







Influence of a Nautical Activity Programme on Success Rate in High School Students

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- A) conception and design of the study
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Abstract

This study examines the academic impact of a structured, nature-based intervention involving nautical activities in coastal environments. Implemented across two secondary schools in Huelva (Spain) as part of the Atlantic Youth Erasmus+ project, the programme engaged 230 students (46.08% female) over a seven-year period (2013–2020). A quasi-experimental interrupted time series (ITS) design was used to analyse shifts in key educational indicators – on-time graduation, dropout, grade repetition, and absenteeism – relative to provincial and regional trends. The findings reveal substantial improvements, particularly in graduation rates and dropout reduction. At CSE González de Aguilar, on-time completion rose from 56.3% to 64.5%, while dropout fell by 58.5%. CSE Guadiana saw an increase in graduation from 49.5% to 59.9%, with a more modest decline in dropout. A difference-in-differences analysis confirmed that these gains outpaced broader educational trends. The intervention's effects varied by context: dropout reduction was more pronounced in González de Aguilar, whereas improved retention was observed in Guadiana. Despite limitations related to follow-up duration and uncontrolled contextual factors, the results underscore the educational potential of immersive, nature-oriented learning, particularly in enhancing academic resilience and student engagement.

Keywords: Nature-based education, educational intervention, academic outcomes, marine environments, student engagement.

Introduction

Nature-based educational programmes - such as hiking, sailing, and other outdoor activities – have demonstrated notable benefits for the holistic development of students. These include improvements in psychophysical well-being, environmental connectedness, and prosocial behaviour (Beery et al., 2020). Such outcomes span across educational stages, from early childhood (Kiewra & Veselack, 2016) to secondary education (Spengler et al., 2017),

and have also proven beneficial for students with diverse abilities, enhancing inclusion and self-esteem (James & Williams, 2017). Learning in natural environments has been shown to strengthen pupils' sense of well-being and engagement, which are key factors for promoting sustained participation in schooling (Larson et al., 2011).

This pedagogical approach is grounded in Kolb's experiential learning theory (2014), which emphasises the transformative role of direct experience in the learning process. Here, "nature-based educational programmes"

refer to structured learning experiences conducted in natural settings – such as forests, rivers, or coastal areas – that integrate physical activity, environmental literacy, and curricular content via experiential methods.” This aligns with both outdoor and place-based learning frameworks, which advocate active engagement with local environments to enhance cognitive, social, and emotional development (Rickinson et al., 2004; Sobel, 2004).

Recent studies indicate that educational interventions in “blue spaces” – coastal or aquatic environments – can enhance awareness of marine ecosystems and promote pro-environmental attitudes (Britton et al., 2020; Zeppel, 2008). Nautical programmes situated within school contexts have been associated not only with gains in ecological knowledge (Medina-Rebollo et al., 2023), but also with enhanced motivation, collaboration, and engagement (Hignett et al., 2017). Typically, these initiatives combine classroom-based theory with practical outdoor components, such as sailing, fieldwork, and problem-solving, offering alternatives to traditional didactics (Silva et al., 2022).

Evidence suggests that such experiences can bolster intrinsic motivation and learning retention, particularly among students at risk of disengagement (Carrier et al., 2013; Duerden & Witt, 2010). By addressing the psychological needs of autonomy, competence, and relatedness (Ryan & Deci, 2000), nature-based activities can improve educational outcomes and foster resilience. The multidimensional benefits of water-based sports – physical, mental, academic, and social – have also been noted (Rocher et al., 2020), with emerging literature suggesting links between experiential engagement and educational attainment (Sadeghi, 2024).

Moreover, outdoor activities in natural environments, including aquatic ones, satisfy students’ essential psychological needs, such as autonomy, competence, and social connection, thus fostering motivation and improving educational outcomes (Ryan & Deci, 2000). In this sense, authors such as Rocher et al. (2020) indicated that water sports in blue spaces generate benefits in the physical, mental, educational, and social dimensions of children and adolescents, as well as a significant association between the effects on these dimensions.

These practical learning contexts not only contribute to the development of academic skills but also allow students to connect theoretical knowledge with its real-world application, facilitating greater retention of scientific concepts (Dillon et al., 2006; Williams & Dixon, 2013). Aquatic-based activities have proven motivating for students experiencing learning difficulties, improving their cognitive development, and offering a stimulating environment that promotes inclusion (Duerden & Witt, 2010; D’Amato & Krasny, 2011). Similarly, programmes such as school-based surfing (Silva et al., 2022) and multi-activity outdoor interventions (Hignett et al., 2017) have demon-

strated positive effects on personal well-being, social cohesion, and student perseverance in learning processes.

While the literature consistently highlights the positive influence of nature-based programmes on student well-being, motivation, and social-emotional development, less is known about their direct impact on academic performance outcomes. Most existing studies have focused on affective or behavioural variables, often overlooking objective academic indicators. There remains a gap in the empirical evidence regarding whether these interventions can improve measurable educational outcomes, such as completing Compulsory Secondary Education (CSE) on-time, reducing early school leaving, or retaining students who are at risk of disengagement but ultimately finish their studies within the expected timeframe (Barker et al., 2002). Addressing this gap is essential for understanding the full potential of nature-based educational interventions.

