American Behavioral Scientist. https://doi.org/10.1177/00027642251390865

American Behavioral Scientist

Advancing Environmental Sustainability through Education: Development and Validation of a Scale to Measure School–Family Collaboration

Journal:	*American Behavioral Scientist*
Manuscript ID	ABS-25-0062
Manuscript Type:	Accepted Article
Keywords:	school-family collaboration, environmental education, measurement scale, validation, educational sustainability
Abstract:	School-family collaboration is a key factor in education for sustainability. However, rigorous evaluation of this relationship has been scarcely addressed from an empirical perspective. This study aimed to design and validate a scale to measure school-family collaboration in the field of environmental education. Based on a conceptual review, four key dimensions were defined: strategies and communication, family participation, impact on ecological habits, and implementation barriers. Content validation was conducted using the Delphi method with a panel of 15 experts. The scale was subsequently administered to 531 participants (312 teachers and 219 family members) from educational centers in various regions of Spain. Exploratory and confirmatory factor analyses confirmed a robust internal structure (KMO = 0.841; CFI = 0.945; RMSEA = 0.062). Internal reliability, assessed through Cronbach's alpha coefficient, was high (total α = 0.91), with consistent values across all dimensions (α > 0.80). The results demonstrate that the scale has structural validity and empirical reliability, making it a useful tool for future research, institutional evaluation processes, and the development of educational policies focused on socio-environmental co-responsibility.

American Behavioral Scientist. https://doi.org/10.1177/00027642251390865

Advancing Environmental Sustainability through Education: Development and Validation of a Scale to Measure School–Family Collaboration

Belkis Rojas Hernández[I], Oscar Ulloa-Guerra [II], Andresa Sartor-Harada [III], Ricel Martínez-Sierra [IV] and Deysi Emilia García-Rodríguez [V]

Abstract

School-family collaboration is a key factor in education for sustainability. However, rigorous evaluation of this relationship has been scarcely addressed from an empirical perspective. This study aimed to design and validate a scale to measure school-family collaboration in the field of environmental education. Based on a conceptual review, four key dimensions were defined: strategies and communication, family participation, impact on ecological habits, and implementation barriers. Content validation was conducted using the Delphi method with a panel of 15 experts. The scale was subsequently administered to 531 participants (312 teachers and 219 family members) from educational centers in various regions of Spain. Exploratory and confirmatory factor analyses confirmed a robust internal structure (KMO = 0.841; CFI = 0.945; RMSEA = 0.062). Internal reliability, assessed through Cronbach's alpha coefficient, was high (total $\alpha = 0.91$), with consistent values across all dimensions ($\alpha > 0.80$). The results demonstrate that the scale has structural validity and empirical reliability, making it a useful tool for future research, institutional evaluation processes, and the development of educational policies focused on socio-environmental co-responsibility.

Keywords: school-family collaboration, environmental education, measurement scale, validation, educational sustainability

[I] Universidad de Valladolid, Spain, belkis.rojas23@uva.es
[II] Universidad Internacional de La Rioja, Spain, oscar.ulloa@unir.net
[III] Universidad Internacional de La Rioja, Spain, andresa.sartor@unir.net
[IV] Universidad Internacional de Valencia, Spain, ricel.martinez@professor.universidadviu.com
[V] Universidad Internacional Iberoamericana, México, deysi.garcia@unini.edu.mx

Corresponding author(s):
Belkis Rojas Hernández, Department of Sociology and Social Work at the Universidad de Valladolid.
Email: belkis.rojas23@uva.es

Introduction

School–family collaboration has been widely recognized as a key factor for students' educational success and for improving the quality of school processes. Numerous studies have shown that active and sustained family participation in school life fosters academic achievement, enhances students' socio-emotional development, and strengthens institutional cohesion. However, the analysis of this collaboration has often focused on general aspects of educational dynamics, without specifically addressing its role in critical thematic areas such as environmental education.

In a global context marked by the urgency of ecological challenges—such as climate change, biodiversity loss, and ecosystem degradation—environmental education emerges as a cross-cutting dimension of civic formation, aimed at promoting environmentally responsible attitudes and behaviors. For such education to be effective, it is not sufficient to simply integrate environmental content into the school curriculum; it is essential to establish participatory and inter-institutional processes that connect schools with their immediate social environment, particularly with families.

The relationship between schools and families in the field of environmental education entails not only the exchange of information but also the shared responsibility for fostering sustainable values and habits. This shared responsibility is, however, shaped by multiple factors, ranging from the institutional policies of schools to the working conditions and cultural backgrounds of families. Understanding and measuring how this collaboration is configured therefore requires specific instruments capable of capturing its complexity and enabling its systematic evaluation.

In Spain, environmental education is regulated and promoted through recent legal and strategic frameworks, such as the Climate Change and Energy Transition Act (2021), the Spanish Strategy for Education for Sustainability (EEES, 2021), and various regional environmental education programs, including the Andalusian Network of Eco-Schools, the Edukabide program in the Basque Country, and the School Agenda 21 initiatives in Catalonia and Navarre. These policies address contemporary issues such as the climate crisis, water management, biodiversity protection, circular economy, and emissions reduction—broadening the traditional focus of environmental education beyond school gardens or basic recycling. Integrating these topics into school–family relationships is essential to ensure that initiatives align with current socio-environmental needs and with the guidelines set by organizations such as UNESCO and the European Union on education for sustainable development.

Within this framework, the present study aims to design and validate a scale to measure school–family collaboration in environmental education, understood as a multidimensional process encompassing joint planning, communication, active participation, impact on students, and structural barriers that hinder it. To this end, a rigorous methodological process was followed, including the development of items based on conceptual categories, expert validation through the Delphi method, administration of

the instrument to a sample of teachers and families, and both exploratory and confirmatory factor analyses.

This work seeks to contribute to the fields of environmental education and the sociology of education by providing a useful tool for empirical research, institutional planning, and the formulation of public policies that promote sustainability from a participatory and inclusive perspective.

Conceptual Framework

In recent years, environmental education has gained prominence in Spain due to various factors, including the growing social awareness of climate change and the need to adopt sustainable measures in the educational sphere. Academic institutions have begun to incorporate strategies into their curricula aimed at raising students' awareness of the importance of sustainability and environmental stewardship. Furthermore, national and international legislative frameworks have promoted the implementation of educational policies focused on environmental training, emphasizing the need to prepare future generations to address the ecological challenges of the twenty-first century (Borsari & Mora, 2020).

