, it is worth noting several limitations. The relatively small sample size and the specific institutional context limit the generalisability of the findings. Furthermore, the design of the service-learning experience may have favoured Physical Education content, which could have influenced specific motivation towards the subject. For these reasons, future research should expand the sample and extend this interdisciplinary approach between mathematics and physical education to other groups of trainee teachers, including those who do not specialise in physical education, in order to achieve a more balanced integration of both disciplines. Furthermore, future workshops should further promote the use of practical mathematical materials and modelling tools, whilst longitudinal designs could help to examine the sustained effects of this type of intervention on socio-educational engagement, motivation and academic attitudes.

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REFERENCES

Andrade-Zapata, J. S., & López-Vélez, A. L. (2023). El aprendizaje-servicio cocurricular en la educación superior: una revisión sistemática. *RIDAS. Revista Iberoamericana de Aprendizaje-Servicio, 16,* 128–158. https://doi.org/10.1344/ridas2023.16.9

Anderson, J., Bahuaud, E., Henrich, A., & Sloughter, J. M. (2016). Addressing Negative Math Attitudes with Service-Learning. *PRIMUS*, 26(8), 788-802. http://doi.org/10.1080/10511970.2016.1174967

Asenjo, J. T., Santaolalla, E., & Urosa, B. (2021). The Impact of Service Learning in the Development of Student Teachers' Socio-Educational Commitment. *Sustainability*, 13(20), 11445. https://doi.org/10.3390/su132011445

Auzmendi, E. (1992). *Las actitudes hacia la matemática-estadística en las enseñanzas medias y universitarias. Características y medición*. Mensajero.

Barrón, Á., & Muñoz, J. M. (2015). Los huertos escolares comunitarios: fraguando espacios socioeducativos en y para la sostenibilidad. *Foro de Educación, 13*(19), 213–239. https://doi.org/10.14516/fde.2015.013.019.010

Blanco Cano, E., & García-Martín, J. (2021). El impacto del aprendizaje-servicio (ApS) en diversas variables psicoeducativas del alumnado universitario: las actitudes cívicas, el pensamiento crítico, las habilidades de trabajo en grupo, la empatía y el autoconcepto. Una revisión sistemática. *Revista Complutense de Educación, 32*(4), 639–649. https://doi.org/10.5209/rced.70939

Cea D´Ancona, M. A. (2010). *Métodos de encuesta. Teoría y práctica, errores y mejora (Survey methods. Theory and practice, errors and improvement).* Síntesis.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Lawrence Erlbaum Associates.

Chiva-Bartoll, O. & Fernández-Río, J. (2021a). Aprendizaje servicio. En A. Pérez-Pueyo, D. Hortigüela-Alcalá & J. Fernández-Río (2021) *Modelos pedagógicos en Educación física: Qué, cómo, por qué y para qué*. (pp.227-246). Universidad de León.

Chiva-Bartoll, O. & Fernández-Río, J. (2021b). Advocating for Service-Learning as a pedagogical model in PE: towards an activist and transformative approach. *PE and Sport Pedagogy, 27*(5), 545–558. https://doi.org/10.1080/17408989.2021.1911981

Do, T., Hufnagle, A. S., Maruyama, G., Lopez-Hurtado, I., Song, W., & Furco, A. (2024). Community engagement, service learning, and underrepresented college student success: An examination of multiple cohorts. *Analyses of Social Issues and Public Policy*, *24*(3), 1226-1251. https://doi.org/10.1111/asap.12408

Edo, H., Vivian, M., Asare, B., & Arthur, Y. D. (2024). Pre-service teachers' mathematics achievement, attitude, and anxiety: The moderative role of pre-service teachers' interest in the learning process. *Pedagogical Research*, *9*(2), em0192. https://doi.org/10.29333/pr/14192

European Observatory of Service-Learning in Higher Education. (2019, January). *Service-Learning definition*. https://www.eoslhe.eu

Evans, S., Willis, C., & Williams, J. (2025). Mathematics on the Move: An Interdisciplinary Approach to Teaching Mathematics Using Physical Education. *Education Sciences*, *15*(12), 1632. https://doi.org/10.3390/educsci15121632