To address this gap in the literature, we hypothesised that students who participate in programmes related to the natural environment, more specifically nautical activities, will exhibit a reduction in grade repetition and early school leaving rates, as well as a higher completion rate of CSE within the established timeframe. These improvements are expected to be driven by key components of the intervention, such as direct contact with marine ecosystems, the physical and cooperative nature of sailing and coastal exploration, and the integration of environmental content with curricular subjects through experiential and interdisciplinary learning. These elements are likely to foster greater student engagement, sense of belonging, and academic persistence – especially among students at risk of disengagement from school. Therefore, this study aimed to evaluate the impact of an educational intervention from the Atlantic Youth project (Erasmus+ Programme) in the secondary schools of CSE González de Aguilar and CSE Guadiana, comparing their progress with provincial and Andalusian averages. Furthermore, the study sought to analyse the stability and consistency of the educational achievements attained through this intervention, providing evidence on the potential of nature-based programmes to improve outcomes, educational persistence and school absenteeism.

Methodology

Study Design

A quasi-experimental, interrupted time series (ITS) design was employed to assess the effects of the intervention on educational performance indicators over a seven-year period (2013–2020). This approach enabled the identification of temporal shifts in outcome measures before and during the intervention and allowed for comparisons with provincial and regional trends.

Participants and Settings

Between 2017 and 2020 (Table 1), a total of 230 students (46.08% female) from CSE González de Aguilar and CSE Guadiana (Ayamonte, Huelva) participated in the intervention, representing 8.45% of the overall student

body across both schools during this period. The combined school population totalled 2,724 students (47.61% female), while the schools represented approximately 3.64% to 3.93% of the province's secondary student population across the study years.

Table 1. Annual distribution of students participating in the Atlantic Youth project participants by school, gender, and representativeness within school and provincial populations (2017–2020)

Academic Year	School	Total Enrolment	Project Participants	Participants: Female participants	Participants– Male	% of schools in each project	Huelva Total Enrolment	% Huelva population
2017–2018	CSE González de Aguilar	288	25	12	13	8.68	23.958	.31%
	CSE Guadiana	584	50	22	28	8.56		
2018–2019	CSE González de Aguilar	297	20	7	13	6.73	24.368	.25%
	CSE Guadiana	607	40	18	22	6.59		
2019–2020	CSE González de Aguilar	305	30	14	16	9.84	24.710	.38%
	CSE Guadiana	643	65	33	32	10.11		

Note. The “% of Huelva Population” indicates the share of project participants (from both schools) relative to the total number of secondary students in the province each year. The percentage is shown only in the first row of each academic year.

More broadly, between 2013 and 2020, CSE González de Aguilar had 288 and 317 students (50.5% female), and CSE Guadiana had 561 students (50.3% female). At the provincial level, these schools represented between 3.64% and 3.93% of the total student population in Huelva, whose student population ranged from 23,057 to 24,710 students. These data allow contextualisation of the sample within a broader regional framework.

Theoretical Framework

The intervention was informed by Kolb's experiential learning theory (1984/2014), which posits that learning is optimised through cyclical processes of active experience, reflection, conceptualisation and application. Nautical and environmental activities provided real-world contexts for curricular engagement and enabled students to link abstract concepts with lived experiences.

Self-Determination Theory (Ryan & Deci, 2000) also underpinned the intervention, particularly its emphasis on fulfilling learners' psychological needs for autonomy,

competence, and relatedness. Outdoor, cooperative activities such as sailing closely align with these motivational constructs, potentially enhancing sustained educational engagement.

In addition, the programme adopted principles from place-based education (Sobel, 2004), situating learning within the coastal environment of Huelva. This approach aimed to foster ecological literacy, local relevance, and a sense of environmental stewardship among participants.

Taken together, these frameworks support the proposition that nature-based, interdisciplinary, and physically engaging interventions can enhance both academic persistence and socio-emotional development, particularly among students at risk of disengagement.

Data Collection and Indicators

Data were obtained from the Ministry of Educational Development and Vocational Training via the Andalusian Regional Government's transparency portal and from the two participating schools. The indicators analysed

included: (1) the percentage of students on-time graduation (i.e., completion without grade repetition); (2) early school leaving from CSE; (3) grade repetition without dropout; and (4) absenteeism rates. The data were compared with provincial (Huelva) and regional (Andalusian) data to assess representativeness.

Indicators were based on cohort analysis from the students' first year of enrolment. For instance, on-time graduation for the 2013/2014 cohort tracked students across the full CSE cycle. Absenteeism, however, was assessed annually to better capture year-by-year student engagement.

The four outcome variables were analysed for both the pre-intervention (2013/2014–2016/2017) and intervention (2017/2018–2019/2020) periods:

On-time CSE Graduation. The percentage of students who completed the CSE without repeating was used as an indicator of academic success and learning efficiency.

Early School Leaving. Students who dropped out before completing CSE, reflecting the intervention's effect on retention.

Grade Repetition without Dropout. Students repeating at least one year but completing CSE within four years, indicating academic resilience and institutional support.

Absenteeism. Percentage of students with unjustified absences per year, reflecting school engagement and potential risk of disengagement.

All indicators were drawn from official administrative records, part of the Andalusian academic monitoring system, to ensure reliability and cross-year comparability (Lyche, 2010; Salvà et al., 2019). Although not psychometric tools, these variables are operationally standardised across Spain and widely used in research on dropout and educational intervention effectiveness (Freeman & Simonsen, 2015; Medina-Rebollo et al., 2023), supporting their validity for evaluating student trajectories and academic performance.

While these metrics are robust, the study did not control for potential confounding factors, such as socioeconomic status, staff characteristics, or concurrent policy changes. Additionally, absenteeism, while informative, is best interpreted as a proxy for school engagement rather than academic performance. Recognising this distinction allows for a more nuanced understanding of how the intervention influences tangible outcomes and underlying behavioural dynamics.