The global environmental crisis underscores the urgency of integrating environmental education into school programs. Issues such as environmental degradation, depletion of natural resources, alarming levels of pollution, and uncontrolled population growth call for an educational response that actively involves both schools and families in promoting sustainable practices from early childhood.

In Spain, environmental education seeks not only to transmit theoretical knowledge about the natural environment but also to foster sustainable behaviors through active and innovative methodologies (Makrakis, 2017). In this regard, the use of participatory and collaborative methods has proven particularly effective in promoting environmental awareness and ecological responsibility among students (Herrera-Franco, Mora-Frank, & Carrión-Mero, 2023). These methodologies not only facilitate meaningful learning but also strengthen young people's commitment to environmental protection.

At present, the concept of educational sustainability is understood as a comprehensive framework that combines environmental literacy with civic engagement and social justice. According to UNESCO (2020), this vision incorporates not only scientific knowledge of environmental problems but also the acquisition of competencies to address them: critical thinking, cross-sector collaboration, and advocacy skills. Contemporary environmental education in Spain also integrates elements of the 2030 Agenda and the Sustainable Development Goals—particularly SDG 4 (Quality Education) and SDG 13 (Climate Action)—representing a qualitative leap from earlier approaches limited to awareness-raising or isolated activities.

Several studies have highlighted that family involvement in educational processes is essential for achieving meaningful and sustainable learning outcomes (Antúnez, 2004; Puyuelo, 1989). Collaboration between schools and families plays a central role in environmental education in Spain. Evidence shows that active family participation in school activities related to sustainability not only reinforces children's and adolescents' learning but also strengthens the link between home and school. Parents' involvement in

ecological projects—such as school garden management, recycling programs, and awareness campaigns—facilitates the internalization of sustainable habits in both domestic and school environments. Moreover, when educational activities are designed, played, or discussed jointly with parents or mentors, inquiry-based learning and social learning are enhanced (Horn et al., 2011; Kynigos & Yiannoutsou, 2018; Musick et al., 2021). These social and contextual connections contrast with the typical application of serious games for individual learning, underscoring the value of family interactions in consolidating environmental concepts (Banerjee & Horn, 2013; Banerjee et al., 2016).

From an educational perspective, environmental education should not be confined to the classroom; it must also integrate the family and the wider community. In this sense, the family plays an essential role in consolidating environmental habits and fostering an active commitment to sustainability (Garreta, 2020). Collaboration between schools and families in environmental education not only promotes the acquisition of ecological habits but also encourages active civic participation in protecting the natural environment.

One of the main gaps in research on the effectiveness of environmental education strategies in Spanish schools lies in the scarcity of longitudinal studies that could assess the long-term impact of such initiatives (Nedungadi, Menon, Gutjahr, & Raman, 2024). While existing research has documented positive short-term outcomes, there is a lack of empirical evidence demonstrating how environmental education influences students' ecological behavior in adulthood (Makrakis, 2017). Moreover, further analysis is needed regarding the influence of socioeconomic and cultural factors on the adoption of sustainable practices within the school context (Ma, Men, & Cui, 2020). The need for more robust research methodologies and the incorporation of interdisciplinary approaches emerges as a key priority for future studies (Herrera-Franco, Mora-Frank, & Carrión-Mero, 2023).

Another significant limitation is the lack of systematic evaluation of school–family collaboration programs in environmental education. There is a clear need to develop methodologies that can measure the actual impact of these initiatives on students' and families' habits and knowledge.

Given the growing importance of sustainability on the educational agenda, it is essential to continue exploring strategies to effectively integrate environmental education into both the school curriculum and the daily lives of families. This requires the design of more inclusive and participatory educational policies, as well as the strengthening of teacher training in active environmental learning methodologies. In this regard, future research should continue to focus on developing assessment tools capable of accurately measuring the impact of school–family collaboration on the formation of environmentally responsible citizens (Leal Filho et al., 2024).

Building on the conceptual foundations presented above, there is a clear need for a specific instrument capable of rigorously and systematically measuring collaboration between schools and families in the field of environmental education. This methodological requirement arises from the limited availability of validated scales that address this phenomenon comprehensively, incorporating both collaborative actions and their outcomes and barriers.

Methodology

• Item Development by Categories

The construction of the scale designed to measure school–family collaboration in the field of environmental education was carried out through a rigorous methodological process, structured around key theoretical categories derived from a review of specialized literature. The aim was to develop a valid, reliable, and applicable instrument for diverse educational contexts within the Spanish school system.

Four central dimensions were defined to organize the content of the instrument: (1) Collaboration Strategies, (2) Family Participation, (3) Impact on Ecological Habits, and (4) Implementation Barriers. These dimensions were operationalized through items specifically designed to capture behaviors, perceptions, and experiences related to environmental educational collaboration.

The item development process was conducted in the following phases:

1. Conceptual delimitation of the dimensions: Operational definitions were constructed based on national and international theoretical references, serving as the foundation for the formulation of indicators.
2. Initial drafting of items: For each dimension, between 6 and 9 items were generated, written in clear language and culturally adapted to the Spanish educational context. A balance between positively and negatively worded items was maintained to mitigate response bias.
3. Incorporation of control questions: Items were included to verify internal consistency and detect mechanical response patterns.
4. Response format: All items were presented using a 7-point Likert scale, with values ranging from 1 (strongly disagree / never / no impact) to 7 (strongly agree / always / maximum impact).

The decision to employ a 7-point Likert scale follows the criteria established by González-Martínez and Hernández (2020), who justify this format for its greater discriminative capacity, allowing for more sensitive detection of variations in responses without creating cognitive overload for participants. According to these authors, the 1-to-7 range offers an optimal methodological balance between analytical depth and ease of use, making it a suitable option for educational studies involving diverse stakeholders such as teachers and families.

This methodological approach facilitated the subsequent validation of the scale and contributed to ensuring its internal consistency, content validity, and applicability in the study of school–family collaboration in environmental education.

• Scale Validation through the Delphi Method

The validation of the scale designed to measure school–family collaboration in environmental education was conducted using the Delphi method, with the aim of ensuring the relevance, clarity, and consistency of its items. This procedure enabled the attainment of technical consensus among specialists in the field, thereby strengthening the instrument's content validity.

