

REUSING WASTE MATERIALS IN ART EDUCATION ACROSS FOUR EUROPEAN COUNTRIES

Abstract

The uneven and often unsupported reuse of waste materials in art education highlights a gap in understanding how teachers integrate sustainable practices across different national contexts. This study examines how teachers in four European countries perceive and implement the reuse of waste materials in art education. Conducted within the international Waste to Art project, the research seeks to identify teachers' practices, knowledge of material properties, perceived barriers, and the types of materials most frequently reused. A mixed-method design was applied, combining Likert-scale items with open-ended questions. The sample included 357 teachers from Italy, Lithuania, Slovenia, and Türkiye, representing varied educational levels and experience. Quantitative data were analyzed using descriptive statistics and non-parametric tests, while qualitative data were examined through thematic analysis. The findings show national differences. Italian and Turkish teachers reported higher confidence and more frequent reuse, Slovenian teachers demonstrated lower integration and greater caution, and Lithuanian teachers expressed solid knowledge but highlighted a lack of methodological examples. Across countries, teachers identified similar barriers, most often limited storage, time constraints, safety concerns, and insufficient institutional support. Paper and plastic were the most reused materials, alongside national specificities such as Lithuania's reliance on natural materials and textiles and the frequent use of metal in Italy and Slovenia. The findings indicate that sustainable art education cannot rely solely on individual teacher motivation. Systemic support through infrastructure, curricular alignment and professional development is needed to move the reuse of waste materials from isolated practices to a regular and well-supported part of art education.

Keywords: *cross-national comparison, mixed-methods research, sustainable art education, teacher practices, waste materials*

Introduction

The growing consumption of natural resources, the accumulation of waste, and related environmental challenges demand new approaches in education. Schools and teachers play a crucial role in shaping sustainable values and practices. Among the key actors are art teachers, who hold a unique position to foster creativity through diverse materials. Integrating waste materials into art projects emerges as a pedagogical strategy that not only reduces environmental impact but also stimulates innovation and creativity in the classroom (Goldman et al., 2021; Huang et al., 2024; Merewether, 2023; Tang, 2023).

Despite its potential, the integration of sustainable practices in education—and particularly in art education—remains uneven and often contingent on individual teacher initiative. Previous studies have shown that teachers' beliefs and attitudes play a decisive role in shaping classroom practices (Aslan, 2021; Shieh & Reynolds, 2019), including whether waste materials are incorporated into lessons (Lee et al., 2021; Tanjung, 2024). Teachers frequently report barriers such as limited time, insufficient storage facilities, safety concerns, and inadequate institutional support (Lee et al., 2021; Jatau & Binbol, 2020).

At the international level, eco-art education has gained recognition for its capacity to foster creativity and environmental awareness (Marques Ibanez, 2023; Pavlou & Vella, 2023; Sanz-Hernandez & Covalada, 2021). However, the empirical evidence on how these practices are implemented across different educational systems remains limited. Existing studies tend to focus on individual experiences or single-country initiatives, offering only partial insights into how structural and cultural contexts shape teachers' practices. Some research in European contexts has suggested that, although sustainability themes are formally included in curricula, their integration into art

education remains limited and often dependent on teacher initiative (Lee et al., 2021; Zemljak & Kerneža, 2023). These indications point to the need for a comparative perspective that can capture both pedagogical and systemic dimensions of reusing waste materials in art education.

To address these gaps, this study explores how teachers in four European countries perceive and implement the reuse of waste materials into art education. It explores the frequency and forms of such practices, teachers' knowledge and available resources, as well as the barriers that influence their implementation. Through this focus, the research situates Waste-to-Art at the intersection of sustainability, creativity, and equity, highlighting its potential to make sustainable art education a more integral part of school practice.

Theoretical Background

Sustainability in Education and Art Education

The concept of Education for Sustainable Development (ESD) emphasizes the integration of environmental, social, and economic dimensions into teaching with the aim of developing competences for responsible action (Kopnina & Meijers, 2014; Laurie et al., 2014; Zemljak & Kerneža, 2023). Art education plays a particular role in this context, as it provides space for creativity, experimentation, and material exploration. Such processes create tangible opportunities to address sustainability through artistic practices that foster critical thinking and environmental awareness. Research shows that incorporating sustainability themes into art education encourages creative engagement with environmental issues and strengthens action-oriented learning (Marques Ibanez, 2023; Pavlou & Vella, 2023; Sanz-Hernandez & Covaleda, 2021).