Intervention Description

The intervention was implemented under the framework of the Atlantic Youth Erasmus+ project (agreement no. 2017-1-PTO1-KA201-035980) and aimed to promote interdisciplinary, experiential learning in marine environments. Coordinated by the Ayamonte City Council's Municipal Sports Board, the initiative included international partners from Portugal, Ireland, France, and the

United Kingdom. CSE González de Aguilar and CSE Guadiana formally joined the project in December 2017 for a three-year implementation period (2018–2020).

The intervention had two core components: local educational actions and transnational exchange experiences. This study focuses exclusively on the local component, which is directly linked to academic indicators. The intervention was structured into two core components:

1. **Local Actions.** Each academic year, all second-year students (approximately equivalent to 8th grade) participated in a series of educational workshops designed as interdisciplinary didactic units. These were held during school hours and aimed to integrate academic content with physical activity and environmental education. In total, four structured local activities were carried out each year, each addressing different dimensions of coastal and marine learning through experiential methods:
 1. **Activity 1: "Ports, Recreational and Fishing, Aquaculture, and Sailing".** Students engaged in introductory sailing sessions and explored cultural elements related to the sea, including types of fishing, marine species, and local maritime economic activities. Environmental awareness and conservation practices were incorporated throughout the project.
 2. **Activity 2: "Tidal Mills, Marshes, and Salt Pan Exploitation".** This session involved a cycling route to key ecological and historical locations, such as the local tide mill, marshlands and salt pans. Students examined human-nature interactions and local biodiversity.
 3. **Activity 3: "Cultural and Historical Heritage through the Fishing Industry and Canoeing".** Combining canoeing and urban hiking, this activity led students through emblematic sites linked to the town's fishing and canning industries, including the shipyard and fish market, linking heritage with physical activity.
 4. **Activity 4: "Coastal Knowledge, Conservation and Biodiversity, Paddleboarding".** Students participated in paddleboarding and coastal hiking, followed by a beach clean-up campaign. The waste collected was categorised and analysed collaboratively, encouraging critical thinking and environmental responsibility.

All workshops were designed to connect curriculum areas – particularly Natural Sciences, Geography, and Physical Education – with tangible, place-based learning experiences. Activities were facilitated by interdisciplinary teaching teams in coordination with local nautical clubs, environmental organisations, and municipal agencies. A facilitator's guide developed by the Erasmus+ consortium ensured consistency across sessions,

covering objectives, content, safety, logistics, and learning outcomes.

2. Transnational Meetings. Complementing the local component, a selected subgroup of 25 students per school joined peers from partner countries for a one-week exchange. These meetings were held in County Clare (Ireland, 2018), Moulin Mer (France, 2019), and – planned but cancelled due to the pandemic – in Viana do Castelo (Portugal, 2020). The selection of participants was based on informal teacher assessments of motivation, absenteeism risk and active engagement in local sessions. Although enriching, these transnational exchanges were excluded from the statistical analyses of academic indicators and are presented to illustrate the programme's outreach and intercultural scope.

Reproducibility and Transferability

The modular structure and curricular alignment of the intervention promote adaptability across diverse educational contexts. Although tailored to coastal towns, the methodology is transferable to inland regions with access to natural environments. The use of regular school hours and local partnerships ensured feasibility and sustainability, while open educational resources developed through the project supported further replication.

Data Analysis

First, a descriptive analysis of the educational indicators for CSE González and CSE Guadiana was conducted, comparing results between the pre-intervention period (2013/2014 to 2016/2017) and the intervention period (2017/2018 to 2019/2020). The indicators analysed were: the percentage of students graduating without repeating a year; the percentage of students leaving CSE; the percentage of students repeating a year but not dropping out before four years; and absenteeism rates. The standard deviation and coefficient of variation (CV) were calculated for each indicator to assess the stability of the results in both periods.

Given that this study involved the entire student population of both participating schools over the full period (2013/2014 to 2019/2020), inferential statistical tests (e.g., *t*-tests or Wilcoxon signed-rank tests) were deemed unnecessary and inappropriate. Such methods are designed to estimate sampling uncertainty and enable generalisation to larger populations, a concern not applicable here (Greenland et al., 2016). Instead, we employed descriptive statistics (means, standard deviations, CVs) and comparative approaches, most notably the difference-in-differences (DID) model, which are considered appropriate and sufficient when analysing complete population data (Biau et al., 2008).

Following this descriptive analysis, an internal temporal comparison was performed by calculating the average

of each indicator for the pre-intervention and intervention periods. This allowed for observation of the mean difference in indicators between the two periods, offering an initial insight into the intervention's effectiveness, both in each CSE and compared with provincial and Andalusian averages. Subsequently, the average annual growth rate of each indicator was calculated for the pre-intervention and intervention periods to assess the rate of change in results during the intervention period compared with previous years, identifying whether the CSE experienced an acceleration or deceleration in the improvement of results.

Finally, to estimate the net effect of the intervention, a DID model was used, a technique that measures the effect of a treatment over a specific period (Abadie, 2005). This analysis compared the differences in indicators between the pre-intervention and intervention periods in the CSE with the changes observed in the province, thus adjusting the effects of the intervention in the CSE for possible general trends in the province and obtaining a more precise local-level impact estimator.