The validation process was carried out over three successive rounds, involving a panel of 18 experts in environmental education, pedagogy, sociology of education, and school–family relations. Expert selection criteria included a minimum of 10 years of experience in research or educational intervention in the field, as well as a competence coefficient (Kcomp) equal to or greater than 0.75.

The determination of each expert's competence coefficient was based on the approach proposed by Oñate-Martínez et al. (1988), which considers two components:

- Kc (Knowledge): Self-assessed on a scale from 0 to 10 and multiplied by 0.1.
- Ka (Argumentation): Determined from the assessment of the influence of the expert's knowledge and experience in relation to the evaluated topic.

The final calculation is expressed using the formula:

$$Kcomp = 0.5 \times (Kc + Ka)$$

The established competence ranges were as follows:

- $Kcomp \geq 0.80$: High competence
- $0.50 \leq Kcomp < 0.80$: Medium competence
- $Kcomp < 0.50$: Low competence (excluded from the panel)

Of the 18 initially selected experts, 15 met the required criteria—8 women and 7 men—who participated in all phases of the process.

First Round

Experts were asked to individually assess each item in terms of semantic clarity, conceptual relevance, and representativeness of its corresponding dimension. In addition, open-ended feedback was collected to suggest improvements or reformulations. Items with a mean score below 4 (on a 1–5 scale) in any of the criteria were flagged for revision.

Second Round

Based on the suggestions provided, 11 items were revised to improve their wording, precision, or alignment with the theoretical framework. This second version was re-evaluated by the same panel of experts. Content analysis techniques were applied to verify consistency between the dimensions and the proposed items. One item was eliminated due to low acceptance levels and thematic redundancy.

Third Round

In the final phase, the refined version of the scale—comprising 32 items distributed across four dimensions—was presented. Experts were asked to confirm the overall adequacy of the instrument. Consensus was high: 93% of the experts considered the scale to be relevant, clear, and coherent with the study's objectives.

Table 1 summarizes the characteristics of the experts who participated in the Delphi process, including their *Kc*, *Ka*, *Kcomp*, gender and years of experienc

Table 1. Expert Evaluation Based on Competence Coefficient and Experience

Expert	Kc	Ka	Kcomp	Years of Experience	Gender	Decision
E1	0.80	0.90	0.85	17	Female	Yes
E2	1.00	1.00	1.00	19	Male	Yes
E3	0.90	0.95	0.93	23	Female	Yes
E4	0.70	0.80	0.75	16	Male	Yes
E5	0.40	0.50	0.45	7	Male	No
E6	0.80	0.75	0.78	8	Female	No
E7	0.90	0.80	0.85	15	Female	Yes
E8	0.90	0.90	0.90	12	Female	Yes
E9	0.90	0.95	0.93	23	Male	Yes
E10	0.90	0.90	0.90	21	Male	Yes
E11	0.70	0.95	0.83	16	Female	Yes
E12	0.90	0.95	0.93	23	Female	Yes
E13	0.70	0.80	0.75	16	Female	Yes
E14	1.00	1.00	1.00	19	Male	Yes
E15	0.90	0.90	0.90	12	Male	Yes
E16	0.70	0.80	0.75	16	Male	Yes
E17	0.90	0.95	0.93	23	Female	Yes
E18	0.70	0.60	0.65	12	Male	No

The use of the Delphi method allowed for the refinement of the instrument from a collaborative and technical perspective, ensuring its content validity and structural coherence. This process strengthened the scientific foundation of the scale, guaranteeing its applicability in studies related to educational collaboration and environmental sustainability.

Context and Participants

The study was conducted within the Spanish educational system as part of a research project aimed at analyzing forms of collaboration between schools and families in promoting environmental education. The research was carried out between February and

June 2024 in public, semi-private (concertado), and private schools across different autonomous communities in Spain.

The inclusion of a diverse sample in terms of geography, institutional type, and socioeconomic background aimed to ensure data representativeness and allow a comprehensive analysis of collaborative practices across different school settings. The study was designed as an exploratory pilot, with the goal of validating the newly developed measurement scale and generating an empirical basis for future longitudinal or comparative research.

Participant Selection

A non-probabilistic, purposive sampling method was employed, targeting education professionals and families directly involved in environmental education activities within their schools. Participation was voluntary, and inclusion criteria ensured participants' active involvement in school environmental programs, projects, or strategies within the past two years.

The sample consisted of 531 participants, distributed as follows:

- Teachers: 312 professionals from various educational levels (Early Childhood, Primary, and Secondary Education) across 14 autonomous communities.
- Families: 219 parents of students enrolled in schools implementing environmental education initiatives.

The geographic distribution included schools located in Andalusia, Aragón, Castile and León, Castile-La Mancha, Catalonia, Valencia, Extremadura, Galicia, Canary Islands, Madrid, Murcia, Navarra, Basque Country, and Cantabria, enabling the collection of data from both urban and rural contexts.

Sociodemographic Characteristics

Participants exhibited considerable variability in terms of age, educational background, type of school, and professional or parental experience. Among teachers, 73.7% worked in public schools, 20.3% in private schools, and 6% in semi-private or other types of schools. Regarding educational level, 59.3% taught in Secondary Education, 22.9% in Primary, and 17.8% in Early Childhood Education.

Among families, 82.2% of parents reported that their children attended public schools, 16.4% semi-private schools, and 1.4% private schools. In terms of educational attainment, 46.6% had higher education, 23.3% vocational training, 17.8% completed secondary education, and 12.3% primary education or lower.

Ethics and Consent

All participants signed informed consent prior to the administration of the instrument, in accordance with the ethical principles outlined in the Declaration of Helsinki. Data confidentiality, respondent anonymity, and the right to withdraw at any time without

consequences were ensured. The study was approved by the ethics committee of the research institution.

Instrument Administration

Following the content validation process via the Delphi method, a pilot application of the designed scale was conducted to measure school-family collaboration in environmental education. The objective of this phase was to evaluate the empirical performance of the instrument, as well as its internal consistency and factorial structure.

The questionnaire was self-administered in two formats: digital (Google Forms) and paper-based, ensuring participation accessibility for teachers and families with technological or connectivity limitations.

