



## Preschool Teachers' Sustainability Literacy and Perspectives on Education for Sustainability: A Mixed Methods Study\*

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second author.*

### ABSTRACT

This explanatory mixed-methods study investigated preschool teachers' sustainability literacy and perspectives on Education for Sustainability (EfS). The quantitative phase involved 197 preschool teachers. Data were collected through a Sustainability Literacy Survey assessing sustainable development knowledge, attitudes, and EfS practices, together with questions on professional background and school conditions. The qualitative phase included semi-structured interviews with nine teachers selected purposively to represent variation in practice levels. Quantitative data were analyzed using descriptive statistics, difference tests, correlation, and regression analyses, while qualitative data were analyzed through qualitative content analysis. Quantitative findings showed that teachers' knowledge, attitudes, and practices were generally at a moderate level. Environmental and economic practices were reported somewhat more frequently than social practices. Most teachers had not received prior training in sustainability, and social media was the most frequently reported information source. Correlations among knowledge, attitudes, and total practice scores were low and non-significant, and neither knowledge nor attitudes significantly predicted reported practices. The qualitative findings helped explain these results by showing that teachers with stronger practices tended to define sustainability more holistically and embed it in everyday classroom routines, whereas others approached it more narrowly through environmental themes and occasional activities. Overall, the findings suggest that strengthening EfS in preschool settings requires not only awareness, but also institutional support, adequate resources, and professional development opportunities.

### KEYWORDS

Sustainability literacy; Early Childhood Education for Sustainability (ECEfS); preschool teachers; teacher practices; whole-school approach; mixed methods research.

## INTRODUCTION

Sustainability refers to a multidimensional approach grounded not only in the protection of natural resources but also in the promotion of justice, participation, responsibility, well-being, and equity. Early childhood, in turn, is regarded as a powerful starting point for EfS, as it is a critical period in which habits, values, and everyday life practices begin to take shape (Davis, 2009; Engdahl & Furu, 2022; Pramling Samuelsson & Kaga, 2008; Somerville & Williams, 2015; UNESCO, 2020).

The contemporary understanding of sustainability has evolved from the broader concept of sustainable development (SD), most associated with the Brundtland Report's emphasis on meeting present needs without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). In the years that followed, international frameworks increasingly positioned education as a central means of responding to sustainability challenges. In particular, the United Nations Decade of Education for Sustainable Development and related UNESCO frameworks emphasized the integration of sustainability into educational systems and highlighted its environmental, economic, and social dimensions (UNESCO, 2005). This emphasis was further strengthened through the Sustainable Development Goals (SDGs), especially Goal 4 on quality education, which reinforced the responsibility of educational institutions and educators in building more sustainable futures (United Nations, 2020). More recently, international policy documents have underlined the importance of engaging with sustainability from the earliest years of learning, thereby placing early childhood education (ECE) in a particularly important position within this broader agenda (Engdahl & Furu, 2022; UNESCO, 2021).

Within this broader educational agenda, sustainability literacy offers a useful conceptual framework for understanding how sustainability is taken up in educational contexts. Sustainability literacy can be understood as a multidimensional construct that includes what individuals know about SD, how they position themselves toward it, and how this understanding is reflected in practice. In this respect, sustainability literacy goes beyond awareness alone and provides a framework for examining the relationship among knowledge, attitudes, and practices in sustainability-related contexts. Building on this perspective, preschool teachers' sustainability literacy can be approached through their understanding of sustainability-related concepts, their attitudes toward SD, and the ways in which these are translated into EfS practices in the classroom (Bianchi et al., 2022; Chen et al., 2022; Kahrman Pamuk et al., 2026).

In ECE, this focus is particularly important because teachers are not only sources of information, but also key actors who shape classroom routines, mediate children's participation, and organize the everyday learning environments in which sustainability becomes visible. Thus, teachers' sustainability literacy is important not only for understanding what teachers know or believe about sustainability, but also for understanding how sustainability is interpreted, organized, and translated into everyday pedagogical practice in preschool settings (Borg et al., 2025; Güler Yıldız et al., 2017; Ohlsson et al., 2022; Ohlsson et al., 2024).

The literature shows that sustainability in ECE has long been addressed primarily through environmental education and nature-based activities, while the social and economic pillars have remained more limited (Ardoin & Bowers, 2020; Güler Yıldız et al., 2021; Hedefalk et al., 2015). At the same time, research on Early Childhood Education for Sustainability (ECEfS) emphasizes that this field cannot be limited to environmental protection activities alone; rather, it should be understood as a multidimensional area that also encompasses children's everyday experiences, participation, relationships, and social contexts (Güler Yıldız et al., 2021). More recent studies likewise indicate that effective EfS practices need to be considered together with teaching strategies, learning environments, school leadership, and whole-school processes (Borg et al., 2025; Karaarslan-Semiz & Sund, 2026; Ohlsson et al., 2022; Ohlsson et al., 2024; Ohlsson et al., 2025; Pramling Samuelsson et al., 2026). Research in the Turkish context further highlights that sustainability is co-constructed as a shared experience among children, parents, and teachers in early childhood (Güler Yıldız et al., 2017).

However, the literature also shows that developing positive attitudes toward sustainability or having awareness of the concept does not necessarily mean that these contents will be implemented effectively in classroom practice. Limited time, constraints related to materials and environmental facilities, insufficient pedagogical guidance, and lack of school and family support may all directly shape practice (Bascopé et al., 2019; Ginsburg & Audley, 2020; Parry & Metzger, 2023; Šindić & Vodopivec, 2025; Vodopivec & Šindić, 2025). At the same time, much of the existing research on sustainability in ECE has been conducted either qualitatively, focusing on teachers' views, or quantitatively, relying on self-report measures (Ardoin & Bowers, 2020; Ginsburg & Audley, 2020; Güler Yıldız et al., 2021; Hedefalk et al., 2015; Kahrman Pamuk et al., 2026; Ohlsson et al., 2024; Park et al., 2016). While sustainability literacy is increasingly recognized as a multidimensional construct encompassing knowledge, attitudes, and practices, quantitative models that examine these dimensions in an integrated manner are only beginning to emerge. Moreover, mixed methods studies that further illuminate these dimensions through teachers' narratives remain limited (Kahrman Pamuk et al., 2026; Somerville & Williams, 2015). In response to this gap, the present study examines preschool teachers' sustainability literacy and deepens the quantitative patterns through interviews with teachers representing different levels of reported practice.

Accordingly, the study addressed the following research questions:

1. What are the levels of preschool teachers' sustainability literacy in terms of knowledge, attitudes, and practices related to EfS?
2. Do preschool teachers' sustainability literacy levels in knowledge, attitudes, and practices differ according to their demographic and professional characteristics, sources of information, and related experiences?
3. How do teachers' perspectives help explain the patterns identified in the quantitative findings?