The provincial and regional averages for Huelva and Andalusia were selected as reference benchmarks for evaluating the intervention's effects. These comparison groups were chosen for three main reasons: (1) their indicators follow the same definitions and formats as those of the participating schools, enabling consistent and standardised comparisons; (2) they represent the immediate and broader educational contexts in which the schools operate, thereby providing a meaningful point of reference for assessing the relative progress of each centre; and (3) they are part of the official academic monitoring systems used by the Andalusian Regional Government, ensuring high reliability, comparability and transparency. Although these groups do not constitute experimental controls in the strict sense, they serve as appropriate contextual baselines for applying DID analysis and identifying possible deviations associated with the implementation of the programme.

It is also relevant to clarify why the DID model was selected over other causal inference methods. DID is particularly appropriate when analysing policy or programme interventions using longitudinal data from multiple time points before and after the intervention, in conjunction with a suitable comparison context. In this study, the provincial and regional averages provide a baseline trend for educational indicators, enabling us to estimate the net effect of the intervention by contrasting changes within the schools against broader, pre-existing trends. Other causal approaches, such as propensity score matching or regression discontinuity, require either more granular individual-level data or a specific cutoff criterion – neither of which was applicable here. Although DID does not fully address all potential unobserved factors (e.g., socioeconomic influences or concurrent policy shifts), it offers a robust means of assessing whether the

observed variations exceed general trends and can be reasonably attributed to the intervention.

No formal statistical adjustments were made for potential differences in demographic or socioeconomic factors between the schools and the provincial and regional comparison groups. The analyses exclusively relied on raw, unadjusted administrative data. Although socioeconomic and demographic characteristics can influence educational outcomes, detailed individual-level data on these variables were not available within the scope of this study. Consequently, the findings should be interpreted with caution, considering the possible influence of the uncontrolled external variables.

Statistical analyses were conducted using R statistical software (v. 4.4.0) for Windows, which was also used to create the figures.

Results

Descriptives

The following section examines changes in the percentage of students who graduated without repeating a year, the school dropout rate, the rate of grade repetition without dropout, and absenteeism rates.

The descriptive analysis of educational indicators for CSE González de Aguilar and CSE Guadiana revealed significant variations between the pre-intervention and intervention periods (Table 2). CSE González de Aguilar's on-time graduation rate increased from 56.32% (SD = 6.53) before the intervention to 64.53% (SD = 4.62) during it. The CV decreased from 11.6% to 7.2%, suggesting greater stability in this indicator. CSE Guadiana also showed an increase, from 49.54% (SD = 4.57) to 59.88% (SD = 5.1), with a slight decrease in the CV from 9.2% to 8.5%. At the provincial and regional (Andalusian) levels, a moderate increase was observed, from 54.48% to 60.89% in the province and from 61.31% to 66.85% in Andalusia, with a reduction in variability in both contexts.

In the school dropout indicator (Table 2), CSE González de Aguilar showed a reduction in the average dropout rate, from 14.01% (SD = 6.43) to 5.82% (SD = 1.07), with a significant decrease in the CV from 45.9% to 18.4%, suggesting improved control over school retention. CSE Guadiana also showed a reduction, from 16.23% (SD = 2.14) to 13.61% (SD = 2.58), although with an increase in the CV from 13.2% to 19.0%. At the provincial and regional levels, the average dropout rates decreased from 11.74% to 9.65% and from 9.38% to 7.88%, respectively, with minimal changes in variability.

Table 2. Educational performance indicators: percentage of students graduating without repeating and school dropout rates in CSE González de Aguilar, CSE Guadiana, the province of Huelva, and Andalusia before and during the intervention period.

	Graduates without repeating				School dropout			
	CSE González	CSE Guadiana	Province	Andalucía	CSE González	CSE Guadiana	Province	Andalucía
Pre								
13/14	61.54	44.6	51.58	58.92	15.38	13.67	11.94	10.26
14/15	59.68	47.24	52.27	59.56	11.29	15.75	12.63	9.62
15/16	46.91	55	56.05	61.59	22.22	16.67	11.24	9.02
16/17	57.14	51.3	58.01	65.16	7.14	18.83	11.15	8.62
Mean	56.32	49.54	54.48	61.31	14.01	16.23	11.74	9.38
SD	6.53	4.57	3.07	2.81	6.43	2.14	.69	.72
CV	11.60	9.20	5.60	4.60	45.9	13.2	5.90	7.70
Inter.								
17/18	67.69	54.72	62.01	66.98	4.62	13.21	8.88	7.70
18/19	59.23	60	60.79	66.73	6.17	11.25	9.65	7.71
19/20	66.67	64.91	59.88	66.83	6.67	16.37	10.43	8.23
Mean	64.53	59.88	60.89	66.85	5.82	13.61	9.65	7.88
SD	4.62	5.10	1.07	.13	1.07	2.58	.78	.30
CV	7.20	8.50	1.80	.20	18.4	19.00	8.10	3.80

Note. Pre.: Pre-intervention; Inter.: intervention; ST: standard deviation; CV: coefficient of variation.

For the percentage of pupils who repeated without dropping out (Table 3), CSE González de Aguilar maintained a stable average rate of grade repetition without dropout, from 29.67% (SD = 5.22) to 29.64% (SD = 4.3), while the CV decreased from 17.6% to 14.5%. The CSE of Guadiana decreased from 34.24% (SD = 6.27) to 26.51% (SD = 6.96), and the CV decreased from 18.3% to 26.3%. At the provincial and regional levels, average repetition rates decreased from 33.78% to 29.45% in the province and from 28.81% to 25.27% in Andalusia, both with notable CV stability.