The reuse of waste materials represents a concrete example of transferring circular economy principles into the school setting: it reduces the amount of waste, extends the life cycle of materials, and simultaneously promotes creative thinking and problem solving. Studies emphasize that such practices—whether in art projects or architectural design—not only reduce resource consumption but also significantly contribute to raising awareness of sustainable development, innovation, and students' creativity (Lee & Manfredi, 2021). Reuse of waste materials is recognized as a key element in the concept of the circular economy, as it enables longer resource lifespans and reduces the need for extracting new raw materials (Kio & Anumba, 2024; Savini, 2021). Recent eco-art education research highlights how these practices can be systematically aligned with environmental education, offering structured ways for teachers to cultivate artistic approaches to sustainability in elementary classrooms (Inwood, 2013).

Waste as a Pedagogical Resource and Creativity

Research on the materiality of learning emphasizes that materials are not neutral tools but actively shape the learning process and creative outcomes. Students do not only learn *about* the world through materials; they also learn *through* them, developing understanding, expression, and their relationship to the environment (Cebi, 2025). Working with materials that are heterogeneous, irregular, and unpredictable—such as many waste materials—stimulates divergent thinking, improvisation, and the reinterpretation of everyday objects and situations (Hassan, 2020). Incorporating waste materials into the pedagogical process also enhances students' creativity, confidence, and innovativeness, as it enables a direct connection between environmental issues and creative practice (Nikoloudakis & Rangoussi, 2024). In addition, students strengthen teamwork skills, problem-solving abilities, and a sustainable mindset (Burky, 2022).

In art education, environmental and didactic goals thus converge. Teachers observe that such approaches promote more engaged learning, greater student autonomy, and a deeper understanding of

the connections between everyday life, art, and sustainability (Caruana et al., 2021). Nevertheless, implementation is often constrained by practical challenges, including insufficient time, storage, safety concerns, and limited institutional support (Cebi, 2025). Findings from higher education settings confirm that eco-art practices can also strengthen students' emotional connection to the environment, encouraging pro-environmental attitudes and action (Ison & Bramwell-Lalor, 2023).

The Teacher's Role and the Accessibility of Art Education

Teachers' beliefs, professional knowledge, and experience significantly influence the adoption of sustainable pedagogical innovations, yet a positive attitude alone is often insufficient without adequate institutional support (Sinakou et al., 2024). Research shows that pre-service teachers are more successful and motivated in implementing sustainability-related content when they participate in carefully designed, transdisciplinary learning experiences that connect different subjects and directly address sustainability challenges (Echegoyen-Sanz et al., 2024). Such experiences not only strengthen the understanding of sustainability concepts but are also recognized by students as valuable for their future pedagogical practice.

In everyday contexts, however, teachers' efforts are constrained by curricular pressures, parental expectations, and limited institutional backing, which hinder the systemic integration of sustainability into teaching (Ginsburg & Audley, 2020). This underscores the need to situate teacher agency within organizational conditions and to redefine the teacher's role in art education, particularly when linked to digital and sustainable practices (Kerneža et al., 2024; Pavlou & Castro-Varela, 2024).

Waste-to-Art practices exemplify this interplay between individual beliefs and institutional context. They connect ecological awareness, creativity, and equitable access to art education, while also exposing teachers to challenges of safety, storage, and time management (Anderson & Guyas, 2012; Inwood, 2013). Teachers may embrace such practices as innovative opportunities, but without structural support their implementation risks remaining fragmented.

Beyond ecological and pedagogical benefits, the reuse of waste materials also carries a social accessibility dimension. By lowering costs, it enables the participation of students from socio-economically disadvantaged backgrounds, provided such practices are thoughtfully integrated rather than treated as mere substitutes for limited resources (Knif & Kairavuori, 2020; Yeboah et al., 2017). In this sense, Waste-to-Art fosters creativity and responsibility while contributing to equity in access to high-quality art education.