4. When considered together, what integrated insights do the quantitative and qualitative findings provide into preschool teachers' sustainability literacy and the factors shaping their EfS practices?

## METHOD

### Research design

This study employed an explanatory sequential mixed methods design. In the first phase, quantitative data was collected and analyzed to identify patterns in preschool teachers' sustainability literacy in relation to EfS practices. In the second phase, qualitative data were collected through teacher interviews to explain and deepen these findings (Creswell & Plano Clark, 2018; Ivankova et al., 2006). Accordingly, the Method section is organized into the quantitative phase, the qualitative phase, and their integration.

### Quantitative Phase

#### Participants

In the quantitative phase, convenience sampling, one of the non-probability sampling approaches commonly used in educational research, was employed (Cohen et al., 2018; Mulisa, 2022). The participants consisted of 197 preschool teachers working in a city in the Aegean region of Türkiye, who were accessible to the researchers and agreed to participate voluntarily.

**Table 1.**

*Demographic characteristics of the teachers (N = 197)*

| Variable                | Category                   | n   | %    |
|-------------------------|----------------------------|-----|------|
| Education level         | Bachelor's degree          | 135 | 68.5 |
|                         | Associate degree           | 34  | 17.3 |
|                         | Non-thesis master's degree | 21  | 10.7 |
|                         | Thesis master's degree     | 7   | 3.6  |
| Professional experience | 11–15 years                | 70  | 35.5 |
|                         | 5–10 years                 | 35  | 17.8 |
|                         | 16–20 years                | 32  | 16.2 |
|                         | 21 years and above         | 30  | 15.2 |
|                         | 1–5 years                  | 30  | 15.2 |
| Type of institution     | Public preschool           | 150 | 76.1 |
|                         | Private preschool          | 47  | 23.9 |
| Eco-Schools Program     | No                         | 188 | 95.4 |
|                         | Yes                        | 9   | 4.6  |

Most participants held a bachelor's degree (68.5%), and the largest group had 11–15 years of professional experience (35.5%). Of the teachers, 76.1% worked in public preschool settings, while 23.9% were employed in private preschools. In addition, only 4.6% of the participants reported that the Eco-Schools Program was implemented in their school.

### **Quantitative data collection tools and data collection process**

The quantitative data collection instruments consisted of two parts: a Personal Information Form created by the researchers in line with the purpose of the study, and a set of measures designed to assess teachers' sustainability literacy through the dimensions of knowledge, attitudes, and practices. In addition to basic demographic and professional information such as teachers' education level, years of professional experience, the type of institution in which they worked, and whether the Eco-Schools Program was implemented in their school, the Personal Information Form consisted of a total of 13 questions aimed at identifying sustainability-related variables, including whether they had received training in sustainability, their sources of information, participation in non-governmental organizations, childhood environment, the school's physical infrastructure, perceived administrative support, the main difficulties encountered in practice, and the frequency with which they included sustainability-related topics in their educational plans. Through this form, it was aimed to collect descriptive and comparative variables to be used in the interpretation of the quantitative findings.

The set of measures consisted of three scales developed by Kahrman Pamuk et al. (2026) within the Sustainability Literacy Survey and adapted to the context of early childhood education. This set of measures aims to assess teachers' sustainability literacy holistically through the dimensions of knowledge, attitudes, and practices. It includes the SD Knowledge Scale, the Attitude toward SD Scale, and the ECEfS Practices Scale. The knowledge and attitude scales were developed drawing on the study by Park et al. (2016), whereas the practices scale was developed drawing on Kahrman (2016); all scales were revised in accordance with the context of early childhood education and the environmental, sociocultural, and economic dimensions of sustainability. The SD Knowledge Scale consists of 28 items and is rated on a three-point Likert scale (1 = No, 2 = Uncertain, 3 = Yes). The Attitude toward SD Scale consists of 21 items and is rated on a five-point Likert scale (1 = Strongly disagree, 5 = Strongly agree). The ECEfS Practices Scale consists of 19 items and is rated on a five-point Likert scale (1 = Never, 5 = Always). In the same study, the knowledge and attitude scales were found to have a unidimensional structure, whereas the practices scale demonstrated a three-factor structure consisting of environmental, sociocultural, and economic practices. In addition, the reverse-coded items in the scales were recoded prior to the analyses. Within the pilot implementation, Cronbach's alpha coefficients were reported as .92, .86, and .74 for the SD Knowledge Scale, the Attitude toward SD Scale, and ECEfS Practices Scale, respectively. In interpreting the scores obtained from the scales, the score range of each scale was taken into account. Since the SD Knowledge Scale was rated on a three-point Likert scale, the mean scores obtained from this scale were interpreted as indicating low, moderate, or high levels. Since the attitude and

practices scales were rated on a five-point Likert scale, the mean scores obtained from these scales were interpreted according to the corresponding score intervals. The level descriptors reported in the Findings section were based on this classification.

The quantitative data collection process was carried out face to face. The researchers visited schools that were accessible to them and first met with school administrators and then with teachers; the necessary explanations about the purpose and scope of the study were provided to the teachers. The data collection forms were handed out to teachers who agreed to participate voluntarily, completed by the teachers in the school setting, and later collected by the researcher through follow-up visits to the schools. In addition, teachers who wished to participate in the qualitative phase to be conducted later were asked to write their contact information at the end of the Personal Information Form.

### **Analysis of quantitative data**

In the analysis of the quantitative data, descriptive statistics were first used to describe teachers' scores on the knowledge, attitude, and practice dimensions of sustainability literacy. Pearson's correlation coefficient and multiple linear regression analysis were then conducted to examine the relationships among these dimensions. For between-group comparisons, independent-samples t-tests and one-way analysis of variance (ANOVA) were used. All quantitative analyses were conducted using the SPSS statistical package (Field, 2018; Tabachnick & Fidell, 2019). Given the number of group comparisons conducted, these analyses were treated as exploratory and are interpreted with caution.

### **Qualitative Phase**

#### **Study group in the qualitative phase**

Purposeful sampling was used in the qualitative phase. In this process, maximum variation sampling and extreme/intensity sampling were used together (Creswell & Poth, 2018; Patton, 2015). The study group was selected from among the teachers who participated in the quantitative phase, based on their total practice scores on the ECEfS Practices Scale. Teachers were ranked according to their total scores on this scale, and those selected for the qualitative interviews were drawn from the highest 20%–25%, the middle range, and the lowest 20%–25% of the distribution. Accordingly, teachers were categorized as those with high practice scores (upper group), moderate practice scores (middle group), and low practice scores (lower group). Among the teachers who indicated that they were willing to participate in the qualitative phase and shared their contact information at the end of the Personal Information Form, a total of nine preschool teachers were included in the study group: three from the upper group (T1, T2, T3), three from the middle group (T4, T5, T6), and three from the lower group (T7, T8, T9). All participants were working in public preschool settings and held bachelor's degrees. Their years of professional experience were 8, 11, 17, 12, 21, 19, 14, 14, and 17, respectively. None of the participants reported having received direct training in EfS. However, the Eco-Schools Program was implemented only in the school where T1 worked, and this teacher stated that they had received an online training related to sustainability through the Eco-Schools Program. In this

way, interviews were conducted with teachers representing high, moderate, and low levels of practice to provide a more detailed explanation of the patterns identified in the quantitative findings.