Regarding absenteeism (Table 3), CSE González de Aguilar showed a slight increase in the average absenteeism rate, from 1.13% (SD = .50) to 1.14% (SD = 1.23), accompanied by an increase in the CV from 44.61% to 107.8%, indicating greater instability in this indicator. CSE Guadiana maintained a very low average absenteeism rate, from .03% (SD = .03) to 0% during the intervention, with no variation in the CV due to the values being close to zero. At the provincial and regional levels, average absenteeism increased from .93% to 1.01% and from 1.22% to 1.28%, respectively, with an increase in variability observed mainly in Andalusia.

Table 3. Educational performance indicators: repetition without dropout and absenteeism rates in CSE González de Aguilar, CSE Guadiana, the province of Huelva, and Andalusia before and during the intervention period.

	Repetition without dropout				Absenteeism			
	CSE González	CSE Guadiana	Province	Andalucía	CSE González	CSE Guadiana	Province	Andalucía
Pre.								
13/14	23.08	41.73	36.48	30.82	1.57	.07	.87	1.17
14/15	29.03	37.01	35.1	30.82	.51	.00	.68	1.22
15/16	30.86	28.33	32.71	27.39	.93	.03	.84	1.18
16/17	35.71	29.87	30.84	26.22	1.51	.01	1.32	1.31
Mean	29.67	34.24	33.78	28.81	1.13	.03	.93	1.22
SD	5.22	6.27	2.50	2.37	.50	.03	.27	.06
CV	17.60	18.30	7.40	8.20	44.61	112.57	29.61	5.23
Inter.								
17/18	27.69	32.08	29.11	25.32	.88	.00	1.09	1.41
18/19	34.57	28.75	29.55	25.56	2.47	.00	1.13	1.51
19/20	26.67	18.71	29.69	24.94	.06	.00	.82	.93
Mean	29.64	26.51	29.45	25.27	1.14	.00	1.01	1.28
SD	4.30	6.96	.30	.31	1.23	.00	.17	.31
CV	14.50	26.30	1.00	1.20	107.80	.00	16.64	24.16

Note. Pre.: Pre-intervention; Inter.: intervention; SD: standard deviation; CV: coefficient of variation.

Internal Comparisons and Growth Rates

Comparing averages over time shows substantial shifts in the indicators. CSE González de Aguilar showed an 8.21 percentage point increase in the proportion of students graduating without repeating a year, while CSE Guadiana experienced a 10.34 percentage point increase. At the provincial and Andalusian levels, increases were 6.41 and 5.54 percentage points, respectively. Regarding school dropouts, CSE González de Aguilar's dropout rate fell by 8.19 percentage points, while CSE Guadiana saw a 2.62-point reduction. In contrast, the provincial and Andalusian levels dropped by only 2.09 and 1.50 points, respectively. In the repetition rate indicator, CSE

González de Aguilar experienced a slight decrease of .03 percentage points, while CSE Guadiana showed a decrease in 7.73 percentage points. At the provincial and Andalusian levels, the averages decreased by 4.33 and 3.54 percentage points, respectively. For absenteeism, CSE González de Aguilar increased by .01 percentage points, while CSE Guadiana reduced its average by .03 percentage points. At the provincial and Andalusian levels, increases were .08 and .06 percentage points, respectively.

Regarding average annual growth rates (Figure 1), the data reveal variations in the rate of change of the indicators.

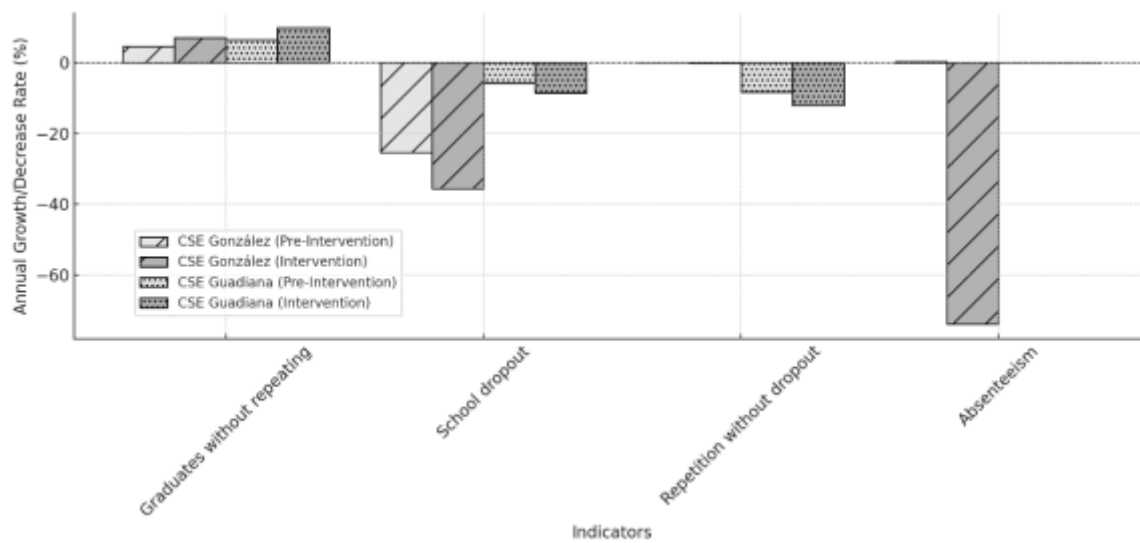


Figure 1. Annual growth and reduction rates in key indicators of CSE González de Aguilar and Guadiana during and before intervention