Research Gaps and Study Objectives

Despite increasing attention to sustainability and eco-art education, research on Waste-to-Art practices remains fragmented and predominantly localized, with limited comparative evidence across national contexts in Europe. Existing studies tend to emphasize individual teacher experiences or single-country initiatives, while little is known about how teachers in different educational systems perceive, implement, and sustain the reuse of waste materials in art education. Moreover, the intersection of ecological, creative, and social dimensions—particularly the role of Waste-to-Art in enhancing equity and accessibility—has not been systematically addressed.

To address this gap, this research examines how teachers in four European countries understand and apply the reuse of waste materials in art education. Its aim is to identify the frequency and forms of waste-to-art practices, the extent of teachers' knowledge and available resources, and the barriers that limit implementation. Accordingly, the study seeks to answer the following research questions:

1. How often do teachers in different countries integrate waste materials into art projects?
2. What knowledge and resources do they report?
3. What barriers do they encounter?

4. Which types of materials are most frequently reused?

Taken together, these research questions position waste-to-art as both a pedagogical strategy and an analytical lens for understanding how sustainability can become an integral and equitable component of art education.

Research Methodology

General Background

The study was conducted within the framework of the international project Waste to Art (WatA) (Waste to Art, 2024), which promotes the integration of sustainability into art education through the creative reuse of waste materials. The empirical research focused on teachers' perspectives and practices related to the use of waste materials in art activities, with particular attention to barriers, resources, and opportunities identified in classroom contexts.

The research was carried out between March and June 2024 across four European countries participating in the project. An exploratory mixed-methods design was applied, combining quantitative and qualitative approaches. The quantitative component relied on Likert-scale items to enable systematic cross-country comparisons, while the qualitative component provided in-depth insights into specific challenges and contexts.

A structured questionnaire was used to ensure standardized data collection, and open-ended items were included to capture contextual differences and local specificities. Teachers with varying levels of professional experience and from different educational levels were included, ensuring a diverse spectrum of pedagogical practices.

The data collection and analysis were designed to address the research questions formulated in the introduction. The findings later informed the development of teaching modules, guidelines, and institutional strategies within the WatA framework.

Sample

The study involved teachers from four European countries—Italy, Lithuania, Slovenia, and Türkiye. The target population consisted of in-service teachers engaged in visual or art-related education across different educational levels. Participants were recruited through institutional mailing lists, professional teacher associations, and partner dissemination channels connected to the Waste to Art (WatA) initiative.

A non-probability, voluntary-response sampling technique was applied. The questionnaire was distributed electronically and made publicly accessible, allowing teachers to participate on a voluntary and anonymous basis. This approach was chosen to ensure inclusiveness and to reach a wide range of practitioners across countries, consistent with the exploratory and comparative aims in the study.

Differences in the number of respondents across countries reflect variations in outreach and participation rates rather than predetermined quotas. The sample therefore represents a diverse group of teachers with varying degrees of engagement in art education, rather than as statistically representative population.

- Italy: 60 teachers, mainly from secondary and higher education, most with 6–15 years of experience.
- Lithuania: 62 teachers, predominantly from preschool education, with most having up to 5 years of experience.
- Slovenia: 31 teachers, balanced across educational levels, with relatively longer professional experience.

- Türkiye: 204 teachers, distributed across all levels of education, with most having 6–15 years of experience.

Although the sample sizes are uneven, with particularly large differences between Türkiye (n = 204) and Slovenia (n = 31), the overall number of 357 participants provides adequate variation for exploratory non-parametric analyses and for identifying indicative cross-national trends. Therefore, the findings should be interpreted as indicative patterns that may guide preliminary insights and highlight areas for future studies with more rigorous sampling, especially concerning cross-national mean comparisons.

The study was conducted in accordance with the Declaration of Helsinki, and in accordance with the research standards and ethics of Institute of Contemporary Technology, Faculty of Natural Sciences and Mathematics, University of Maribor (FNM ICT) and approved by the Ethical commission for studies involving humans (October, 2023).