The instrument was applied between March and April 2024, in coordination with school management teams and environmental project coordinators. Detailed instructions were provided alongside the questionnaire, explaining the study objectives, the voluntary and anonymous nature of participation, and the estimated time required to complete it (15–20 minutes).

The final instrument included:

- 32 items structured on a 7-point Likert scale, distributed across four theoretical dimensions: collaboration strategies, family involvement, impact on ecological habits, and barriers to implementation.
- Control questions strategically inserted to detect inconsistencies and enhance data reliability.
- Sociodemographic items, differentiated for teachers (educational level, type of school, years of experience) and families (educational level, occupation, type of school, number of children).

To optimize response rates, a two-week completion period was established, with reminders sent to participating schools and individual contacts who confirmed participation. The response rate was high, with 86.4% of distributed forms returned (n = 615).

Data collection was centralized by the research team, which verified questionnaire quality and excluded incomplete or inconsistent responses (n = 27). The final sample consisted of 531 valid questionnaires (312 teachers and 219 families), evenly distributed across the participating regions.

Data were subsequently coded and processed using SPSS v.24 for statistical analysis, including internal consistency testing (Cronbach's alpha), exploratory factor analysis (EFA), and confirmatory factor analysis (CFA) with support from AMOS v.24.

This phase allowed for the assessment of the instrument's feasibility in real educational settings and laid the groundwork for the subsequent stage of results analysis.

Results Analysis

- **Exploratory Factor Analysis (EFA)**

After administering the 32-item version of the instrument, an exploratory factor analysis (EFA) was conducted to identify the underlying structure of the scale and evaluate the empirical grouping of items into factors consistent with the proposed theoretical dimensions. This analysis enabled the assessment of the instrument's psychometric performance and informed adjustments to its design based on the results obtained.

Originally, the scale was conceptualized around five dimensions: collaboration strategies, family participation, school-family communication, impact on ecological habits, and implementation barriers. However, empirical analysis revealed a more compact and coherent structure, in which some items from the theoretical dimensions of strategies and communication loaded onto a single factor due to high collinearity. As a result of the EFA, four main factors were identified, leading to a theoretical reorganization of the instrument.

Prior to conducting the analysis, sample adequacy was verified using the Kaiser-Meyer-Olkin (KMO) measure, which yielded a value of 0.841, considered meritorious (Kaiser, 1974). Bartlett's test of sphericity was also significant ($\chi^2 = 2964.71$; $df = 496$; $p < 0.001$), confirming that sufficient correlations existed among the items to justify factor analysis.

The principal components method with Varimax rotation was employed, and a minimum factor loading of 0.50 was set as the inclusion criterion. Eigenvalues greater than 1 were also considered for factor retention. During this process, five items were removed due to loadings below the established threshold or ambiguous cross-loadings, reducing the instrument to 27 valid items grouped into four factors. These factors accounted for 62.3% of the total variance while maintaining the original conceptual logic of the instrument, supported by empirically justified regrouping.

Table 2. Rotated Component Matrix (Varimax) from the Exploratory Factor Analysis

Factor loadings ≥ 0.50 are shown in bold.

Item	F1: Strategies & Communication	F2: Family Participation	F3: Ecological Habits	F4: Barriers
I1. The school regularly informs about its environmental projects.	**0.78**	0.11	0.09	0.05
I2. There are fluid communication channels with families regarding environmental issues.	**0.74**	0.13	0.12	0.06
I3. Joint activities on sustainability are promoted.	**0.71**	0.21	0.16	0.08
I4. Family participation in environmental decision-making is encouraged.	**0.67**	0.32	0.13	0.09
I5. The school organizes environmental campaigns with family participation.	**0.69**	0.35	0.12	0.11
I6. Families participate in ecological events organized by the school.	0.22	**0.73**	0.17	0.10
I7. Families collaborate in environmental activities outside school hours.	0.18	**0.71**	0.15	0.13
I8. There is a family culture of environmental participation.	0.11	**0.69**	0.18	0.09
I9. Families propose ideas to improve school environmental education.	0.25	**0.68**	0.14	0.12

I10. Parents reinforce at home the habits learned at school.	0.19	**0.67**	0.25	0.11
I11. Students transfer what they learn about the environment to their family setting.	0.15	0.21	**0.75**	0.10
I12. Students apply sustainable habits outside the classroom.	0.12	0.18	**0.74**	0.13
I13. The school environmental program influences changes at home.	0.09	0.17	**0.72**	0.12
I14. The school promotes composting, recycling, and responsible consumption.	0.13	0.20	**0.70**	0.11
I15. Greater ecological awareness is observed in families after participation.	0.16	0.24	**0.68**	0.09
I16. School environmental initiatives generate community impact.	0.22	0.26	**0.66**	0.10
I17. Families face time-related difficulties to participate.	0.07	0.08	0.12	**0.73**
I18. The school does not always provide sufficient advance notice.	0.06	0.09	0.15	**0.71**
I19. Environmental activities are not a priority for many families.	0.11	0.06	0.14	**0.69**
I20. Some teachers lack environmental training.	0.10	0.13	0.11	**0.68**

I21. The socioeconomic environment hinders environmental participation.	0.12	0.07	0.13	**0.66**
I22. The language used in communications is not always clear.	0.13	0.09	0.10	**0.65**
I23. Environmental planning is carried out in coordination with families.	**0.66**	0.30	0.17	0.12
I24. Environmental meetings have active family representation.	**0.63**	0.34	0.12	0.10
I25. The school offers environmental training to families.	**0.62**	0.31	0.11	0.09
I26. Communication channels allow for real feedback.	**0.60**	0.28	0.14	0.11
I27. Families value the school's environmental efforts positively.	0.30	**0.59**	0.18	0.09

The exploratory factor analysis revealed a four-factor solution explaining 62.3% of the total variance of the instrument. The first factor, labeled *Strategies and Communication for Collaboration*, accounted for 23.1% of the variance; the second factor, *Family Involvement*, explained 16.5%; the third factor, *Impact on Ecological Habits*, represented 13.6%; and the fourth factor, *Implementation Barriers*, explained 9.1%. These results indicate a robust internal structure, where each dimension contributes significantly to the overall understanding of the construct under study.