Figure 1 illustrates how average annual growth rates vary across the different indicators. For students graduating without repeating a year, CSE González de Aguilar experienced an annual growth rate of 7.04% during the intervention period compared to 4.64% in the pre-intervention period, while CSE Guadiana registered a rate of 9.94% versus 6.52% in the pre-intervention period. At the provincial and Andalusian levels, the rates were 5.72% and 4.42%, respectively, during the intervention period and 3.78% and 2.93%, respectively, in the pre-intervention period. In terms of school dropout, the CSE González de Aguilar exhibited an annual decrease of 35.55% during the intervention period compared with a 25.38% reduction in the pre-intervention period. CSE Guadiana registered an 8.43% reduction versus 5.70% in the pre-intervention period, while the provincial and

Andalusian levels showed reductions of 9.34% and 8.34% during the intervention compared to 6.33% and 5.64% in the pre-intervention period. For the repetition rate (excluding dropouts), CSE González showed an annual decrease of .05% during the intervention compared with a slight increase of .03% in the pre-intervention period. CSE Guadiana experienced a decrease of 12.01% versus 8.18% in the pre-intervention period, while the provincial and Andalusian levels showed rates of -6.63% and -6.34% during the intervention compared to -4.47% and -4.28% in the pre-intervention period. Regarding absenteeism, CSE González de Aguilar experienced an annual decrease of 73.9% during the intervention compared to a slight increase of 0.29% in the pre-intervention period, while CSE Guadiana maintained insignificant rates due to values close to zero (see Table 4).

Table 4. Annual growth and reduction rates in key indicators of CSE in González de Aguilar and Guadiana during and before intervention

	Graduates without repeating	School dropout	Repetition without dropout	Absenteeism
CSE González				
Pre-intervention	4.64%	-25.38%	.03%	.29%
Intervention	7.04%	-35.55%	-.05%	-73.90%
CSE Guadiana				
Pre-intervention	6.52%	-5.7%	-8.18%	.00%
Intervention	9.94%	-8.43%	-12.01%	.00%

Difference in Difference Estimates

Finally, the DID analysis estimated the net effect of the intervention on each indicator. For students who graduated without repeating a year, CSE González de Aguilar showed a net effect of 1.80 percentage points, and CSE Guadiana showed a net effect of 3.93 percentage points. For school dropout, the net effect was -6.10 percentage points at CSE González de Aguilar and -.53 percentage

points at CSE Guadiana. For repetition without dropout, CSE González de Aguilar had a net positive effect of 4.3 percentage points, while CSE Guadiana had a net negative effect of -3.4 percentage points. For absenteeism, the net effect of the intervention was -.08 percentage points at CSE González and -.11 percentage points at CSE Guadiana (see Figure 2).

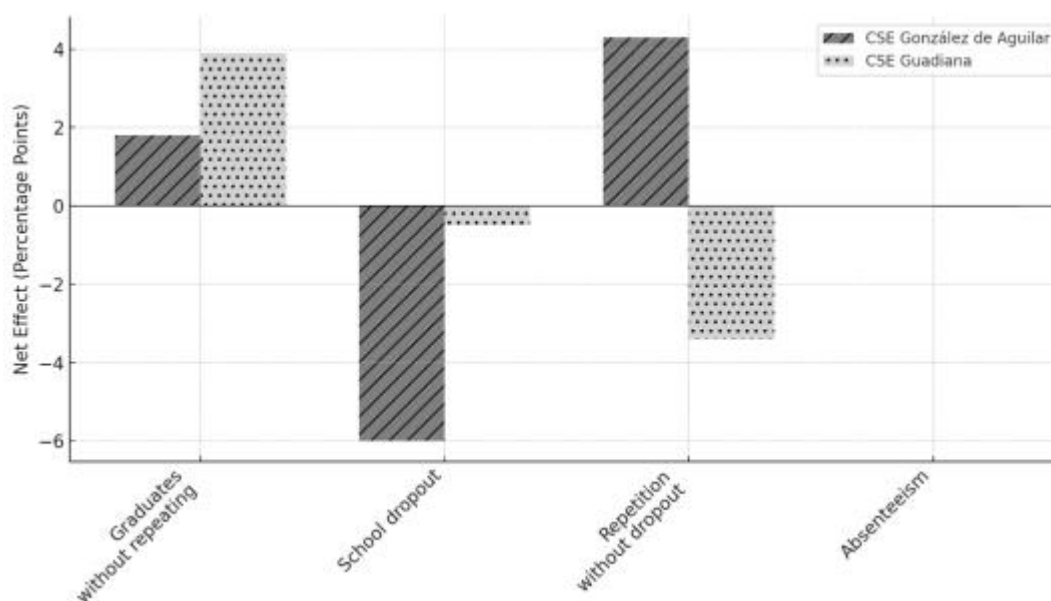


Figure 2. Net effects of interventions on educational indicators: A DID analysis for CSE González de Aguilar and CSE Guadiana

Discussion

This study aimed to evaluate the impact of a nature-based educational intervention implemented at CSE González de Aguilar and CSE Guadiana. The findings from both schools suggest that structured nautical activities can positively influence key academic indicators. Both CSE González de Aguilar and CSE Guadiana improved their rates of on-time graduation without repetition, showing more favourable trends than those observed at the provincial and regional levels. The slightly stronger improvement at CSE Guadiana may be linked to specific contextual conditions or ways in which the programme was implemented locally, which appear to have contributed to its greater impact. These findings suggest that incorporating outdoor experiential activities into the secondary school curriculum – especially in coastal areas – can help promote academic resilience and increase student engagement.

One possible explanation for the more notable progress at CSE Guadiana is its established culture of extracur-

ricular sports and ties with the broader community. According to the school staff, involvement included previous involvement in local aquatic programmes. In addition, the school appeared to benefit from stronger family engagement and formal partnerships with organisations like nautical clubs and municipal services. Although these elements were not measured systematically, qualitative insights suggest that school ethos, external support and available resources may have shaped the intervention's outcomes. These contextual differences illustrate how local dynamics can influence the success of educational initiatives based in nature.