Instrument and Procedures

Data were collected using a structured questionnaire developed within the WatA project and adapted for use in four participating countries. The adaptation involved translation into national languages (Italian, Lithuanian, Slovene and Turkish) and linguistic validation to ensure conceptual and terminological consistency. The instrument was reviewed by subject-matter experts in art education and underwent pilot testing with a small group of teachers in each country to confirm clarity and cultural relevance. Minor linguistic adjustments were made based on pilot feedback.

The questionnaire comprised five thematic areas: (1) the reuse of waste materials from the teachers' perspective, (2) the reuse of waste materials from the school perspective, (3) sustainability in art projects, (4) encouraging creativity and interest in art, and (5) the accessibility of art activities through the reuse of materials. The present paper focuses on Area 1, which explores teachers' own practices and perspectives on the reuse of waste materials. Because of the exploratory scope of the project and the uneven sample sizes across countries, formal tests of measurement invariance across the translated questionnaire versions were not conducted. This represents an important limitation for interpreting cross-national mean differences, as it cannot be fully established that all items measured the underlying constructs in the same way in each linguistic and cultural context.

Area 1 included seven items rated on a 6-point Likert scale (0 – I don't know, I can't rate, 1 – I do not agree at all, 2 – I do not agree, 3 – I neither agree nor disagree, 4 – I agree, 5 – I strongly agree). The six-point format was selected to reduce central-tendency bias and to allow respondents who were uncertain to choose a separate "I don't know" category (0), rather than forcing a neutral midpoint.

In addition to the closed items, two open-ended questions were included to obtain qualitative contextual data. Teachers were asked to describe the obstacles and challenges they encounter when using waste materials in art activities, as well to indicate which types of materials they most frequently reuse (e.g., paper, plastic, textiles, metal, natural materials, or other). The qualitative responses were subsequently analyzed using content analysis to identify recurring themes and illustrative examples.

Data Analysis

The data analysis was designed as a combination of quantitative and qualitative procedures, allowing for triangulation of data. In the quantitative part, for each Likert-scale item we first calculated basic descriptive statistics (arithmetic means and standard deviations) separately by country in order to capture central tendencies and variability of responses. Since Likert-scale responses were treated as interval-level data for the purpose of computing means and standard deviations, but their distributions did not meet normality assumptions, cross-country comparisons

were conducted using the non-parametric Kruskal–Wallis test. This test is rank-based and robust to deviations from normality and heterogeneity of variances, making it suitable for comparing four independent groups. Whenever the Kruskal–Wallis test indicated statistically significant differences ($\alpha = .05$, two-tailed), post-hoc pairwise comparisons were carried out using Dunn’s test with Bonferroni correction for multiple testing. In addition to p -values, interpretation was complemented with effect size estimates (ϵ^2 for Kruskal–Wallis), providing an assessment of the practical significance of differences beyond their statistical detectability.

The response “0” on the Likert scale was defined in the instrument as “I don’t know, I can’t rate.” Accordingly, values of 0 were treated as invalid for inferential comparisons and were excluded from the calculation of central tendencies and hypothesis testing; however, they were included in descriptive frequency distributions, as they provide information about the level of indecision or lack of knowledge on specific items. Missing data were handled on a pairwise basis (i.e., by item), without imputation, in order to retain as much information as possible in each analysis; item-level sample sizes are reported in the results tables.

The qualitative part of the analysis was based on thematic analysis of open-ended responses. The procedure followed several stages: initial familiarization with the material and open coding, subsequent grouping of coherent codes into broader thematic clusters, and refinement of these clusters to capture recurring patterns of meaning (e.g., spatial and logistical limitations, time–curricular constraints, safety and hygiene concerns, institutional support and coordination). The codebook was developed iteratively within the research team and adjusted through comparative reading of responses across countries, in line with the principle of conceptual equivalence, thereby reducing the risk of misinterpretation due to linguistic or cultural differences. Discrepancies in the interpretation of specific statements were resolved through consensus after revisiting the context of the response. The final thematic map was then used to frame and interpret the quantitative results, ensuring that qualitative insights explain observed cross-country differences and illuminate mechanisms underlying the numerical patterns. This integrative approach follows the logic of explanatory triangulation, where qualitative data are used to clarify and contextualize statistical outcomes (Braun & Clarke, 2006; Johnson et al., 2007).