- **Confirmatory Factor Analysis (CFA)**

To verify the structural validity of the scale and assess the fit of the factorial model identified in the exploratory analysis, a confirmatory factor analysis (CFA) was conducted using the maximum likelihood estimation method. This technique allowed for the evaluation of the proposed theoretical model against the empirical data and established the consistency of item clustering around the four latent factors.

The CFA was performed using AMOS v.24, based on the covariance matrix derived from the 531 valid questionnaires. A first-order hierarchical model was tested, consisting of four latent factors:

1. Strategies and Communication for Collaboration
2. Family Involvement
3. Impact on Ecological Habits
4. Implementation Barriers

Each factor comprised the items that had shown significant loadings in the EFA, and correlations between factors were freely estimated under the theoretical assumption that all factors form part of the general construct of school-family collaboration in environmental education.

- **Model Fit Indices**

To evaluate model fit, the indicators recommended by Hu and Bentler (1999) and Byrne (2010) were used. The results are presented in Table 3:

Table 3. Model Fit Indices from Confirmatory Factor Analysis

Index	Obtained Value	Acceptance Criterion
χ^2/df	2.73	< 3 (acceptable fit)
GFI (Goodness-of-Fit Index)	0.913	> 0.90 (good fit)
CFI (Comparative Fit Index)	0.945	> 0.95 (excellent fit, >0.90 good)
TLI (Tucker-Lewis Index)	0.932	> 0.90 (good fit)
RMSEA (Root Mean Square Error of Approximation)	0.062	< 0.08 (acceptable fit)
SRMR (Standardized Root Mean Square Residual)	0.049	< 0.08 (good fit)

The obtained values indicate that the proposed model fits the data adequately, both in absolute and incremental indices. The model faithfully reproduces the theoretical structure, supporting the construct validity of the instrument.

- **Factor Loadings and Convergent Validity**

Standardized factor loadings of the items ranged from 0.58 to 0.84, indicating a significant contribution of all items to their respective factors. Additionally, composite reliability (CR) and average variance extracted (AVE) were calculated for each factor, with the results presented in Table 4:

Table 4. Composite Reliability (CR) and Average Variance Extracted (AVE) by Dimension

Factor	CR	AVE
Strategies and Communication	0.89	0.58
Family Involvement	0.87	0.56
Impact on Ecological Habits	0.85	0.52
Implementation Barriers	0.82	0.51

All CR values exceeded the 0.70 threshold, and AVE values were higher than 0.50, indicating adequate internal reliability and convergent validity. These results support the conclusion that each dimension of the instrument consistently and accurately measures the construct it is intended to assess.

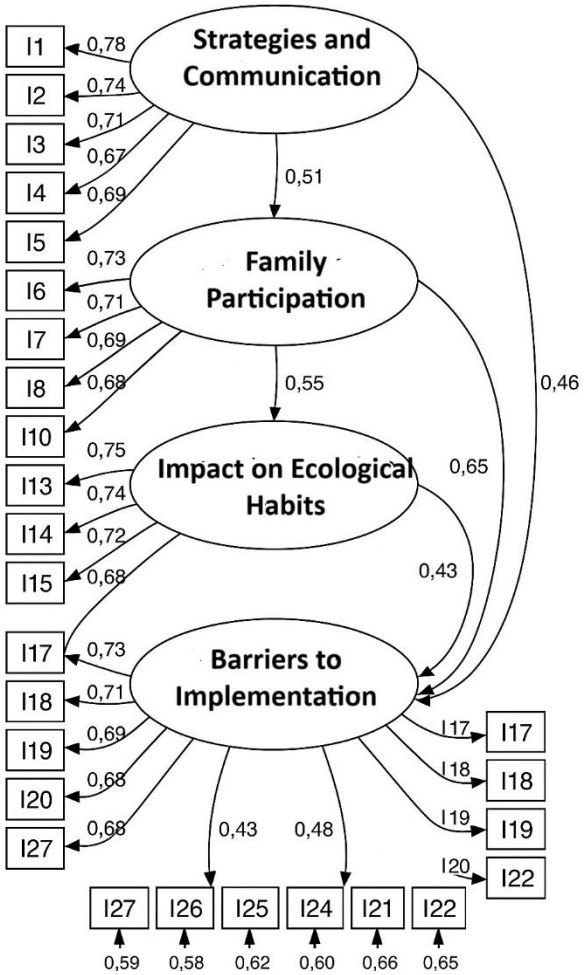
Factor Correlations

Correlations between the latent factors were moderate and statistically significant ($p < 0.001$), suggesting that, although each dimension represents a specific facet of environmental education collaboration, they all share a common core, consistent with the notion of an overarching underlying construct.

Overall, the CFA results provide robust empirical evidence of the instrument's internal structure and confirm its suitability for measuring perceptions and practices of school-family collaboration in environmental education contexts. This validated model establishes a foundation for its future application in institutional assessments, comparative studies, and educational improvement programs with a sustainability focus.

Figure 1 graphically presents the validated measurement model, including standardized factor loadings for each item and the correlations between factors. This representation allows an integrated visualization of the scale's internal structure and the behavior of its latent dimensions.

Figure 1. Confirmatory Factor Analysis Model of the School-Family Collaboration Scale in Environmental Education



- **Reliability Analysis and Item Correlations**

Reliability Analysis

An internal reliability analysis was conducted for each of the identified dimensions to assess the consistency of the items grouped within each factor of the validated model. Cronbach's alpha coefficient, widely accepted as an indicator of the degree of homogeneity among items composing a scale, was used for this purpose. The results showed values above 0.80 for all factors, indicating high internal reliability, as presented in Table 5.

Table 5. Cronbach's Alpha by Dimension

Dimension	No. of Items	Cronbach's Alpha
Strategies and Communication	9	0.89
Family Participation	6	0.87
Impact on Ecological Habits	6	0.85
Implementation Barriers	6	0.82
Total Scale (27 items)	27	0.91

These results indicate that the instrument is psychometrically sound and reliable, both at the overall level and for each specific dimension.

Item Correlations Within the Same Factor

In addition to reliability analysis, bivariate correlations among the items within each dimension were calculated to examine the internal homogeneity of each factor and to rule out potential issues of item overlap or excessive dispersion. Pearson correlation coefficients, recommended for this type of analysis in Likert-type scales, were used.

The results are presented below in four tables, differentiated by dimension.