It is noteworthy that the observed improvements stem from the descriptive data covering the entire student population of the participating schools. No inferential statistics were used because the study did not involve sampling. Therefore, while these trends are not statistically significant in the traditional sense, they do show positive shifts that are aligned with the programme's goals and existing research. It is likely that the nature-based strategies helped increase motivation, fostered a sense

of belonging, and reduced disengagement – factors that could help explain the outcomes. This interpretation aligns with prior studies on outdoor and experiential learning, which have demonstrated similar effects across a variety of educational contexts (Carrier et al., 2013; Ryan & Deci, 2000; Malone, 2008).

These results are consistent with prior studies, such as those by Salvà et al. (2019) and Medina-Rebollo et al. (2024), which emphasise the importance of fostering inclusive learning environments and refining educational structures to improve student outcomes. The literature underscores that curricular innovation and adaptive strategies are central to motivating students and enhancing engagement – key elements in reducing both grade repetition and dropout rates. Notably, Malone (2008) also demonstrated how outdoor education can provide a stimulating and inclusive context that enriches learning experiences and fosters academic achievement.

The intervention had a particularly notable effect on reducing dropout rates at CSE González de Aguilar, with CSE Guadiana also showing a positive trend, although less marked. These outcomes suggest that nature-based initiatives not only support student retention and reinforce students' sense of belonging and motivation. This observation is in line with earlier research that highlighted similar benefits in outdoor learning environments (e.g., Larson et al., 2011; Waite, 2017). In this context, Lyche (2010) noted that multifaceted education interventions – especially those grounded in enriched settings – can be crucial in addressing school dropouts and enhancing inclusivity.

Among the remaining enrolled students, grade repetition decreased significantly at González de Aguilar CSE and to a lesser extent at Guadiana CSE. This trend suggests a strengthened institutional capacity to support students at risk of academic failure. These findings align with foundational research by Rickinson et al. (2004), who synthesised evidence on the academic and motivational benefits of outdoor learning, and Sobel's (2004) advocacy for place-based education to deepen students' ties to their surroundings and improve educational outcomes. For example, Dillon et al. (2006), Hignett et al. (2017) and Britton et al. (2020) reported that structured programmes in blue spaces – such as coastal, estuarine or marine environments – can promote academic engagement, ecological literacy and socio-emotional development, particularly among students at risk of disengagement. Similarly, Silva et al. (2022) and Medina-Rebollo et al. (2023, 2024) provided empirical support for the integration of aquatic activities into formal schooling as a strategy to foster inclusion, intrinsic motivation, and academic persistence. This body of work reinforces the theoretical and practical relevance of the approach adopted in this study.

In addition to evaluating the intervention's impact, the progress of the CSE was compared with the provincial

and Andalusian averages. The data show that the increase in the percentage of students who graduated without repeating a year at both CSE levels was higher than that observed at the regional level. Improvements at CSE González de Aguilar and CSE Guadiana clearly surpassed provincial and regional growth. The difference-in-differences analysis confirmed a higher positive impact of the intervention at both schools, with CSE Guadiana showing a somewhat stronger effect.

Beyond descriptive comparisons, the Difference-in-Differences (DID) analysis offers a more robust estimation of the intervention's net effect by isolating school-level improvements from general trends occurring at the provincial and regional levels. This method strengthens the internal validity of the study because it attributes part of the observed gains to the intervention itself rather than to broader systemic improvements. The fact that both CSE González de Aguilar and CSE Guadiana showed positive DID coefficients for key indicators – particularly on-time graduation and school dropout – supports the interpretation that the programme had an added educational impact. In this sense, the DID results provide essential confirmatory evidence that complements the descriptive trends and reinforces the relevance of nature-based educational interventions in vulnerable contexts.

Dropout rates improved notably at CSE González de Aguilar were notably improved compared with the provincial benchmarks, suggesting a strong positive impact of the intervention. At CSE Guadiana, dropouts also decreased, although the magnitude was smaller. Studies such as Ernst & Theimer (2011) have shown that participation in educational Programmes in aquatic and natural environments has a positive effect on students' attitudes towards learning and conservation, which is reflected in the reduction of school dropout.

The intervention had different effects on repetition rates between schools. At the CSE González de Aguilar, repetition was associated with greater student retention in the educational system. Conversely, CSE Guadiana presented a less favourable outcome, with decreased repetition rates relative to provincial trends. The literature suggests that educational interventions in nature, especially in aquatic contexts, have the potential to foster engagement and perseverance in learning, contributing to greater school retention (Nisbet et al., 2009; D'Amato & Krasny, 2011; Ernst & Theimer, 2011).

Absenteeism at CSE González de Aguilar exhibited increased variability without significant changes in average attendance levels, whereas at CSE Guadiana, absenteeism remained consistently low and stable throughout the intervention. This change indicates that absenteeism showed greater instability during the intervention period at this school, which could reflect an oscillation in attendance levels rather than a sustained increase or decrease. On

the other hand, at CSE Guadiana, absenteeism remained under control, denoting remarkable stability in student attendance.

At the regional level, absenteeism showed a modest increase during the intervention period in both province and Andalusia, accompanied by contrasting trends in variability. Specifically, absenteeism became slightly more stable in the province but less consistent at the regional level, highlighting some instability during the intervention.

