

Journal of Education and Teaching Learning

Vol. 4, No. 2 (2026) · pp. 1100–1108

p-ISSN 2986-3791 · e-ISSN 2986-3015

https://jurnalilmiah.co.id/index.php/MJPJETL

PUBLISHED BY

PT Media Jurnal dan Pendidikan

RESEARCH ARTICLE

OPEN ACCESS

Implementation of Student Management in Fostering a Culture of Environmental Care in Madrasahs

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ARTICLE HISTORY

Received 6 November 2026

Revised 9 November 2026

Accepted 9 November 2026

Published 21 October 2026

KEYWORDS

Adiwiyata Program; Environmental Behavior; Islamic Schooling; Research Synthesis; Student Environmental Care

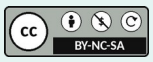
DOI

https://doi.org/10.59211/mjpjetl.v4i2.587

ARTICLE LINK

https://jurnalilmiah.co.id/index.php/MJPJETL/article/view/587/version/595

LICENSE



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ABSTRACT

Environmental care is a sustainability priority; however, associations between institutionally managed school environmental programs and student outcomes in Islamic education remain insufficiently synthesized. This exploratory meta-analysis synthesized three Indonesian studies (N = 186) reporting unadjusted correlations between Adiwiyata-related implementation and environmental-care outcomes. Correlations were converted to Fisher's z and pooled using a restricted maximum likelihood random-effects model; conventional and Hartung–Knapp confidence intervals, heterogeneity statistics, and leave-one-out estimates were examined. The pooled association was positive ($r = 0.635$; conventional 95% CI 0.497–0.742; Hartung–Knapp 95% CI 0.310–0.827), with $Q(2) = 3.647$ ($p = 0.161$), $I^2 = 45.16\%$, and $\tau^2 = 0.01513$. Leave-one-out correlations ranged from 0.569 to 0.693. However, the three studies represented a madrasah, an Islamic boarding school, and an integrated Islamic school, and they combined related but non-equivalent attitudinal and behavioral outcomes. With $k = 3$, estimation of τ^2 and the pooled correlation are unstable. The evidence is observational, reflects a targeted rather than exhaustive search, and does not establish causality or effects of student management as a whole. Future studies should distinguish attitudes from observed behavior, report comparable unadjusted and adjusted estimates, and conduct a preregistered systematic review prior to policy generalization.

HOW TO CITE

S. Hadi, "Implementation of Student Management in Fostering a Culture of Environmental Care in Madrasahs," *Journal of Education and Teaching Learning*, vol. 4, no. 2, pp. 1100–1108, 2026, doi: 10.59211/mjpjetl.v4i2.587.

1. Introduction

Environmental sustainability requires institutional practices that develop students' environmental care alongside formal instruction. Prior meta-analyses have established positive associations between environmental education and knowledge, attitudes, and behavior [1], [2], [3]. However, those pooled findings address broad educational interventions and do not directly quantify the association between institutionally managed environmental programs and students' environmental care in Indonesian Islamic educational institutions. School environmental management is relevant because program planning, student participation, and behavioral routines may provide practical opportunities for environmentally responsible action [4], [5], [6]. Recent syntheses further map school environmental education, sustainability competence, and climate-literacy research, but they address different exposures and outcome definitions [7], [8], [9], [10], [11]. These bodies of literature are relevant contextual background rather than

additional effect sizes for the present model. The distinction is important: evidence about instructional activities, sustainability awareness, or climate literacy cannot automatically be treated as evidence about institutionally managed Adiwiyata programs.