### **Qualitative data collection instruments and data collection process**

In the qualitative phase, a semi-structured teacher interview form prepared by the researchers was used as the data collection instrument. Semi-structured interviews were preferred because they allow for the generation of comparable data around common themes while also making it possible to explore participants' experiences in depth (Creswell & Poth, 2018; Merriam & Tisdell, 2016). The interview form was developed to provide an explanatory account of the quantitative findings through teachers' perspectives, and the questions were constructed in line with the prominent findings from the quantitative phase, the purpose of the study, and the relevant literature. In addition, the draft interview form was reviewed by experts in early childhood education and Education for Sustainability to evaluate the relevance, clarity, and scope of the questions in relation to the study aims. Based on their feedback, minor revisions were made to improve the wording and comprehensibility of several questions before the pilot implementation. The form consisted of three warm-up questions designed to identify participants' years of professional experience, the type of institution in which they worked, and whether an Eco-School or a similar initiative was implemented in their school; seven open-ended main questions addressing teachers' perceptions of sustainability, how they defined EfS, their classroom practices, physical conditions, the barriers they encountered, the support they needed, and their personal life habits; and one closing question. Each main question was accompanied, where necessary, by probing questions intended to elicit more detailed information. In this context, the interview form included questions such as, for example, "How do you define the concept of sustainability?", "Do you see EfS in preschool as a topic/theme, or as an approach/way of life?", "How do you include sustainability-related practices in your classroom?", and "What kinds of support do you think you need to strengthen your EfS practices?" The interview form was pilot tested with two preschool teachers prior to the data collection process.

During the qualitative data collection process, teachers who had indicated at the end of the Personal Information Form in the quantitative phase that they were willing to participate in the interviews were contacted using the contact information they had provided. The interviews were conducted individually in an online setting. Before each interview, the purpose and scope of the study were explained again to the participants, they were reminded that participation was voluntary, and their consent for audio recording was obtained. The interview form indicated that each interview would take approximately 20–35 minutes, and the data collection process was carried out accordingly. The audio recordings obtained during the interviews were subsequently transcribed, and the teachers' names were kept confidential and replaced with codes (T1, T2, ...) to prepare the data for analysis.

### **Analysis of qualitative data**

The qualitative data were analyzed through qualitative content analysis in line with the explanatory sequential mixed methods design, with the aim of better understanding and explaining the results that emerged from the quantitative findings (Creswell & Poth, 2018; Schreier, 2012). In this process, the prominent findings from the quantitative phase and the topics included in the interview form in connection with these findings were taken as the basis. In this respect, particular attention was paid to how teachers defined sustainability and EfS, their classroom practices and the frequency of these practices, physical conditions, the barriers they encountered, the support they needed, and their personal life habits.

In the analysis process, the interview transcripts were first read repeatedly, after which salient statements were coded. Similar codes were then brought together, subthemes were developed, and, in the final stage, broader themes were identified. The coding process was based on identifying meaningful statements that stood out in the data and evaluating similar content together (Saldaña, 2021). To support the consistency of the coding process, a portion of the interview transcripts was independently coded by a second researcher. Inter-coder reliability was calculated using the formula proposed by Miles, Huberman, and Saldaña (2014), and was found to be 87%. This result indicates that an adequate level of consistency was achieved in the coding process.

As a result of the analysis, the data were organized under four themes: (1) how teachers made sense of sustainability, (2) the place of EfS in the classroom and the way it was implemented, (3) the supports and constraints shaping practice, and (4) teachers' personal awareness, their role as role models, and their need for practice-oriented support. Table 2 presents the conceptual framework used in qualitative data analysis.

### **Integration of the Quantitative and Qualitative Phases**

In this study, the qualitative phase was planned to explain and deepen the patterns identified in the quantitative findings. In an explanatory sequential mixed methods design, one of the primary ways of achieving integration is for the findings obtained in the first phase to inform participant selection and the data collection process in the second phase (Fetters & Tajima, 2022). Accordingly, practice scores obtained in the quantitative phase were considered in participant selection, and the interview questions were developed based on the key issues highlighted in the quantitative findings. In the final stage, the quantitative and qualitative findings were interpreted together to develop a more holistic understanding of EfS in preschool. Since mixed methods research emphasizes the importance of explicitly demonstrating the relationship between the quantitative and qualitative phases and showing how this relationship contributes to the study, the integration process is presented in Table 3 (Fetters & Freshwater, 2015; Fetters & Molina-Azorin, 2019).

### **Credibility and Trustworthiness**

To support credibility in the qualitative phase, the findings were supported with direct participant quotations, and the analysis process was described in detail. In addition, the



preparation of the interview questions in line with the quantitative findings, the research objectives, and the relevant literature strengthened the alignment of the data collection process with the research problem. In qualitative research, thick description, a transparent analysis process, and direct quotations are widely recognized as practices that enhance credibility and trustworthiness (Creswell & Poth, 2018; Merriam & Tisdell, 2016).

### Ethical Considerations

Prior to the study, ethical approval was obtained from the Research Ethics Committee of the Institute of Educational Sciences at Hacettepe University (dated 28.05.2024, document no. E-51944218-050-00003559753).

## FINDINGS

In this section, the findings of the study are presented in line with the explanatory sequential mixed methods design and organized according to the research questions. First, the quantitative findings related to the levels of preschool teachers' sustainability literacy and the differences across demographic, professional, and contextual variables are presented. These are then followed by the qualitative findings used to explain and deepen the quantitative results, and finally by an integrated interpretation of the quantitative and qualitative findings.

### RQ1. Levels of Preschool Teachers' Sustainability Literacy

The findings obtained from the set of measures indicate that teachers' levels of sustainability-related knowledge, attitudes, and practices were generally moderate.