Facal, D., Diz López, M. J., & Gutiérrez Moar, M. del C. (2024). Interdigitales: Una experiencia de aprendizaje-servicio (ApS) intergeneracional. *Revista Boletín Redipe, 13*(1), 76–90. https://doi.org/10.36260/rbr.v13i1.2067

Fernández Cézar, R., Solano Pinto, N., Rizzo, K., Gomezescobar Camino, A., Iglesias, L. M., & Espinosa, A. (2016). Las actitudes hacia las matemáticas en estudiantes y maestros de educación infantil y primaria: Revisión de la adecuación de una escala para su medida. *Revista Iberoamericana de Ciencia, Tecnología y Sociedad*, *11*(33), 227-238. Retrieved from: https://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S1850-00132016000300012&lng=es&nrm=iso&tlng=es

Ferriz, R., González-Cutre, D., & Sicilia, Á. (2015). Revisión de la Escala del Locus Percibido de Causalidad (PLOC) para la inclusión de la medida de la regulación integrada en educación física. *Revista de psicología del deporte*, *24*(2), 1-10.

Furco, A., & Norvell, K. (2019). What is service learning? Making sense of the pedagogy and practice. In P. Aramburuzabala, L. McIlrath & H. Opazo (eds.), *Embedding service learning in European higher education: Developing a culture of civic engagement* (pp. 13-35). Routledge.

Garay Ibáñez de Elejalde, B., López-de-Arana Prado, E., Vizcarra Morales, M. T., & Larrazabal Barrio, X. (2021). Análisis de una propuesta de Aprendizaje-Servicio en Educación Física dirigida a menores con experiencias adversas tempranas. *Contextos Educativos. Revista de Educación, 27*, 47–64. https://doi.org/10.18172/con.4592

García-Gutiérrez, J., & Corrales Gaitero, C. (2020). Las políticas supranacionales de educación superior ante la «tercera misión» de la Universidad: el caso del aprendizaje-servicio. *Revista Española de Educación Comparada,* (37), 256–280. https://doi.org/10.5944/reec.37.2021.27535

García, L., Gutiérrez, D., & Fernández, J. (2019). Emprendimiento docente en la transición de educación primaria a educación secundaria: Una propuesta desde la educación deportiva y el aprendizaje servicio. *Contextos educativos: Revista de educación*, (24), 113-121. http://doi.org/10.18172/con.3913

Ghufron, M. A., & Ermawati, S. (2018). The Strengths and Weaknesses of Cooperative Learning and Problem-based Learning in EFL Writing Class: Teachers and Students'

Perspectives. *International Journal of Instruction, 11*(4), 657-672. https://doi.org/10.12973/iji.2018.11441a

Gómez-Escobar, A., & Simón-Medina, N. (2022). Las Matemáticas pueden ser divertidas: proyecto de innovación de Aprendizaje-Servicio en la Universidad con alumnado de Educación Primaria. *Revista Complutense de Educación, 33*(3), 425-434. https://doi.org/10.5209/rced.74267

González, A., Peña, C., Prat, M., & Rodríguez, L. (2015). Una biblioteca para la Escuela Infantil 0-6. Una propuesta de Aprendizaje Servicio. *Procedia-Social and Behavioral Sciences, 196*, 142-148. http://dx.doi.org/10.1016/j.sbspro.2015.07.024

González-Sánchez, R., Medina-Salgado, S., Torrejón-Ramos, M., González-Mendes, S., & Alonso-Muñoz, S. (2022). The service-learning methodology as a facilitating tool for education for sustainable development (ESD). *REIRE Revista d'Innovació i Recerca EnEducació, 15*(2), 1–9. https://doi.org/10.1344/reire.38357

Gregori-Giralt, E., & Menéndez-Varela J. L 2014. El arte de aprender arte: El aprendizaje-servicio como instrumento para construir la identidad profesional del estudiante. Una propuesta para los estudios universitarios de arte. *Procedia-Social and Behavioral Sciences, 196*, 100-105. http://dx.doi.org/10.1016/j.sbspro.2015.07.018

Haynes, A. B., Haukoos, J. S., & Dimick, J. B. (2021). TREND reporting guidelines for nonrandomized/quasi-experimental study designs. *JAMA Surgery, 156*(9), 879-880. https://doi.org/10.1001/jamasurg.2021.0552