Madrasahs, integrated Islamic schools, and Islamic boarding schools represent related but non-identical educational settings. The Adiwiyata program offers an identifiable institutionally managed exposure, but its measurement may still differ across settings. Environmental care attitudes and behaviors are similarly related rather than interchangeable; operational differences should therefore be recognized in the synthesis [12], [13], [14]. A narrowly scoped quantitative synthesis can estimate the association between reported Adiwiyata implementation and environmental care while acknowledging that this exposure does not encompass every component of student management. Moreover, environmental learning can involve civic participation and action competence [15], environmental justice [16], and the development of knowledge about the Sustainable Development Goals [17]. Such constructs overlap with environmental care but are not identical to it. School-level contextual factors, teacher preparation, and assessment practices also deserve attention when institutional programs are interpreted [18], [19], [20]. Consequently, the present study retains a deliberately narrow definition of its measured exposure and avoids generalizing findings to all dimensions of sustainability education.

Primary evidence was located at MAN 1 Bandung Regency, Daarun Nahdhah Thawalib Bangkinang Islamic boarding school, and SMPIT Insan Madani Tangerang [21], [22], [23]. Their published samples and zero-order correlations permit a transparent, exploratory Fisher-z meta-analysis. Other relevant studies provide partial regression estimates, broader character outcomes, nonmatching predictors, or incomplete sample information, and were therefore not combined in the same effect-size model [24], [23], [24]. Other published interventions address the involvement of parents [25], educational games [26], digital tools [27], technology-supported learning [28], augmented reality [29], and values education [30]. These studies illustrate the diversity of environmental-education approaches rather than providing interchangeable correlations for the current pooled estimate. A narrow synthesis helps avoid treating different program mechanisms as if they represented the same institutional-management construct.

The analytical gap addressed here is not whether environmental education has ever been shown to work, but the absence of a transparent quantitative synthesis restricted to institutionally managed environmental programs and environmental-care outcomes in Islamic educational settings. Because these studies use observational associations, effect sizes should not be interpreted causally. Small numbers of available studies further constrain precision, heterogeneity interpretation, and claims of generalizability. The broader literature also considers environmental identity [31], sustainability-related determinants [32], youth participation and educational relevance [33], and intergenerational environmental influence [34], [35]. Indonesian research on human–nature relationships [36] adds context for the local setting. These strands motivate research on environmental care; yet they cannot establish that the specific management practices studied here account for the observed student-level correlations.

This exploratory synthesis aims to: calculate individual Fisher-z effect sizes and their confidence intervals; estimate a random-effects pooled correlation across the three eligible institutional-program/environmental-care comparisons; quantify heterogeneity and leave-one-out sensitivity; and identify limitations that must be addressed in a subsequent exhaustive PRISMA-based review. This targeted evidence set should not be presented as a completed systematic search of Scopus and Web of Science. Accordingly, the paper makes a limited methodological contribution: it identifies precisely which available summary statistics can be combined and distinguishes this quantitative exercise from the wider literature used to interpret it. It does not claim exhaustive discovery or a causal effect of student management.

2. Literature Review and Hypotheses

Student management encompasses student-related planning, organization, participation, behavioral support, supervision, and evaluation. For the quantitative analysis in this paper, the operational exposure is narrower: student-facing institutional environmental-program implementation, usually measured as the Adiwiyata program. The outcome comprises reported environmental care attitudes or behavior. This restricted operationalization permits comparability while preventing conclusions about management components not directly measured by the primary studies [21], [22], [23].

A whole-school sustainability approach emphasizes the influence of school organizational practices on environmental learning and behavior [4], [5], [6]. Environmental attitudes and practices may respond differently to educational programs [1], [2], [12], whereas self-report measures, cross-sectional designs, and implementation differences can introduce bias [39], [13]. Accordingly, correlations are analyzed on the Fisher-z scale using known group sizes and without assigning causal interpretations.

The exploratory hypothesis is that published zero-order correlations between institutionally managed environmental programs and student environmental care are positive in Islamic educational settings. Heterogeneity is evaluated descriptively, without relying on a nonsignificant Q test as evidence of homogeneity. Broader student-management mechanisms remain a theoretical framing rather than a separately tested exposure.