**Table 4.**

*Descriptive statistics for the Sustainability Literacy Survey scores*

| Scale / Subdimension             | n        | M    | SD   | Min  | Max  | Scale score range |
|----------------------------------|----------|------|------|------|------|-------------------|
| SD Knowledge (Total)             | 197      | 1.75 | 0.15 | 1.25 | 2.14 | 1–3               |
| SD Attitude (Total)              | 197      | 3.47 | 0.27 | 2.71 | 4.29 | 1–5               |
| ECEfS Practices<br>Environmental | –<br>197 | 3.07 | 0.39 | 1.89 | 4.00 | 1–5               |
| ECEfS Practices – Social         | 197      | 3.04 | 0.47 | 2.00 | 4.33 | 1–5               |
| ECEfS Practices – Economic       | 197      | 3.22 | 0.65 | 1.25 | 4.75 | 1–5               |
| ECEfS Practices (total)          | 197      | 3.09 | 0.26 | 2.42 | 3.74 | 1–5               |

As shown in Table 4, teachers' mean score for SD knowledge was 1.75 (on a 1–3 scale). This finding indicates that teachers' levels of knowledge regarding SD were generally moderate. Teachers' mean score for attitudes toward SD was 3.47 (on a 1–5 scale), suggesting that their attitudes were generally at a moderately positive level. The mean total score for EfS practices was 3.09, which suggests that teachers reported their classroom sustainability practices at a moderate level. Although the practice subdimensions were close to one another, the mean scores for economic ( $M = 3.22$ ) and environmental practices ( $M = 3.07$ ) were relatively higher

than the mean score for social practices ( $M = 3.04$ ). This pattern suggests that economic and environmental practices were reported somewhat more frequently than social practices.

When the relationships among the variables were examined, no statistically significant relationship was found among knowledge, attitude, and practice scores related to sustainability.

**Table 5.**

*Pearson correlations among the scale scores ( $N = 197$ )*

| Variable                   | 1    | 2    | 3 |
|----------------------------|------|------|---|
| 1. SD Knowledge            | —    |      |   |
| 2. SD Attitude             | -.02 | —    |   |
| 3. ECEfS Practices (total) | .08  | -.05 | — |

As shown in Table 5, the correlations among SD knowledge, SD attitudes, and total ECEfS practice scores were low and not statistically significant.

**Table 6.**

*Multiple linear regression results predicting total practice scores ( $N = 197$ )*

| Predictor            | B      | SE(B) | $\beta$ | t     | p      | Lower 95% CI | Upper 95% CI |
|----------------------|--------|-------|---------|-------|--------|--------------|--------------|
| Constant             | 2.992  | 0.325 | —       | 9.21  | < .001 | 2.351        | 3.633        |
| SD Knowledge (Total) | 0.143  | 0.125 | .08     | 1.15  | .253   | -0.103       | 0.390        |
| SD Attitude (Total)  | -0.044 | 0.068 | -.05    | -0.64 | .522   | -0.177       | 0.090        |

Note. Dependent variable: Practices–Total. Model fit:  $R^2 = .009$ , adjusted  $R^2 = -.001$ ,  $F(2, 194) = 0.88$ ,  $p = .418$

According to the multiple linear regression model predicting total practice scores, the model was not statistically significant,  $F(2, 194) = 0.88$ ,  $p = .418$ ,  $R^2 = .009$ . Neither SD Knowledge ( $\beta = 0.08$ ,  $p = .253$ ) nor SD Attitude ( $\beta = -0.05$ ,  $p = .522$ ) significantly predicted practice scores (Table 6). This finding indicates that knowledge and positive attitudes do not always translate directly into practice.

## **RQ2. Differences According to Demographic, Professional, and Contextual Variables**

When indicators more directly related to sustainability were examined, it was found that the majority of the teachers had not previously received any training in sustainability/SD (78.2%). Among those who reported having received such training, the most common sources were non-governmental and environmental organizations (44.2%), followed by in-service training provided by the Ministry of National Education (MoNE) (25.6%), Eco-Schools practices (16.3%), and other channels (14.0%). The teachers reported that they most frequently accessed information about sustainability through social media (44.2%), followed by news bulletins and newspapers (27.4%), training/seminars provided by the MoNE or other official institutions (24.4%), non-governmental organizations (23.9%), and university education/academic

publications (14.7%). It was also found that only 4.6% of the institutions in which the participants worked were eco-schools, that 64.0% of the teachers were not members of any non-governmental organization and did not engage in voluntary activities, that nearly one-third of the schools did not have any physical infrastructure element supporting sustainability (28.9%), and that recycling units were the most common physical feature (39.6%). Administrative support was generally perceived to be at moderate to high levels; 36.5% of the teachers stated that school administrators supported sustainability-focused activities, while 28.4% reported full support. The most frequently reported difficulties in practice were curriculum intensity and time constraints (34.5%), inadequate physical facilities at school (19.8%), and lack of materials/resources (19.3%). When the frequency with which sustainability-related topics were included in educational plans was examined, the most common responses were “once or twice a week” (33.0%) and “only on specific days and weeks” (20.8%), whereas the proportion of those who reported doing so “almost every day” remained at 17.3%.

The difference analyses similarly showed that SD Knowledge, SD Attitude, and ECEfS Practices scores did not differ significantly according to teachers’ education level, years of professional experience, school type, the presence of the Eco-Schools Program, prior training in sustainability, membership in or voluntary participation with non-governmental organizations, or the environment in which they had spent their childhood ( $p > .05$ ). Nevertheless, some noteworthy differences were also identified (Tables 7–10).

**Table 7.**

*Independent samples t-test results for pairwise comparisons with significant differences*

| Dependent variable   | Groups                                               | n        | M             | SD            | t(df)       | p     | Cohen's d |
|----------------------|------------------------------------------------------|----------|---------------|---------------|-------------|-------|-----------|
| SD Knowledge (Total) | Academic publications/university education: Yes / No | 29 / 168 | 1.818 / 1.743 | 0.132 / 0.149 | 2.51 (195)  | .01 3 | 0.51      |
| Social practices     | News bulletins/newspapers: Yes / No                  | 54 / 143 | 2.917 / 3.089 | 0.435 / 0.472 | -2.33 (195) | .02 1 | 0.37      |

According to Table 7, teachers who identified university education/academic publications as a source of information had higher SD Knowledge scores than those who did not. Teachers who reported using sources such as news bulletins and newspapers had lower scores on social practices.

Table 8 shows that environmental practice scores differed significantly according to the level of perceived administrative support. The Tukey post-hoc test indicated that teachers who reported receiving full support from school administrators (Level 5) had higher environmental practice scores than those who reported little support (Level 2) and those who reported no support at all (Level 1).