The combination of these two approaches makes it possible to link broader quantitative trends with in-depth qualitative explanations. The non-parametric testing framework ensured methodological consistency with the scale properties and distribution of the data, post-hoc corrections controlled the risk of Type I error in multiple comparisons, and the thematic analysis added contextual depth to clarify why certain differences emerged. This analytical design strengthens the internal validity of the findings and supports transferable conclusions about the factors that promote or hinder the reuse of materials in art education across different national contexts.

Research Results

Teachers’ Perspectives on Reusing Waste in Art Education

The survey data provide a broad picture of how teachers evaluate their knowledge, practices, and confidence in reusing waste materials. The analysis captures both the frequency of these practices and the main challenges teachers encounter in classroom implementation

Table 1

Teachers’ Perceptions of Reusing Waste Materials in Art Education Across Countries

Item	Country	Italy		Lithuania		Slovenia		Türkiye	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Use waste often (class-produced)		3.9	1.2	4.0	1.3	2.9	1.1	4.1	1.3

Knowledge of properties	4.0	1.2	3.5	1.1	3.3	1.0	4.1	1.1
Sufficient application examples	3.6	0.8	3.4	1.2	2.9	1.0	3.8	1.3
Obstacles when using waste	2.5	1.1	2.9	1.2	2.5	1.1	2.5	1.3
Waste reused in new projects	3.8	1.0	3.4	1.3	2.9	1.2	3.8	1.3
Encourage students to use waste	4.0	0.9	3.8	1.1	3.5	1.2	4.2	1.0
Plenty of resources/ideas	3.6	0.9	3.6	1.1	3.3	1.1	3.9	1.2

Descriptive statistics (Table 1) confirm that attitudes toward reusing waste materials are generally positive across all countries, though with meaningful national differences. Türkiye and Italy consistently reported the highest scores, while Slovenia lagged behind. Lithuania showed an intermediate position: teachers expressed relatively strong knowledge of material properties but showed uncertainty regarding the sufficiency of application examples and methodological guidance.

Cross-National Patterns of Waste Reuse

To test whether these differences were systematic, Kruskal-Wallis tests with Dunn post-hoc comparisons were conducted.

Table 2

Cross-Country Differences in Teachers' Practices of Waste Reuse

Item	$H(3)$	p	ϵ^2	Significant post-hoc differences (Dunn test, Bonferroni)
Use waste often (class-produced)	10.72	.013*	.020	Slovenia < Italy, Türkiye
Knowledge of properties	12.89	.005**	.025	Slovenia < Italy, Türkiye
Sufficient application examples	9.81	.020*	.018	Slovenia < Türkiye
Obstacles when using waste	3.42	.331	.001	n.s.
Waste reused in new projects	7.65	.054	.013	n.s.
Encourage students to use waste	8.63	.035	.015	Slovenia < Türkiye
Plenty of resources/ideas	6.92	.074	.011	n.s.

Note. H = Kruskal-Wallis test statistic with 3 degrees of freedom; ϵ^2 = effect size; $p < .05$, $**p < .01$, n.s. = not significant.

The results confirm that cross-country differences were statistically significant for several items. Slovenian teachers reported significantly lower use of waste materials compared to Italy and Türkiye, and they also scored lower on knowledge of material properties and sufficiency of application examples. Turkish teachers were significantly more likely to encourage students to reuse waste than Slovenians. No significant differences were found for obstacles, suggesting a shared recognition of structural barriers across contexts.

Although the statistically significant effects were small ($\epsilon^2 = .011-.025$), they indicate consistent, systematic differences across national contexts rather than random variation, reflecting the influence of distinct institutional and cultural conditions on teachers' practices.

Structural and Pedagogical Barriers

While the quantitative results reveal broad patterns, the open-ended responses provide deeper insight into the kinds of challenges teachers face in daily practice. Across all countries, teachers identified three recurring barriers: insufficient infrastructure and storage space, time constraints linked to curricular demands, and safety or hygiene concerns when handling waste materials.