3. Methods

An exploratory quantitative meta-analysis was performed on a targeted set of primary empirical reports dated 2016–2026. The eligibility criteria required (i) an Islamic educational institution, defined for this synthesis as a madrasah, integrated Islamic school, or Islamic boarding school; (ii) a measured institutional environmental program such as Adiwiyata; (iii) student environmental-care attitude or behavior as the outcome; (iv) a directly reported zero-order Pearson correlation (or clearly equivalent unadjusted simple-regression r) and sample size; and (v) independently sampled participants. The review framework followed PRISMA 2020 reporting principles [40]; however, the targeted source audit was not a comprehensive database search and is not reported as a completed PRISMA flow. Reports were treated as eligible for pooling only when the exposure, outcome, statistic, and sample size could be matched to the predefined synthesis question; related environmental education research was retained solely for contextual interpretation. This deliberate separation reduces the risk of combining statistically incompatible outcomes, although it does not replace a prospectively registered systematic search.

The targeted identification and verification considered nine distinct empirical reports from journal websites, Indonesian publication portals, and accessible repositories, and classified each against the above criteria. Three records were accepted for the exploratory quantitative set [21], [22], [23]. Six were set aside because: their predictor was environmental citizenship rather than program management; the reported statistic was a partial coefficient or a multivariate ANOVA; the environmental-care result was unavailable as a comparable estimate; the respondent count was missing; the outcome combined wider character domains; or the setting was outside the specified Islamic-education population [24], [23], [24]. These counts describe the nine-record targeted audit only and cannot substitute for a full Scopus/Web of Science/GARUDA systematic screening. The identification count is therefore an audit of documents examined by the authors, not a database-derived PRISMA identification total. Absence of a record from the quantitative set does not establish that the underlying study is low quality, only that the required comparable statistics were not confirmed in this audit.

The accepted records were the MAN 1 Bandung Regency study ($n = 85$, $r = 0.543$) [21], the Daarun Nahdhah Thawalib Bangkinang study ($n = 60$, $r = 0.734$) [22], and the SMPIT Insan Madani Tangerang study ($n = 41$, $r = 0.621$) [23]. The Bandung full text explicitly specifies 85 respondents; the remaining two sample sizes and reported correlations were verified against publisher abstracts. Because their instruments and school levels are not identical, comparability is conceptual rather than perfect.

For study i, the observed correlation r_i was transformed to $z_i = \operatorname{arctanh}(r_i)$, with estimated within-study sampling variance $v_i = 1/(n_i - 3)$. A random-effects model was fitted to Fisher-z values using restricted maximum likelihood (REML), and the pooled estimate was back-transformed to r. Cochran's Q used fixed-effect inverse-variance weights; $I^2 = \max(0, (Q - (k - 1))/Q) \times 100\%$. The REML between-study variance τ^2 was reported on the Fisher-z scale. Both a conventional 95% normal-approximation CI and a Hartung–Knapp t-based 95% CI (2 df) were calculated because $k = 3$. Each individual study received a Fisher-z confidence interval back-transformed to r [41], [42], [43], [37]. Because only three studies were available, estimation of between-study variance by REML is especially unstable: small changes in the included studies can materially change τ^2, random-effects weights, and the pooled correlation. The resulting point estimate should therefore be regarded as preliminary rather than as a stable population parameter.

For study i, the observed correlation r_i was transformed to $z_i = \operatorname{atanh}(r_i)$, with estimated within-study sampling variance $v_i = 1/(n_i - 3)$. A random-effects model was fitted to Fisher-z-transformed values using restricted maximum likelihood (REML), and the pooled estimate was back-transformed to r. Cochran's Q used fixed-effect inverse-variance weights; $I^2 = \max(0, (Q - (k - 1))/Q) \times 100\%$. The REML between-study variance τ^2 was reported on the Fisher-z scale. Both a conventional 95% normal-approximation CI and a Hartung–Knapp t-based 95% CI ($df = 2$) were calculated given $k = 3$. Each individual study received a Fisher-z confidence interval back-transformed to r [41], [42]. Because only three studies were available, estimation of between-study variance by REML is especially unstable: small changes in the included studies can materially change τ^2, random-effects weights, and the pooled correlation. The resulting point estimate should therefore be regarded as preliminary rather than as a stable population parameter.