Factor 1: Strategies and Communication for Collaboration

The nine items within this factor exhibited significant inter-item correlations ranging from r = 0.52 to r = 0.78. This indicates high internal consistency without redundancy, confirming that the factor reliably captures communicative and joint planning practices between school and family.

Table 6. Inter-Item Correlations for Factor 1: Strategies and Communication

	I1	I2	I3	I4	I5	I23	I24	I25	I26
I1	1	.61	.63	.58	.60	.55	.59	.52	.56
I2		1	.65	.60	.62	.53	.57	.50	.54
I3			1	.67	.66	.58	.60	.55	.57
I4				1	.63	.56	.58	.54	.52
I5					1	.59	.60	.51	.53
I23						1	.64	.57	.58
I24							1	.55	.56
I25								1	.54
I26									1

Factor 2: Family Participation

The items in this dimension showed correlation values between r = 0.53 and r = 0.66, indicating a consistent relationship among the different forms of participation measured, without excessive overlap. This reflects appropriate complementarity among passive, active, and proactive family participation.

Table 7. Inter-Item Correlations for Factor 2: Family Participation

	I6	I7	I8	I9	I10	I27
I6	1	.63	.58	.61	.59	.54
I7		1	.60	.64	.61	.55
I8			1	.62	.58	.53
I9				1	.66	.57
I10					1	.59
I27						1

Factor 3: Impact on Ecological Habits

In this dimension, correlations ranged from r = 0.59 to r = 0.75, reflecting high internal consistency and indicating that the items converge in measuring the degree of transfer of ecological learning from the school to students' family and social environments.

Table 8. Inter-Item Correlations for Factor 3: Impact on Ecological Habits

	I11	I12	I13	I14	I15	I16
I11	1	.68	.65	.62	.60	.59
I12		1	.67	.63	.61	.60
I13			1	.66	.62	.61
I14				1	.64	.63
I15					1	.66
I16						1

Factor 4: Implementation Barriers

This factor exhibited somewhat lower correlations (r = 0.50 to r = 0.66), though all were statistically significant ($p < 0.001$). This suggests adequate internal homogeneity despite the diversity of items, which address different types of obstacles (time, training, institutional factors, communication clarity).

Table 9. Inter-Item Correlations for Factor 4: Implementation Barriers

	I17	I18	I19	I20	I21	I22
I17	1	.60	.57	.55	.52	.50
I18		1	.61	.58	.56	.53
I19			1	.59	.57	.54
I20				1	.60	.55
I21					1	.56
I22						1

Overall, these results confirm that the items within each dimension exhibit adequate levels of internal correlation, without signs of redundancy or excessive dispersion, thereby reinforcing the structural coherence and convergent validity of each identified factor.

Discussion

The scale developed and validated to evaluate school-family collaboration in environmental education has proven to be a robust instrument, coherent with the conceptual framework and with strong psychometric indicators. High internal consistency ($\alpha > 0.80$ across all factors), adequate exploratory and confirmatory factorial structures, and the semantic clarity of the items indicate that the instrument is useful for both research purposes and educational interventions.

The final grouping of items into four dimensions—strategies and communication, family participation, impact on ecological habits, and implementation barriers—provides a functional synthesis of the phenomenon under study. These dimensions largely align with

theoretical categories identified in the literature, although the empirical process allowed for their reorganization in a way that is more coherent from an applied perspective. This outcome supports the positions of authors such as Antúnez (2004) and Garreta (2020), who advocate a dynamic and relational view of family participation, dependent on the school, cultural, and organizational context.

Furthermore, the decision to use a 7-point Likert scale—as suggested by González-Martínez and Hernández (2020)—enabled a more precise capture of nuances in perceptions, enhancing the sensitivity of the analysis. The high response rate (86.4%) and the regional and socioeconomic diversity of the sample validate the applicability of the instrument in diverse contexts within the Spanish educational system.

The relevance of this scale goes beyond its technical utility. From a socio-pedagogical perspective, it represents a significant advancement in the empirical operationalization of a relational and complex phenomenon, namely the collaboration between schools and families regarding environmental sustainability.

Each of the factors identified in the instrument is associated with key processes in the development of transformative education, as highlighted by Makrakis (2017) and Herrera-Franco et al. (2023):

- Strategies and communication for collaboration: reflects the quality of the relational bond between families and schools, based on transparency, bidirectionality, and trust. Its assessment allows the identification of the presence (or absence) of an institutional climate open to participation.
- Family participation: addresses active involvement of families not only in occasional activities but as part of a shared sustainability project. This aligns with the ecological education approach proposed by Horn et al. (2011), which emphasizes the inclusion of all social agents in the educational transformation process.
- Impact on ecological habits: relates to the behavioral dimension of environmental education and enables measurement of concrete effects in the domestic environment. Its inclusion responds to calls by authors such as Banerjee et al. (2016) to evaluate not only knowledge acquisition but also its transfer to everyday life.
- Implementation barriers: provides a critical perspective by highlighting structural factors that hinder family participation. These barriers, rather than being individual, reflect social inequalities, institutional limitations, and persistently hierarchical school models (Ishimaru, 2019).

The instrument can be used by school leadership teams, environmental program coordinators, educational researchers, and policymakers to diagnose situations, design interventions, or evaluate policy impacts. Its versatility and clarity make it a valuable tool to strengthen equity, inclusion, and the effectiveness of educational strategies aimed at sustainability.

The study findings underscore the need for an ecological, relational, and inter-institutional approach to understanding and enhancing environmental education. The lack of significant correlation between teacher and family assessments ($\rho = -0.088$, $p = 0.339$),

also observed in previous studies, suggests ongoing misalignments in communication and the establishment of shared objectives.

This discrepancy can be interpreted, as noted by Garreta (2020), as an expression of school participation models still centered on a top-down information logic rather than dialogue and co-responsibility. Overcoming this approach requires not only instruments like the one presented here but also cultural, institutional, and pedagogical transformations.

Moreover, the positive impact on ecological habits ($R^2 = 0.228$, $p < 0.001$) reported in the regression analysis confirms that family involvement has sustainable effects over time, particularly when continuous, as evidenced in the longitudinal follow-up subgroup. This conclusion aligns with international research (Priatmoko & Sholihah, 2023; Liu, 2023) highlighting the central role of the family in fostering responsible citizenship from early ages.