National variations were also evident. In Türkiye, teachers often pointed to lack of institutional support, difficulties in accessing appropriate waste materials, and students' preference for ready-made resources. Lithuanian respondents highlighted a shortage of creative ideas and application examples,

particularly in early childhood education. In Slovenia, the most pressing concerns were the deterioration of stored materials, weak institutional encouragement, and limited collaboration among teachers. Italian teachers, by contrast, frequently mentioned safety risks and the insufficient skills of students to handle complex reuse tasks.

These qualitative insights align closely with the quantitative results. For example, Slovenian teachers' low scores on application examples mirror their open-ended comments about limited guidance and coordination.

Material Practices in the Classroom

To further contextualize these findings, the analysis examined which materials were most frequently reused in art projects.

Table 3
Teachers Reporting Reuse of Specific Materials in Art Projects (%)

Item	Country	Italy	Lithuania	Slovenia	Türkiye
Paper		76.5	95.1	76.5	84.3
Plastic		74.5	45.2	74.5	62.7
Textiles		27.5	72.6	27.5	41.2
Metal		58.5	4.8	58.5	19.6
Natural materials		17.6	90.3	17.6	60.8
Clay		5.9	9.7	5.9	12.7
Electronic waste		5.9	1.6	5.9	11.8
Wood		17.6	-	17.6	1.0

Note. Percentages represent the proportion of teachers who reported reusing each material. Multiple responses were allowed.

The data reveal both universal and context-specific patterns. Paper and plastic dominate across countries, confirming their accessibility and versatility. Lithuania stands out for its strong reliance on natural materials (90.3%) and textiles (72.6%), reflecting both pre-school contexts and cultural traditions of craft. Italy and Slovenia report frequent use of metal ($\approx 59\%$), likely linked to availability of industrial scrap and specific pedagogical approaches. Türkiye shows the broadest diversity, ranging from paper and natural materials to niche items such as electronic waste. The appearance of wood in Italy, Slovenia, and Türkiye—despite not being listed in the questionnaire—further illustrates teachers' creativity in adapting to locally available resources.

The differences in material use reported in Table 3 were analyzed descriptively rather than inferentially, as the categorical nature of the data and uneven sample sizes limited the applicability of robust statistical testing. This analytical choice precludes strong inferential claims about material preferences across countries. Nevertheless, the observed cross-national contrasts provide contextually meaningful insights into how material availability and pedagogical traditions shape reuse practices.

Integrated Interpretation of Findings

Bringing together the quantitative and qualitative strands of analysis, the results highlight a paradox. Teachers across all four countries recognize the pedagogical and ecological value of reusing waste materials and often integrate them into art education, yet their practices are highly contingent on institutional infrastructure, cultural traditions, and curricular frameworks.

In Türkiye and Italy, reuse is embedded in everyday practice but constrained by organizational and storage challenges. In Lithuania, positive attitudes and strong use of natural materials coexist with

a lack of structured methodological support. In Slovenia, reuse remains sporadic and hindered by limited resources, weak institutional encouragement, and insufficient collaboration.

This multi-country comparison demonstrates that the success of waste-to-art initiatives depends not only on individual teacher motivation but also on systemic conditions. To fully realize the pedagogical and ecological potential of sustainable art education, future efforts must integrate policy measures, institutional infrastructures, and teacher professional development. Moreover, cross-national exchange of best practices may provide pathways to overcome country-specific barriers and ensure that reuse becomes a normalized component of art education across Europe.

These findings directly relate to the first research question by showing that, although teachers share positive attitudes toward reusing waste, the extent and form of implementation differ significantly depending on national contexts and systemic support. These findings underscore that fostering sustainable art education requires moving beyond individual teacher initiatives. Only through systemic alignment—combining policy frameworks, institutional resources, and international collaboration—can the reuse of waste materials transition from isolated practices to a mainstream educational paradigm.

Discussion

The findings of this study demonstrate that teachers across four European countries share positive orientations toward the reuse of waste materials in art education, yet their practices remain unevenly distributed across contexts. While Turkish and Italian teachers report frequent integration and high levels of student encouragement, Slovenian teachers show lower uptake and more limited reliance on exemplars, with Lithuanian teachers positioned in between—exhibiting relatively strong knowledge but uncertainty regarding practical application. Despite differences, three recurring barriers were consistently emphasized: insufficient storage and infrastructure, time constraints linked to curricular demands, and safety or hygiene concerns. These results resonate with and extend existing research on education for sustainable development (ESD), eco-art education, and teacher agency. Although the effect sizes were small, this is typical for non-experimental, perception-based studies in education. These small effects indicate that differences across national contexts are modest in practical terms and should be interpreted with caution. At the same time, their consistency across items suggest that they are unlikely to be purely random and may reflect underlying institutional structures, curricular frameworks, and pedagogical cultures.