**Table 8.**

*Comparison of environmental practice scores according to perceived administrative support (ANOVA and Tukey post-hoc)*

| Level of administrative support | n                  | M          | SD               |
|---------------------------------|--------------------|------------|------------------|
| 1. Does not support at all      | 16                 | 2.996      | 0.382            |
| 2. Supports a little            | 21                 | 2.915      | 0.331            |
| 3. Moderate support             | 32                 | 3.222      | 0.410            |
| 4. Supports                     | 72                 | 3.065      | 0.390            |
| 5. Full support                 | 56                 | 3.257      | 0.331            |
| ANOVA                           | $F(4, 192) = 3.93$ | $p = .004$ | $\eta^2 = 0.076$ |

*Note. According to the Tukey post-hoc test, the significant pairwise comparisons were: 5 > 2 (MD = 0.342,  $p = .015$ ); 5 > 1 (MD = 0.261,  $p = .020$ )*

**Table 9.**

*Comparison of total practice scores according to the frequency of including sustainability topics in educational plans (ANOVA and Tukey post-hoc)*

| Frequency of inclusion in educational plans | n                  | M          | SD               |
|---------------------------------------------|--------------------|------------|------------------|
| 1. Almost every day                         | 34                 | 3.228      | 0.277            |
| 2. Once or twice a week                     | 65                 | 3.075      | 0.266            |
| 3. Once or twice a month                    | 39                 | 3.005      | 0.233            |
| 4. On specific days/weeks                   | 41                 | 3.141      | 0.240            |
| 5. Very rare/never                          | 18                 | 3.099      | 0.269            |
| ANOVA                                       | $F(4, 192) = 2.84$ | $p = .026$ | $\eta^2 = 0.056$ |

*Note. According to the Tukey post-hoc test, the significant pairwise comparison was: 1 > 3 (MD = 0.223,  $p = .022$ ).*

According to Table 9, teachers' total practice scores differed significantly according to how often they included sustainability topics in their educational plans. The Tukey post-hoc test showed that the group that included these topics almost every day (Level 1) had higher total practice scores than the group that included them once or twice a month (Level 3).

**Table 10.**

*Comparison of social practice scores according to the frequency of including sustainability topics in educational plans (Welch ANOVA and post-hoc)*

| Frequency of inclusion in educational plans | n  | M     | SD    |
|---------------------------------------------|----|-------|-------|
| 1. Almost every day                         | 34 | 3.287 | 0.533 |
| 2. Once or twice a week                     | 65 | 3.108 | 0.522 |
| 3. Once or twice a month                    | 39 | 2.846 | 0.391 |
| 4. On specific days/weeks                   | 41 | 2.933 | 0.448 |

|                    |                      |            |                  |
|--------------------|----------------------|------------|------------------|
| 5. Very rare/never | 18                   | 3.020      | 0.340            |
| Welch ANOVA        | $F(4, 73.75) = 3.43$ | $p = .013$ | $\eta^2 = 0.067$ |

According to the post-hoc test, the significant pairwise comparisons were:  $1 > 3$  ( $MD = 0.441, p = .031$ );  $2 > 3$  ( $MD = 0.262, p = .036$ ).

Table 10 shows that social practice scores differed significantly according to the frequency of including sustainability topics in educational plans. According to the post-hoc test, the group that included these topics once or twice a month (Level 3) had lower social practice scores than both the groups that included them once or twice a week (Level 2) and the group that included them almost every day (Level 1).

### RQ3. Qualitative Explanations of the Quantitative Findings

The data obtained from the semi-structured interviews conducted to explain and deepen the quantitative findings were organized under four themes: (1) how teachers made sense of sustainability, (2) the place of EfS in the classroom and the way it was implemented, (3) the supports and barriers shaping practice, and (4) teachers' personal awareness, their role as role models, and their need for practice-oriented support.

#### **Theme 1: How Teachers Made Sense of Sustainability**

The interviews showed that teachers generally viewed sustainability as a positive and necessary concept; however, the ways in which they made sense of this concept differed according to their scores on the ECEfS Practices Scale. Teachers with higher practice scores did not define sustainability only in terms of protecting the environment, recycling, and saving resources; they also described social aspects such as living together, sharing, classroom responsibility, and respecting rights as part of this concept.

T1 expressed this as follows: *"From the very beginning, children need to be shown how to take care of things that are shared, not to harm living beings in nature, to take only what they need, and what to do with the food left on their plate."*

Similarly, T2 drew a more holistic picture by stating, *"So, it is not only about nature or the environment. Time is part of it, materials are part of it, food is part of it, and relationships are part of it as well."* T3 also supported this view by saying, *"I think it should not be seen only as nature and natural cycles; life in the classroom, at home, or among friends may also be part of it."*

Among teachers with moderate practice scores, sustainability was defined mostly in terms of protecting the environment, recycling, and saving resources; however, some teachers also referred to social aspects such as sharing and protecting what is shared. By contrast, teachers with low practice scores described sustainability in a much narrower way, focusing mainly on recycling, environmental cleanliness, and saving resources.

T4 stated, *"What first comes to my mind is, of course, protecting our environment... Then sharing also comes to mind..."*, whereas T7 said, *"Recycling, making use of things instead of throwing them away, being aware of these... More about the effects we have on the*

*environment...*" Similarly, T9 remarked, *"When I think of sustainability, recycling comes to mind first; climate-related issues are also part of it, of course, although it is actually a complex topic."*

### **Theme 2: The Place of Education for Sustainability in the Classroom and the Way It Was Implemented**

All the teachers emphasized that EfS should be included in the preschool period. However, clear differences emerged across the groups in terms of how this education was structured in the classroom. Teachers with higher practice scores regarded EfS not as a separate topic, something addressed only on specific days and weeks, or a periodic activity, but rather as a way of life and a set of routines integrated throughout the entire day.

T1 stated, *"Yes, I do include it. But I do not treat it as just another activity time. I try to integrate it into daily life."* T2 explained this approach as follows: *"It is not just a matter of doing an activity, putting it on the board, and being done with it. The child will see it in play, in the garden, in the organization of the classroom, or even from the moment the day begins to the moment they leave the classroom at the end of the day..."* T3, in turn, said, *"I think children need to learn this by experiencing it, not just by hearing about it."*

Teachers with moderate practice scores described EfS more in terms of small daily reminders, special days, activities included in weekly plans, and activities based on recycled materials. By contrast, the statements of teachers with low practice scores suggested that these practices were not fully integrated into the daily flow of classroom life and remained more activity based.

T4 stated, *"I address it mostly through small daily reminders and activities,"* while T5 said, *"Yes, I already cover it on all specific days, and I also do it through play and family involvement."* In the lower group, T7 said, *"I include it from time to time. I cannot say it is very regular... mostly when such an activity happens to fit into my plan,"* and T8 stated, *"Of course, I have activities like that. We also do them at certain times,"* thereby revealing the less holistic nature of these practices.

### **Theme 3: Supports and Barriers Shaping Practice**

One of the most frequently recurring themes in the interviews was that sustainability practices did not depend solely on teachers' individual willingness; rather, they were also closely related to family support, school leadership, physical conditions, and school-wide systems. In particular, family support was regarded as critical across nearly all groups.

T1 stated, *"If there is a parent who supports it, the child picks it up more quickly. But sometimes what you talk about at school finds no response at all at home."* Similarly, T5 said, *"But if the family does not support it, it remains somewhat limited to the classroom."* In the lower group, T8 stated, *"But the family also needs to embrace it. Otherwise, the child does not really learn it or internalize it. Maybe they do it at school, but it does not continue in social life,"* while T9 remarked, *"If it is not there in the parents, it is not very lasting. I think it also needs to continue at home."*

Physical conditions and the organizational structure of the school also emerged as important barriers. Although the presence of a garden was seen as an advantage, many teachers pointed out that these spaces were not used in a planned and educationally purposeful way, and that there was a lack of space in the classroom for storing materials, sorting them, and setting up learning centers.