Finally, this study addresses a methodological need identified by authors such as Borsari and Mora (2020) and Leal Filho et al. (2024): developing empirical tools to evaluate participatory processes in educational sustainability. The validated scale represents, in this sense, an original and replicable contribution that can be adapted to other geographical contexts and educational levels, opening new avenues for research and educational action.

Conclusions

This study presents the development, validation, and application of a scale designed to measure school-family collaboration in environmental education, anchored in a clear theoretical framework and a rigorous methodological approach. The scale was constructed through a multi-phase process, including conceptual review, categorical development, expert validation, and empirical testing with teachers and families from diverse regions.

Factor analyses—both exploratory and confirmatory—revealed four core dimensions: strategies and communication, family participation, impact on ecological habits, and implementation barriers. These dimensions align closely with relational and ecological perspectives, underscoring the importance of sustainable, collaborative engagement in educational settings.

The instrument demonstrated excellent reliability, structural validity, and contextual relevance, positioning it as a versatile tool for educational research, institutional planning, and the evaluation of programs and public policies. Beyond its methodological rigor, the scale contributes sociopedagogically by operationalizing the complex concept of shared responsibility in environmental education. It emphasizes the necessity of fostering strong, horizontal connections among schools, families, and communities—an essential condition for advancing critical, transformative, and socially engaged educational models.

Several limitations should be noted. Using the same sample for both exploratory and confirmatory factor analyses may introduce validation biases. The cross-sectional design

prevents causal inference, and voluntary participation could entail self-selection bias. Additionally, while geographic and socioeconomic diversity was included, their effects were not explored in depth. Future research should extend the scale's application to international contexts, implement longitudinal studies to track changes over time, and examine differences by gender, age, and socioeconomic status.

In sum, this validated scale offers an innovative, replicable approach to measuring and enhancing school-family collaboration in environmental education, opening new pathways for research and practice in sustainability-focused pedagogy.

Declarations

Author Contributions

Conceptualization: Rojas Hernández, B. **Data curation:** Rojas Hernández, B.; Ulloa-Guerra, O.; Sartor-Harada, A.; Martíz-Sierra, R.; García-Rodríguez, D. E. **Methodology, software, validation, and formal analysis:** Rojas Hernández, B.; Ulloa-Guerra, O.; Sartor-Harada, A.; Martíz-Sierra, R.; García-Rodríguez, D. E. **Investigation and writing-original draft:** Rojas Hernández, B.; Ulloa-Guerra, O.; Sartor-Harada, A.; Martíz-Sierra, R.; García-Rodríguez, D. E. **Writing—review and editing:** Rojas Hernández, B.; Ulloa-Guerra, O.; Sartor-Harada, A.; Martíz-Sierra, R.; García-Rodríguez, D. E. All authors have read and agreed to the published version of the manuscript.

ORCID iDs

Belkis Rojas Hernández https://orcid.org/0000-0002-8374-5598

Oscar Ulloa-Guerra https://orcid.org/0000-0002-9505-7768

Andresa Sartor-Harada https://orcid.org/0000-0003-2045-7502

Ricel Martínez-Sierra https://orcid.org/0000-0001-6535-1723

Deysi Emilia García-Rodríguez https://orcid.org/0000-0003-1339-1664

Acknowledgments: We are grateful to Universidad de Valladolid for their constant support of the research.

Ethical Considerations: Approved by the Grupo de Investigación de Ciencias Sociales Aplicadas group, code.

Consent to participate: Written, informed consent was obtained from all participants.

Consent for publication: All participants in this research provided written informed consent to report the results of our study anonymously.

Funding: The author(s) received no financial support for the research, authorship, and/or publication of this article.

Competing interests: The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Availability of data and materials: The data supporting this study are available from the corresponding author upon reasonable request.

Referencias

Antúnez, S. (2004). Educación y familia: un binomio imprescindible. Barcelona: Gedisa.

Banerjee, A., & Horn, M. S. (2013). Ghost hunter: Parents and children playing together to learn about energy consumption. In: Proceedings of the 8th international conference on tangible, embedded and embodied interaction—TEI '14:267–274. https://doi.org/10.1145/2540930.2540964

Banerjee, A., Horn, M. S., & Davis, P. (2016). Invasion of the energy monsters: A family board game about energy consumption. In Proceedings of the 2016 CHI conference extended abstracts on human factors in computing systems (1828–1834). https://doi.org/10.1145/2851581.2892507

Boonk, G., Gijselaers, R., Ritzen, H., & Brand-Gruwel, S. (2018). Participación familiar y comunitaria en el éxito académico. Qualitative Research in Education, 7(3), 307-319.

Borsari, B., & Mora, C. (2020). Education reform through a systems approach for sustainable development. In W. Leal Filho et al. (Eds.), Quality education. Encyclopedia of the UN Sustainable Development Goals. Cham: Springer.

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (2nd ed.). Routledge.

Chen, G.-M., & Starosta, W. (2000). The development and validation of the intercultural communication sensitivity scale. *Human Communication*, 3, 1–15.

Espinosa-Díaz, Y., & Lloréns-Báez, L. (2015). Exploración de la capacidad de liderazgo para la incorporación de TICC en educación: Validación de un instrumento. *Revista Latinoamericana de Tecnología Educativa*, 14(3), 35–47. https://doi.org/10.17398/1695-288X.14.3.35

Garreta, J. (2020). Intervención educativa y sostenibilidad. Barcelona: Octaedro.

González-Martínez, E., & Hernández, B. R. (2020). Validación de una escala de mediaciones culturales en el contexto de proyectos socioculturales comunitarios. *Sociologias*, *22*, 194-227. http://dx.doi.org/10.1590/15174522-91231

Herrera-Franco, G., Mora-Frank, C., & Carrión-Mero, P. (2023). Sustainable development in Latin American higher education institutions. In W. Leal Filho et al. (Eds.), Sustainability in Higher Education.

Horn, M. S., Davis, P., Hubbard, A. K., Keifert, D., Leong, Z. A., & Olson, I. C. (2011). Learning sustainability: Families, learning, and next-generation eco-feedback technology.