The results align with ESD scholarship showing that teachers widely endorse sustainability principles but face challenges in systematic classroom integration (Kopnina & Meijers, 2014; Laurie et al., 2014). In the field of art education, earlier research has underlined the potential of eco-art practices to foster critical and action-oriented learning (Marques Ibanez, 2023; Pavlou & Vella, 2023; Sanz-Hernandez & Covaleda, 2021). The present study confirms these insights but also highlights that favorable attitudes are insufficient without structural supports, particularly storage systems, safety guidelines, and methodological exemplars. These elements have been identified in prior eco-art studies as crucial for ensuring sustained enactment across classrooms and schools (Inwood, 2013).

Patterns of material use reinforce this point. The widespread reliance on paper and plastic corresponds with literature suggesting that accessible and low-risk materials are more readily integrated into classroom routines (Lee & Manfredi, 2021). Lithuania's pronounced use of natural materials and textiles is consistent with research on early childhood eco-art practices, where tactile and culturally embedded resources are emphasized (Merewether, 2023). Italy and Slovenia's relatively high engagement with metal reflects contexts where industrial off-cuts are available, resonating with studies that associate such practices with expanded material literacy when safety is adequately addressed (Savini, 2021). Türkiye's broader experimentation, which in some cases includes the use of electronic waste, shows that teachers are willing to explore more complex

materials. At the same time, several comments point to uncertainties regarding safety and handling procedures, a concern also highlighted in environmental education research (Goldman et al., 2021).

The results further illustrate the distinction emphasized in prior scholarship between teacher beliefs, which shape intentions, and institutional infrastructures, which determine enactment (Aslan, 2021; Shieh & Reynolds, 2019). Slovenia provides a clear example: teachers' relatively low reported use and perceived scarcity of application examples correspond with qualitative accounts of material deterioration and weak institutional encouragement. Türkiye and Italy, by contrast, show stronger integration despite similar infrastructural challenges, suggesting that cultural norms and leadership signals may offset logistical constraints. The Lithuanian results show that teachers possess solid knowledge of material properties, yet often lack methodological examples or structured guidance. This gap indicates a need for concrete, practice-oriented exemplars, particularly in preschool settings where teachers requested clearer models for implementation (Echegoyen-Sanz et al., 2024; Sinakou et al., 2024).

These findings suggest that teachers' knowledge, confidence and motivation form an important foundation for reuse practices. However, without practical supports such as storage space, clear safety routines, concrete exemplars, and coordinated guidance from school leadership, these intentions rarely become regular classroom practice. This combination of individual capacity and institutional support helps explain both the similarities and the country-specific differences identified in the study.

Research on the materiality of learning stresses that heterogeneous and irregular materials stimulate divergent thinking and improvisation (Cebi, 2025; Hassan, 2020). The findings support this claim while also highlighting the pragmatics that guide teachers' material choices. Categories such as paper and cardboard represent low-friction reuse, requiring minimal preparation, while textiles, metal, or e-waste demand higher-friction practices with explicit safety routines and storage solutions. Reports of teachers incorporating wood, despite its absence from the questionnaire, reflect the adaptability and creativity documented in studies of place-based art education (Caruana et al., 2021; Ison & Bramwell-Lalor, 2023).

Consistent with prior research, the results demonstrate that Waste-to-Art practices carry a strong equity dimension, reducing costs and expanding access for socio-economically disadvantaged students (Knif & Kairavuori, 2020; Yeboah et al., 2017). At the same time, qualitative comments reveal potential framing challenges: without careful positioning, reuse may be perceived as a low-status or cost-saving measure rather than an opportunity for creative exploration. The literature suggests that such risks can be mitigated by embedding reuse within broader design and environmental stewardship frameworks and by showcasing exemplary student work to establish aspirational norms (Inwood, 2013; Pavlou & Vella, 2023).