Himelein, M., Passman, L., & Phillips, J. M. (2010). College Teaching and Community Outreaching: Service Learning in an Obesity Prevention Program. *American Journal of Health Education, 41*(6), 368-378. https://doi.org/10.1080/19325037.2010.10599166

Honey, M. A., Pearson, G., & Schweingruber, H. A. (Eds.). (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research*. The National Academies Press. https://doi.org/10.17226/18612

Hwang, S., & Son, T. (2021). Students' attitude toward mathematics and its relationship with mathematics achievement. *Journal of Education and E-Learning Research*, *8*(3), 272-280. https://doi.org/10.20448/journal.509.2021.83.272.280

Lamoneda Prieto, J., Carter-Thuillier, B., & López-Pastor, V. M. (2019). Efectos de un programa de aprendizaje servicio para el desarrollo de prosocialidad y actitudes positivas hacia la inmigración en educación física. *Publicaciones*, *49*(4), 127–144. https://doi.org/10.30827/publicaciones.v49i4.11732

Lázaro-Cantabrana, J. L., Sanromà Giménez, M., Molero Aranda, T., & Sanz Benito, I. (2021). La formación en competencias digitales de los futuros docentes: una experiencia de Aprendizaje-Servicio en la universidad. *Edutec. Revista Electrónica de Tecnología Educativa, 78*, 54–70. https://doi.org/10.21556/edutec.2021.78.2243

Lobo-de-Diego, F. E., Monjas-Aguado, R., & Manrique-Arribas, J. C. (2024). Experiences of Service-Learning in the initial training of PE teachers. *Espiral. Cuadernos del Profesorado, 17*(35), 58-68. https://doi.org/10.25115/ecp.v17i35.9688

Luna González, E., Gezuraga Amundarain, M., & Legorburu Fernández, I. (2024). Aprendizaje-servicio universitario. Participación estudiantil, servicio y desarrollo de competencias. *Contextos Educativos. Revista De Educación*, (33), 239–260. https://doi.org/10.18172/con.5141

Martínez-Costa, S., Formoso, F., & Sanjuán.,A. (2018).Efectos y proceso dela metodología del aprendizaje-servicio en comunicación audiovisual. *International Journal of Educational Research and Innovation (IJERI), 9*, 72-89

Martínez-Usarralde, M. J., Tarazona Gil, C., & Carbonell Marqués, Á. (2024). Revisión sistemática del Aprendizaje-Servicio digital en instituciones de educación superior en Europa. *Revista mexicana de investigación educativa, 29*(103), 801-827.

Mayor, D. M. (2020). Aprendizaje-Servicio como estrategia metodológica para impulsar procesos de educación expandida. *Multidisciplinary Journal of Educational Research*, *10*(1), 47-74. https://doi.org/10.17583/remie.2020.4562

Mayor, D., & Guillén-Gámez, F. D. (2021). Aprendizaje-Servicio y responsabilidad social del estudiantado universitario: un estudio con métodos univariantes y correlacionales. *Aula Abierta*, *50*(1), 515–524. https://doi.org/10.17811/rifie.50.1.2021.515-524

Meyer, M., Neumayr, M. & Rameder, P. (2019). Students' Community Service: Self-Selection and the Effects of Participation. *Nonprofit and Voluntary Sector Quarterly 48*(6), 1162–1185. https://doi.org/10.1177/0899764019848492

Nunnally, J., & Bernstein, I. (1994). *Psychometric Theory.* (3rd ed.). McGraw-Hill, New York.

Ortega-Ruipérez, A., & Correa-Gorospe, J. M. (2024). Active methodologies to enhance blended learning: Exploring the perceptions of pre-service teachers. *International Journal of Instruction, 17*(3), 117-136. https://doi.org/10.29333/iji.2024.1737a

Ortega-Torres, W., Vahos, A. & Sánchez Medina, J. A. (2020). Escuela y comunidad. La experiencia colombiana con los Proyectos de Servicio Social Estudiantil. *International Journal of Educational Research and Innovation (IJERI), 14*, 304-323. https://doi.org/10.46661/ijeri.4986

Oviedo, H. C., & Campo-Arias, A. (2005). Aproximación al uso del coeficiente alfa de Cronbach. *Revista colombiana de psiquiatría*, *34*(4), 572-580.