In: *Proceedings of IDC 2011 - 10th International Conference on Interaction Design and Children*. https://doi.org/10.1145/1999030.1999051

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Ishimaru, A. (2019). From Family Engagement to Equitable Collaboration. *Educational Policy, 33*, 350-385. https://doi.org/10.1177/0895904817691841

Kynigos, C., & Yiannoutsou, N. (2018). Children challenging the design of half-baked games: Expressing values through the process of game modding. *International Journal of Child-Computer Interaction, 17*, 16–27. https://doi.org/10.1016/j.ijcci.2018.04.001

Leal Filho, W., Trevisan, L. V., Dinis, M. A. P., Ulmer, N., Paço, A., Borsari, B., Sierra, J., & Salvia, A. (2024). Fostering students' participation in the implementation of the sustainable development goals at higher education institutions. *Discover Sustainability*. https://doi.org/10.1007/s43621-024-00204-7

Liu, Y. (2023). Research on the Collaborative Education Mechanism of Family School Cooperation in Preschool Education. *Academic Journal of Humanities & Social Sciences*. https://doi.org/10.25236/ajhss.2023.062410

Ma, Y., Men, J., & Cui, W. (2020). Does environmental education matter? Evidence from provincial higher education institutions in China. *Sustainability, 12*(16), 6338. https://doi.org/10.3390/su12166338

Makrakis, V. (2017). Unlocking the potentiality and actuality of ICTs in developing sustainability-justice curricula and society. Knowledge, Culture, 5, 103–122.

Mawhinney, H., & Smrekar, C. (1996). Institutional Constraints to Advocacy in Collaborative Services. *Educational Policy, 10*, 480-501. https://doi.org/10.1177/0895904896010004004

Musick, G., Freeman, G., & McNeese, N. J. (2021). Gaming as family time: Digital game co-play in modern parent-child relationships. In: *Proceedings of the ACM on Human-Computer Interaction*, *5*(CHI PLAY), pp. 1–25. https://doi.org/10.1145/3474678

Nedungadi, P., Menon, R., Gutjahr, G., & Raman, R. (2024). Evaluating Holistic Education and Digital Learning model for advancing SDG4: A longitudinal mixed-effects modeling approach. Cogent Social Sciences, 10(1), 2299134. https://doi.org/10.1080/23311886.2023.2299134

Oñate-Martínez, N., Ramos-Morales, L., & Díaz-Armeso, A. (1988). Utilización del Método Delphi en la pronosticación: Una experiencia inicial. *Economía Planificada*, 3(4), 9–48. JUCEPLAN.

Priatmoko, S., & Sholihah, S. (2023). School, Parents, and Community Collaboration in Developing Student's Environmental Awareness. *JMIE (Journal of Madrasah Ibtidaiyah Education)*. https://doi.org/10.32934/jmie.v7i2.560

Proctor, R., Guell, C., Wyatt, K., & Williams, A. (2020). What is the evidence base for integrating health and environmental approaches in the school context to nurture healthier and more environmentally aware young people? A systematic scoping review of global evidence. *Health & Place, 64*, 102356. https://doi.org/10.1016/J.HEALTHPLACE.2020.102356

Puyuelo, M. (1989). La relación familia-escuela en la educación ambiental. Revista de Pedagogía, 42(5), 23-39.

Ramírez, M. C., Ruiz, J.-A., Torrente, G., & Rodríguez, Á. (2014). Desarrollo de una escala de estrés de aculturación en autóctonos. *Revista de Psicología Social: International Journal of Social Psychology*, 27(1), 55–67. https://doi.org/10.1174/021347412798844024

Tal, R. (2004). Community-based environmental education—a case study of teacher–parent collaboration. *Environmental Education Research, 10*, 523-543. https://doi.org/10.1080/1350462042000291047

UNESCO. (2014a). *Cómo medir la participación cultural. Manual del marco de estadísticas culturales de la UNESCO 2009 nº2*. Instituto de Estadística de la UNESCO.

UNESCO. (2014b). *Indicadores UNESCO de cultura para el desarrollo. Manual metodológico*. UNESCO.

Author Biographies

Belkis Rojas Hernández is a Professor in the Department of Sociology and Social Work at the University of Valladolid. She works at the "Duques de Soria" University Campus, Faculty of Education. Her research focuses on the sociology of education, school-family relationships, educational and community participation, rural development, and gender perspectives.

Oscar Ulloa-Guerra is a professor and researcher at the Universidad Internacional de La Rioja, Spain. He is accredited by ANECA-Spain as an Associate Professor. He has a Ph.D. in Education, a Master's degree in Community Development, and a Bachelor's degree in Psychology. He has 20 years of experience in higher education institutions in Cuba, Brazil, Spain, Mexico, and Puerto Rico. He currently works as a postgraduate lecturer and doctoral thesis supervisor. His main research areas include: inclusive and intercultural education, sex education, school coexistence, innovation and learning, ICT and education, and teaching methods in higher education.

Andresa Sartor-Harada is a teacher and researcher at the Universidad Internacional de La Rioja, Spain, accredited by ANECA-Spain as Profesor Contratado Doctor. PhD. in Education, Master's Degree in Educational Psychology, Bachelor's Degree in Pedagogy. Experience of 20 years in higher education in institutions in Brazil, Spain, Colombia,

Mexico and Puerto Rico. Currently works as a postgraduate teacher and director of doctoral theses. Main research interests: innovation and learning, educational technologies, artificial intelligence and didactics in higher education.

Ricel Martínez-Sierra is a teacher and researcher at the Universidad Internacional de Valencia, Spain. She holds a Ph.D. in Pedagogy from the Universidad de Oriente, Cuba, and a degree in Psychology from the same university. She currently works as a postgraduate lecturer and doctoral thesis advisor. Her main research areas include professional competencies, active methodologies, inclusive education, gender, health, and interculturality.

Deysi Emilia García-Rodríguez is a research professor at the Universidad Internacional Iberoamericana, Mexico. She holds a Ph.D. in Psychology from the Universidade Federal de Santa Catarina (UFSC), Brazil; a Master's degree in Educational Psychology from the Universidad de La Habana, Cuba; and a Bachelor's degree in Psychology from the Universidad Central "Marta Abreu" of Las Villas, Cuba. She has 25 years of experience in higher education institutions in Cuba, Brazil, Spain, Angola, Mexico, and Puerto Rico. Her main research areas include human development, professional training, inclusion, and health in educational contexts.