Several limitations must be acknowledged when interpreting these findings. First, the study relied on non-probability, voluntary-response sampling, and the national samples were highly uneven in size, with particularly small numbers in some countries (e.g. Slovenia). As a result, the data cannot be treated as nationally representative, and cross-national mean comparisons should be viewed as exploratory and indicative rather than definitive. Second, because measurement invariance across the translated questionnaire versions were not formally tested, it remains uncertain whether all items functioned identically across linguistic and cultural contexts; this further warrants caution in interpreting differences in mean scores between countries. Third, the data are based solely on self-reporting teacher perceptions (Area 1), without complementary perspectives from school leadership, students, or parents, which offers only a partial view on how waste reuse is enacted and supported in schools. Fourth, although several national differences reached statistical significance, the effect sizes were small, meaning that the practical magnitude of these differences is modest. Finally, the categorical material-use data were analyzed only descriptively, limiting inferential claims about material preferences across contexts. Despite these limitations, the convergence of quantitative and

qualitative findings across four countries strengthen the interpretive validity of the patterns identified and supports their relevance for understanding the opportunities and constraints in sustainable art education.

Building on these limitations, several research directions emerge. First, design-based implementation studies could investigate how storage systems, safety protocols, and exemplar-sharing platforms influence teacher workload and student learning. Second, longitudinal analyses are needed to examine whether Waste-to-Art practices persist beyond initial novelty. Third, cross-national intervention trials of professional development modules could clarify which forms of support most effectively translate positive beliefs into sustainable practice.

The results point to three priority areas. First, micro-infrastructures such as hygienic storage, labeling systems, and scheduled material rotations are necessary to alleviate teachers' most pressing barriers. Second, safety protocols—including age-appropriate guidelines and tool compatibility matrices—are critical for expanding material repertoires beyond paper and plastic. Third, practice-proximal professional development should provide curated exemplars, lesson blueprints, and assessment tools, thereby addressing the shortage of application examples identified in several contexts. At the systemic level, school leadership and policy frameworks must recognize Waste-to-Art not as an optional enrichment activity but as a core strategy for integrating sustainability into art education.

The findings point to several practical implications for teachers, school leaders, and policymakers. First, addressing teachers' most frequently reported barriers requires micro-level infrastructures, such as dedicated and hygienic storage areas, clear labelling systems, and scheduled material rotations, which can reduce the perceived burden and risk associated with collecting and reusing waste materials. Second, safety and hygiene guidelines need to be made explicit, age-appropriate, and easily accessible so that teachers feel confident expanding material repertoires beyond paper and plastic to include textiles, metal, and selected forms of electronic waste. Third, practice-proximal professional development should provide concrete examples of Waste-to-Art projects, ready-to-use lesson blueprints, and assessment tools, particularly in early childhood and primary education, where teachers in this study reported a lack of methodological support. Finally, school leadership and local education authorities can play a decisive role by explicitly recognizing Waste-to-Art as a core component of sustainable art education, integrating it into curricula, allocating time and space for material collection, and supporting cross-school sharing of good practices.

Conclusions and Implications

This study has shown that the reuse of waste materials in art education represents more than a classroom practice: it is a pathway toward cultivating creativity, ecological responsibility, and equity. Teachers across countries recognize the pedagogical potential of Waste-to-Art, yet their ability to implement it consistently depends on the interplay between individual capability and systemic support. Differences observed between national contexts highlight that positive attitudes alone are insufficient; without infrastructures such as storage systems, safety protocols, and leadership backing, reuse remains sporadic and fragmented.

By examining both quantitative trends and qualitative insights, the research provides a multi-layered picture of opportunities and constraints. The results underscore that sustainable art education cannot rely solely on isolated initiatives but requires institutional alignment and cross-national exchange of practices. When embedded in supportive frameworks, Waste-to-Art can move beyond occasional projects to become an integral part of curricula, equipping students with creative skills, sustainable values, and equitable access to meaningful learning experiences.

Ultimately, the findings stress the importance of reimagining waste not as a limitation but as a resource that can transform both art education and sustainability education when pedagogical innovation is matched with systemic commitment.

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