T1 stated, *"You want to keep something, but there is no space. You want to separate waste, but when there is no school-wide system, the teacher's effort can only go so far."* Similarly, T7 said, *"The classroom is also small. When you want to sort things out and set up a learning center, space becomes a problem,"* while T9 pointed to the same issue by stating, *"There is no system for separating waste. There is a garden, but we do not use it much for educational purposes."*

Administrative support and school-wide ownership also emerged as a strong subtheme. Teachers emphasized that sustainability practices could be strengthened not through the efforts of individual teachers alone, but through the school's overall approach.

T1 stated, *"I do not think this should be left to a single teacher. The administration really needs to take it seriously."* T2 likewise said, *"Administrative support is necessary... How far can a teacher go on their own? A recent example is that we wanted to participate in the municipality's waste oil collection competition, but our principal did not allow it, saying, 'Are we supposed to collect people's oil here at school?'"* T9 expressed the same need by stating, *"If this is left only to the teacher, it becomes a heavy burden; it is difficult."*

#### **Theme 4: Teachers' Personal Awareness, Their Role as Role Models, and Their Need for Practice-Oriented Support**

Another noteworthy finding was that teachers drew a connection between their own life practices and their classroom practices. While teachers with higher practice scores demonstrated more consistent personal awareness, some teachers with moderate and low practice scores offered a more critical self-assessment in this regard.

T1 stated, *"I do. I try not to consume too quickly. I do not throw something away immediately in the classroom... Because children notice that right away. I do not think a teacher can talk about something as if it were genuine in the classroom if they never do it in their own life."* T2 similarly said, *"I try to do myself, as much as possible, what I tell children about. Because if we do not serve as role models for them, they will not believe us and will not turn it into behaviour."*

By contrast, T5 stated, *"I am sensitive about this, but am I very regular and systematic about it? No, I am not."* T8 said, *"If you ask whether I do it in every detail, unfortunately no,"* and T9 remarked, *"Even though I know it, sometimes I still cannot fully put it into practice..."* In this way, they indicated that they were aware of the limitations in their own everyday practices.

Finally, almost all the teachers emphasized that they needed practice-oriented and high-quality professional development support. In particular, the participants stated that they needed support in seeing concrete examples, learning about practices that would strengthen

teachers' capacity to implement sustainability, knowing what to do when materials were unavailable, and involving families in the process.

T1 expressed this need clearly by stating, *"Teacher training should be more practice oriented."* T2 similarly said, *"Less theoretical... I mean, not just telling us and moving on, but really seeing how it can be done."* T6 stated, *"We need to see real examples... things that will strengthen the teacher's hand,"* while T8 remarked, *"Teachers need to see clearly what they can do. A few examples, a little time, a few materials, and a lot of support."*

When all of the qualitative findings are considered together, it becomes clear that teachers generally held positive views of sustainability; however, the way this positive orientation was reflected in practice was closely related to how teachers understood sustainability, the school's culture and resources, support from school leadership, family support, physical conditions, and the extent to which teachers felt prepared to implement it in practice. According to the accounts of teachers with higher practice scores, sustainability was addressed in a more holistic way, integrated into daily classroom routines, classroom relationships, and children's school experiences, and reflected in concrete classroom practices and children's behaviours. By contrast, among teachers with lower practice scores, the concept appeared to remain narrower, more environmentally focused, and more activity based.

#### **RQ4. Integrated Interpretation of the Quantitative and Qualitative Findings**

When the quantitative and qualitative findings are considered together, it becomes evident that teachers' generally positive views of sustainability and their recognition of its importance do not mean that this understanding is reflected in classroom practices to the same extent. The qualitative findings showed that teachers with higher practice scores did not view sustainability only in terms of protecting the environment, recycling, or saving resources; rather, they approached it as a more integrated understanding reflected in children's daily classroom routines, classroom relationships, ways of using shared spaces, and approaches to resources.

In contrast, among teachers with lower practice scores, sustainability appeared to remain limited mostly to environmental content, specific activities, and practices carried out only from time to time. This indicates that the differences in practice identified in the quantitative phase were related not only to teachers' positive views of sustainability, but also to the breadth of meaning they attributed to the concept and the extent to which they were able to translate that understanding into classroom life.

In addition, the qualitative findings help explain why no significant relationships were found among SD knowledge, SD attitudes, and ECEfS practices in the quantitative phase, and why knowledge and attitudes did not significantly predict practices. The interviews showed that teachers generally viewed sustainability as important and necessary; however, this understanding was not reflected in classroom practices to the same extent. It became clear that practices varied particularly depending on physical infrastructure, the extent to which gardens and outdoor spaces could be used for educational purposes, family support, support from



school leadership, the availability of materials and time, and teachers' need to see practical examples and receive professional support.

In this respect, the qualitative findings help explain why, although no significant differences were found for most demographic and professional variables in the quantitative phase, limited but noteworthy differences emerged in some contextual variables that directly affected practice. Indeed, the qualitative findings showed that although teachers' personal awareness and efforts to serve as role models were important, they were not sufficient on their own; when the school's overall approach, the frequency of planning, and concrete conditions supporting implementation were lacking, these efforts were reflected in classroom practice only to a limited extent. In this way, the qualitative findings deepen the quantitative results by showing that EfS practices are shaped not only by individual knowledge or attitudes, but also by how teachers make sense of sustainability and by the contextual conditions in which they work.

## DISCUSSION

When the findings are considered together, preschool teachers' sustainability literacy appeared to be generally moderate in terms of SD Knowledge, SD Attitudes, and ECEfS Practices; however, no statistically significant relationships were found among these variables. In addition, the lack of a significant predictive relationship between knowledge and attitudes and practices suggests that the commonly assumed linear progression from knowledge to attitudes to practices may not fully capture the complexity of EfS contexts. This finding is consistent with research in environmental behavior, which emphasizes that contextual and structural factors often mediate the relationship between knowledge, attitudes, and action (Ajzen, 1991; Bamberg & Möser, 2007; Kollmuss & Agyeman, 2002).