Perry, C., Sampson, S., & Ayala-Diaz, M. (2023). Investigating Hispanic Preservice Teachers' Mathematics Anxiety, Attitudes, and Self-Efficacy. *International Journal of Educational Studies in Mathematics*, 10(3), 166-179. https://doi.org/10.17278/ijesim.1217360

Potts, A., & Schlichting, K. (2011). Developing Professional Forums that Support Thoughtful Discussion, Reflection, and Social Action: One Faculty's Commitment to Social Justice and Culturally Responsive Practice. *International Journal of Teaching and Learning in Higher Education*, *23*(1), 11-19.

Red de Aprendizaje-Servicio de las Universidades Catalanas (2019). *Guía 0. Hacer aprendizaje-servicio en la universidad*. ACUP. Retrieved from: https://www.acup.cat/sites/default/files/2019-06/GUI%CC%81A%200%20-%20Hacer%20aprendizaje%20servicio%20en%20la%20universidad.pdf

Saavedra, J. A., Ruiz, L., & Alcalá, L. (2022). Critical Service-Learning Supports Social Justice and Civic Engagement Orientations in College Students. *Michigan Journal of Community Service Learning*, *28*(1), 1-27. https://doi.org/10.3998/mjcsl.292

Santaolalla, E., Martín-Carrasquilla, O., & Urosa, B. (2025). Mejora de las actitudes hacia las matemáticas y la autoeficacia docente con Aprendizaje-Servicio y Gamificación. *Revista Complutense de Educación*, 36(3), 419-428. https://doi.org/10.5209/rced.96438

Schanke, A. (2022). Improving Mathematical Self-Efficacy of Preservice Elementary Teachers. *PRIMUS, 3*(33), 271-284. https://doi.org/10.1080/10511970.2022.2068092

Simarro, C., & Couso, D (2018). Visiones en educación STEAM: y las mates, ¿qué?. *Uno-Revista de Didáctica de las Matemáticas, 81*, 49-65

Stipek, D., Givvin, K. B., Salmon, J. M., & MacGyvers, V. L. (2001). Teachers' beliefs and practices related to mathematics instruction. *Teaching and Teacher Education, 17*(2), 213–226. https://doi.org/10.1016/S0742-051X(00)00052-4

Streiner, D. L. (1994). Figuring out factors: the use and misuse of factor analysis. *The Canadian Journal of Psychiatry, 39*(3), 135-140.

Sumarmi, Bachri, S., Baidowi, A., & Aliman, M. (2020). Problem-Based Service Learning's Effect on Environmental Concern and Ability to Write Scientific Papers. *International Journal of Instruction, 13*(4), 161-176. https://doi.org/10.29333/iji.2020.13411a

Valentini, M., & Sbarbati, I. (2024). The effects of interdisciplinary teaching between mathematics and physical education: A Systematic Review. *Formazione & Insegnamento*, *22*(S1), 83–93. https://doi.org/10.7346/-feis-XXII-01-24_11

Warsah, I., Morganna, R., Uyun, M., Hamengkubuwono., & Afandi, M. (2021). The Impact of Collaborative Learning on Learners' Critical Thinking Skills. *International Journal of Instruction, 14*(2), 443-460. https://doi.org/10.29333/iji.2021.14225a

Wilkerson, J. B. (2020). Cultivating a productive disposition towards mathematics by engaging in service-learning. *PRIMUS, 31*(8), 869-882. https://doi.org/10.1080/10511970.2020.1776803

Wong, K. L., Briffett-Aktaş, C., Kong, W. F. O., & Ho, C. P. (2023). The student voice for social justice pedagogical method: learning outcomes and challenges. *Active Learning in Higher Education, 26*(1), 25-39. https://doi.org/10.1177/14697874231176488

Zhenghui, W., Shiri, M., Baigutov, K., Ibragimov, A., Assembaiuly, Y., & Rabilova, Z. (2026). Improving the quality of ceramic teaching through a student-centered learning approach. *International Journal of Instruction, 19*(1), 195-214. https://doi.org/10.29333/iji.2026.19110a