Overall improvement in the stability of academic results, particularly at CSE González de Aguilar. Graduation rates without repetition became more consistent at this school, whereas stability remained mostly unchanged at CSE Guadiana. At the regional level, Andalusia exhibited the highest stability in graduation rates without repetition, surpassing the consistency observed at both school centres. These observations support evidence indicating that Programmes in natural environments can improve not only academic performance but also consistency in retention and long-term student success (Beery & Jørgensen, 2018; Ernst & Theimer, 2011).

The dropout rates at the CSE González de Aguilar became notably more stable, contrasting with the increased variability observed at the CSE Guadiana. The stability of dropout rates also improved both provincially and regionally, reflecting overall enhanced consistency in these indicators across the wider contexts. The stability of repetition rates improved slightly at CSE González de Aguilar, while it decreased notably at CSE Guadiana, indicating divergent trends in educational consistency between schools. These results underscore the importance of education in natural environments as an effective strategy to foster a stable and meaningful educational experience, especially for students with difficulties (Malone, 2008).

This study has several limitations that should be acknowledged. First, the analysis was limited to two educational centres in a specific coastal municipality, which constrains the generalizability of the findings. Second, the intervention period was relatively short, preventing the evaluation of the long-term effects on academic outcomes. Third, the absence of random assignment and the use of administrative cohort-level data limited control over external factors that may have influenced the results independently of the intervention.

Several potential interference factors were not controlled for. These include students' socioeconomic backgrounds, professional experience, or teaching styles of staff members, the presence of parallel institutional initiatives or policy changes and differences in resource allocation across schools. The variability in absenteeism reporting and inconsistencies in school records may have also introduced noise into the data. Moreover, weather and logistical constraints inherent to outdoor and nature-based

programmes could have affected participation rates and the fidelity of implementation.

The absence of a direct comparison group using alternative educational approaches (e.g., classroom-based innovation or non-nautical experiential learning) further limits the ability to isolate the specific contribution of nature-based design. Finally, no long-term follow-up was conducted at the end of the intervention, making it difficult to assess whether the observed improvements were sustained over time.

These limitations suggest that caution should be exercised when interpreting the results. Further studies with broader samples, more rigorous control of external variables, and longitudinal follow-up are essential to strengthen causal inference and confirm the generalisability of the findings.

The intervention in a natural environment demonstrated a positive influence on student performance at both CSE levels, notably increasing the proportion of students who graduated without repetition and reducing school dropout, particularly at CSE González de Aguilar. These findings are consistent with previous research showing that nature-based experiences can enhance student motivation and engagement (Beery & Jørgensen, 2018), even though extended longitudinal follow-up would be necessary to capture their lasting effects (Malone, 2008). Given the positive net effects observed, especially in dropout reduction and academic consistency, nature-based interventions may serve as strategic levers in educational policy, particularly in socioeconomically vulnerable areas. This study adds to the growing body of literature advocating context-sensitive interventions and lays the groundwork for future research aimed at consolidating their impact across diverse educational environments.

These findings have relevant practical implications for schools and educational policymakers seeking to improve retention and academic success, particularly in socioeconomically vulnerable contexts. The integration of nature-based educational Programmes – such as aquatic or outdoor learning experiences – may serve as a complementary strategy to traditional curriculum delivery, enhancing student engagement, reducing dropout, and supporting on-time graduation. These Programmes can be implemented at relatively low cost in coastal or rural areas and offer added value by fostering motivation, responsibility, and teamwork through experiential learning. Furthermore, incorporating these strategies into school development plans can strengthen inclusion policies and reduce educational inequality. School leadership teams and regional education authorities can consider these findings when designing context-sensitive interventions that go beyond academic instruction to address students' social and emotional needs.

Conclusions

The results support the revised hypothesis, indicating that the intervention positively influenced academic performance at both CSE González de Aguilar and CSE Guadiana. Specifically, more students graduated on-time without repetition, and dropout rates declined – most notably at González de Aguilar. Additionally, the intervention appeared to stabilise educational indicators overall, suggesting an improvement in student engagement and retention. While provincial and regional trends were more moderate, the direction of change supports the idea that structured outdoor learning can enhance academic progress and promote a more supportive and inclusive educational environment.

Practical Applications and Policy Implications

The findings of this study offer meaningful insights for developing future interventions and guiding education policy, especially in contexts where academic disengagement or early school leaving is prevalent. The observed improvements in on-time graduation and reduced dropout suggest that nature-based programmes – particularly those implemented in blue spaces – can effectively complement traditional educational approaches, particularly in socio-economically disadvantaged areas.

These outcomes align with prior studies demonstrating the feasibility and impact of experiential, environment-centred learning (e.g., Britton et al., 2020; Dillon et al., 2006; Medina-Rebollo et al., 2023). To ensure sustained results, long-term institutional commitment, cross-sector collaboration (including partnerships with environmental or sports organisations), and structured follow-up systems are likely to be essential.

Adaptability is another key strength. Although the intervention was implemented in a coastal setting, its core components – experiential learning, environmental engagement, and physical activity – are transferable to other natural environments such as rivers, forests, and urban green spaces. Policymakers should consider integrating such approaches into school development plans and ensuring access to adequate resources, teacher training, and local partnerships to support their long-term success.

Ethics Approval and Informed Consent

The individuals who were interviewed for this study were provided with both oral and written information, and their consent was documented verbally and digitally archived. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of the University of Huelva, specifically from the Commission for Doctoral Studies Protocol Reference (protocol code Medina-Rebollo, 9 November 2023).

Competing interests

The authors declare no competing interest for any commercial associations or financial interests held by the authors.

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