The ECEfS literature likewise shows that teachers' positive views and awareness are not always reflected in classroom practices to the same extent; rather, practices are often shaped by teachers' pedagogical interpretations and their pedagogical understanding of how sustainability can be enacted in classroom practice (Güler Yıldız et al., 2021; Hedefalk et al., 2015; Kahriman-Pamuk & Pramling Samuelsson, 2024). At the same time, the quality of teachers' practices is shaped by teaching strategies, learning environments, school organization, and the professional learning opportunities available to teachers (Bascopé et al., 2019; Pramling Samuelsson et al., 2026). From this perspective, the present findings suggest that EfS practices emerge not simply as a natural outcome of knowledge and positive attitudes, but through the combined influence of pedagogical and contextual conditions. At the same time, this pattern should be interpreted with some caution, given that the quantitative findings were based on self-report measures. Reported practices may not always correspond fully to enacted classroom practice, and response tendencies such as social desirability may have contributed to a weaker or less differentiated picture of the relationship among knowledge, attitudes, and practices.

When the practice subdimensions were examined, environmental and economic practice scores were found to be relatively higher than social practice scores. This suggests that teachers

tend to address sustainability in the classroom through more concrete content that can be more easily incorporated into children's daily lives and routines. This interpretation was also supported by the qualitative findings, in which teachers first referred to practices such as recycling, saving resources, sorting waste, protecting nature, and making use of leftover or recycled materials. This result suggests that, in the ECEfS literature, the environmental pillar has long been more visible, while practices associated with the economic aspect such as saving resources, preventing unnecessary consumption, and using available resources carefully may also be more easily adapted to preschool classroom routines (Chen et al., 2022; Güler Yıldız et al., 2021). By contrast, the fact that social sustainability is more often addressed through relatively indirect and pedagogically more complex areas such as relationships, democracy, rights, child agency and participation, and living together may help explain why practices in this area appear more limited (Borg & Pramling Samuelsson, 2022). Therefore, the finding that environmental and economic practices were higher than social practices in the present study points to the areas through which teachers can most readily make sustainability concrete in the classroom.

The findings regarding teachers' prior training in sustainability and their sources of information can be interpreted in a similar way. The fact that most participants reported not having received any training in sustainability or SD may help explain why literacy scores remained at a moderate level and why the knowledge–attitude–practice link appeared weak. What seems decisive here is not only whether training was provided, but also its quality. Research on teachers' professional development for sustainability in early childhood indicates that effective programs tend to be practice-oriented, reflective, and continuous rather than limited to one-off informational sessions (Bascopé et al., 2019; Dymont et al., 2014). Similarly, Alici and Şahin (2023) showed that teachers' professional development in EfS can be strengthened through practice-oriented processes supported by critical media literacy. In a similar vein, Pramling Samuelsson, Engdahl, and Ärlemalm-Hagsér (2026) emphasize that, in the development of sustainable preschool settings, not only access to new knowledge, communication, and leadership, but also the continuous and organized structure of the program is decisive. The findings on information sources further reinforce this point. Teachers who reported university education and academic publications as sources of information had higher knowledge scores, whereas those who reported using sources such as news bulletins and newspapers had lower social practice scores. Taken together, these findings suggest that access to information alone is not sufficient; rather, what matters is whether such knowledge is reliable, sufficiently deep, and capable of being translated into early childhood pedagogy (Elmas et al., 2024; Pamuk et al., 2021). In this respect, the present findings are also consistent with the GreenComp framework, which conceptualizes sustainability competence not only in terms of knowledge, but also through values, participation, futures thinking, and taking action (Bianchi et al., 2022; Chen et al., 2022).

One of the most important mixed methods findings of the study is that the weak relationships identified in the quantitative phase became more understandable in the qualitative phase. The interviews showed that teachers with higher practice scores approached sustainability not merely through specific activities, but through a more holistic understanding reflected in children's daily classroom routines, classroom relationships, ways of using shared spaces, and approaches to resources (Višnjić-Jevtić et al., 2022). By contrast, in the accounts of teachers with lower practice scores, sustainability appeared to remain more at the level of environmental content and specific classroom activities. This interpretation is consistent with findings showing that sustainability studies in early childhood have often concentrated on environmental themes (Güler Yıldız et al., 2021). At the same time, studies showing that sustainability teaching can be structured through children's participation, experiences, and daily classroom routines also support the more holistic approach observed among teachers with higher practice scores (Borg, 2019; Ohlsson et al., 2024; Šindić & Vodopivec, 2025; Wang et al., 2019).

This interpretation is also supported by the quantitative findings regarding the frequency of including sustainability topics in educational plans. The fact that teachers who included sustainability topics in their educational plans almost every day had higher total practice scores than those who included them only once or twice a month suggests that, as sustainability becomes more continuous in classroom life, it is reflected more strongly in practice. Similarly, the finding that social practice scores also differed significantly according to the frequency of inclusion in educational plans indicates that the social sustainability aspect, in particular, is strengthened not spontaneously, but through more regular and deliberate pedagogical integration. This shows that the differences in practice scores identified in the quantitative phase were related not only to whether teachers held positive views of sustainability, but also to how they made sense of this concept within classroom life and to the extent to which they integrated it systematically into the educational process. In this respect, the qualitative phase did not merely contextualize the quantitative results but also made teachers' perspectives visible as a distinct source of insight into how sustainability is understood, prioritized, and translated into preschool practice.

Another important contribution of the quantitative findings is that, although demographic and professional variables did not explain practices, some variables more directly related to practice showed limited but meaningful differences. In this respect, the findings suggest that sustainability practices may be shaped less by who the teachers are in demographic terms and more by the immediate conditions under which practice takes place. The qualitative findings support this interpretation. Factors such as limited time, curriculum intensity, lack of materials, insufficient educational use of gardens and outdoor spaces, lack of space in the classroom, and lack of family support appeared to constrain the extent to which sustainability could be integrated into everyday classroom life (Pamuk et al., 2021). These results are consistent with the findings of Parry and Metzger (2023), who point to time, competing

priorities, and lack of support, and with Cheng and Yu (2022), who highlight the resource-related and institutional support challenges faced by early childhood teachers.

The influence of the physical environment and the organization of learning environments on EfS has also been emphasized both in studies on preschool physical environments and in recent research focusing on teachers (Kahriman-Pamuk & Olgan, 2018; Ohlsson et al., 2024). Taken together, these findings suggest that sustainability practices are shaped not only by knowledge and attitudes, but also by the extent to which teachers are able to work within supportive conditions related to time, materials, physical space, family support, and institutional support (Kahriman-Pamuk, 2025).

Another important contextual factor was school leadership and institutional ownership. The quantitative finding that environmental practice scores differed significantly according to the level of perceived administrative support clearly highlights the role of school leadership in this process. In particular, the fact that teachers who reported receiving full support from school administrators had higher environmental practice scores than those who reported little or no support suggests that sustainability practices are strengthened not only by individual teacher effort but also by institutional commitment. The qualitative findings support this pattern, as teachers emphasized that the process became easier when school leadership attached importance to sustainability, developed a shared approach, and extended implementation across the whole school.

The literature indicates that the physical environment, school organization, and leadership directly influence sustainability practices (Mogren & Gericke, 2019; Tilbury & Galvin, 2022). A study focusing on preschool principals also showed that leadership plays an important role in the multidimensional development of sustainability practices (Borg et al., 2025). In this respect, the absence of significant differences across broad demographic variables, together with the presence of limited but meaningful differences in variables such as perceived administrative support, planning frequency, and information sources, suggests that the quality of practice may depend more on institutional conditions and everyday enactment than on background characteristics alone.

The absence of significant differences according to education level, years of professional experience, school type, and Eco-School participation similarly indicates that sustainability practices cannot be explained by these variables alone. This finding is consistent with some studies comparing eco-school and non-eco-school preschool settings. Borg et al. (2017), for example, found no significant difference in children's sustainability-related learning between eco-school and non-eco-school preschool institutions. Ohlsson et al. (2025) likewise reported only limited differences overall, noting that these differences were more evident in areas such as the extent to which children's experiences were taken into account in planned and semi-planned teaching and the degree to which learning environments were more adapted. By contrast, Vodopivec and Šindić (2025) reported that the environmental, social, and economic dimensions were addressed in a more integrated way in institutions implementing an eco-

school program. Taken together, these findings suggest that the absence of significant differences in the present study does not mean that the Eco-School label is ineffective; rather, it may indicate that what matters is the extent to which the program is embedded in the school's daily functioning, learning environments, and pedagogical practices.

## CONCLUSIONS

The findings of this study indicate that general informational efforts aimed solely at increasing teachers' awareness may not be sufficient to strengthen EfS in preschool settings. In particular, the findings suggest that teachers need concrete examples of classroom practices, activities appropriate to children's age and developmental level, planning support that can be integrated into daily classroom routines, and whole school approach that supports sustainability. In this regard, preservice teacher education should relate the environmental, social, and economic pillars of sustainability to early childhood pedagogy. In-service education should also provide teachers with concrete classroom examples, routine-based practices, the use of outdoor spaces, family involvement, and practical solutions for contexts with limited materials. In addition, school leadership should take ownership of sustainability not only through projects or activities, but also through time planning, the organization of learning environments, and a collaborative culture among teachers. A whole-school approach that brings together teachers, school leadership, and families may therefore provide a more effective framework for strengthening EfS practices. The study also shows that teachers' perspectives are important for understanding why similar levels of reported knowledge and attitudes may lead to different ways of interpreting and enacting sustainability in practice.

By examining sustainability literacy through the framework of knowledge, attitudes, and practices, quantitatively revealing the relationships among these components, and deepening the understanding of how teachers' practices are interpreted through qualitative findings, this study makes important contributions to the field; however, it also has some limitations. One important limitation is that the quantitative data were collected through self-report scales, meaning that teachers' practices were assessed based on their own statements rather than direct classroom observation. For this reason, reported practices may not fully reflect enacted practice, and the findings may also have been affected by response tendencies such as social desirability. This should be considered particularly when interpreting the weak and non-significant relationships among knowledge, attitudes, and practices. In addition, because multiple t-tests and ANOVA-based comparisons were conducted without a formal correction procedure, these between-group findings should be interpreted as exploratory rather than confirmatory. In addition, the fact that the sample was limited to a specific region restricts the generalizability of the findings. Moreover, the small number of participants in some subgroups, particularly with respect to the Eco-School variable, may also have reduced the power of group comparisons.

Future research may benefit from examining teachers' sustainability practices not only through self-reports, but also through data sources such as classroom observations, document analysis, and the longitudinal follow-up of practice examples. In particular, tracking how teacher education is reflected in practice through intervention studies and action research designs may help explain more deeply the knowledge–attitude–practice disconnect identified in this study. In addition, including mediating variables such as school climate, teachers' perceived support, self-efficacy, their beliefs about their ability to implement sustainability practices, and the school's overall approach within quantitative models may help explain why practices remain stronger among some teachers and more limited among others.

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## APPENDIX

**Table 2.***Themes, subthemes, and sample codes derived from the qualitative content analysis*

| Theme                                                                                                    | Subtheme                                                        | Sample codes                                                                                                                    |
|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| 1. How teachers make sense of sustainability                                                             | 1.1. Sustainability understood primarily in environmental terms | recycling, protecting the environment, saving resources, environmental cleanliness, making use of waste                         |
|                                                                                                          | 1.2. A more holistic understanding of sustainability            | living together, sharing, respecting rights, responsibility in the classroom, using only what is needed                         |
| 2. The place of EfS in the classroom and the way it is implemented                                       | 2.1. Practices integrated into daily classroom routines         | integrating into everyday life, routines, reflecting in behaviour, learning by doing                                            |
|                                                                                                          | 2.2. Practices largely limited to specific activities           | special days, weekly activities, small reminders, doing it from time to time, activity-based practice                           |
| 3. Supports and constraints shaping practice                                                             | 3.1. Family support                                             | reinforcement at home, family acceptance, permanence, extending beyond school                                                   |
|                                                                                                          | 3.2. Physical conditions and infrastructure                     | lack of space, limited educational use of the garden, absence of a waste-sorting system, lack of materials/learning centers     |
|                                                                                                          | 3.3. Administrative support and school-wide ownership           | administrators' support, school-wide approach, teachers being left alone, institutional support                                 |
| 4. Teachers' personal awareness, their role as role models, and their need for practice-oriented support | 4.1. Personal awareness and being a role model                  | applying it in one's own life, being a role model for children, consistency, self-evaluation                                    |
|                                                                                                          | 4.2. Need for practice-oriented professional support            | practice-oriented training, seeing examples, strengthening teachers' hands, material support, involving families in the process |

**Table 3.***Linking the quantitative findings with the qualitative data collection process*

| Key finding / indicator from the quantitative phase                                  | How it was used in the qualitative phase                                            | Relevant interview questions / topics                        | Purpose                                                                                                      |
|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| SD Knowledge level                                                                   | Used to understand how teachers conceptualized sustainability                       | Definitions and conceptualizations (Questions 1–3)           | To explain how teachers' perceptions of sustainability relate to the quantitative patterns                   |
| Findings related to total practice scores, subdimensions, and frequency of practices | Used in participant selection and in developing questions about classroom practices | Examples of practices and frequency of practice (Question 4) | To provide a more detailed explanation of the classroom practices of teachers with different practice scores |
| Indicators related to school infrastructure                                          | Used to guide discussions about physical conditions                                 | Physical conditions and infrastructure (Question 5)          | To understand how the educational environment supported or constrained practice                              |
| Reported barriers to practice and perceived administrative support                   | Used to develop questions about barriers and support needs                          | Barriers and support needs (Question 6)                      | To deepen the limitations highlighted in the quantitative phase through teachers' perspectives               |
| Contextual indicators such as NGO participation and sources of information           | Related to questions about teachers' personal life habits and awareness             | Personal life habits / preferences (Question 7)              | To understand the relationship between personal awareness and classroom practices                            |