Leave-one-out analyses repeated the random-effects calculation after removing each study, and pooled values were compared. Subgroup, meta-regression, funnel-plot asymmetry, and publication-bias tests were not performed because only three comparable studies were available; their absence is a prespecified limitation rather than a missing computed value. No individual raw respondent records were generated or imputed. The Hartung–Knapp procedure was presented as a sensitivity analysis to quantify uncertainty in a few-study context, not as a remedy for the small evidence base. With only two degrees of freedom, the corresponding interval provides limited precision for policy decisions. No study-level data beyond the reported published summary values were assumed.

4. Results

4.1 Targeted Study Identification and Eligibility

The targeted audit considered nine reports, of which three supplied compatible unadjusted correlations ($N = 186$). Six were excluded for incompatible predictors, outcomes, missing sample details, or statistics. These nine records are not an exhaustive

PRISMA search denominator. The source attributed to Jannah and Purwono (2020) remains bibliographically unverified and was therefore excluded from pooling.

Table 1. Targeted Primary-Evidence Audit

Targeted eligibility-audit stage	Observed count / interpretation
Unique records assessed in targeted audit	9 distinct reports
Reports with directly compatible unadjusted r and sample n	3
Reports not included in the same model	6
Total sample across included studies	186 students
Records from formal madrasahs among the 3 included	1
Additional integrated Islamic school / Islamic boarding-school studies	2
Comprehensive database hits / duplicates / PRISMA full-text flow	Not claimed: targeted search, not exhaustive PRISMA review
Statistical model performed	Three-study REML correlation meta-analysis

4.2 External Environmental Education Benchmarks

Independent syntheses [1], [2], [3] show variation across environmental knowledge, attitudes, intentions, and behavior. Their reported standardized mean differences served as contextual benchmarks only and were not pooled with the present Pearson correlations.

Table 2. Published Environmental Education Meta-Analysis Benchmarks

Published meta-analysis	Verified sample size	Outcome / Hedges' g
van de Wetering et al. [1]	169 studies; 512 effects; N=176,007	Environmental knowledge: 0.953
van de Wetering et al. [1]	Same evidence base	Environmental attitudes: 0.384
van de Wetering et al. [1]	Same evidence base	Behavioral intentions: 0.256
van de Wetering et al. [1]	Same evidence base	Environmental behavior: 0.410
Świątkowski et al. [2]	65 studies; 76 effect sizes	Pro-environmental behavior: 0.530
Hu et al. (2025) [3]	90 articles; 187 effects; N=34,283	Overall: 1.110
Hu et al. (2025) [3]	Same evidence base	Environmental knowledge: 1.350
Hu et al. (2025) [3]	Same evidence base	Environmental attitudes: 0.940
Hu et al. (2025) [3]	Same evidence base	Environmental behavior: 0.680

4.3 Exploratory Random-Effects Correlation Meta-Analysis

Three correlations from the included institutional settings produced a REML pooled r = 0.635 (conventional 95% CI 0.497–0.742; Hartung–Knapp 95% CI 0.310–0.827). Heterogeneity was Q(2) = 3.647 (p = 0.161), I^2 = 45.16%, and τ^2 = 0.01513 on the Fisher-z scale. These estimates reflect exploratory observational associations and should not be interpreted as program effects.

Table 3. Random-Effects Correlation Synthesis and Model Diagnostics

Original Analytical Parameter	Computed Result
Independent included studies (k)	3
Total independent student respondents (N)	186
Pooled Fisher z	0.74987
Pooled correlation r, REML	0.63507
Conventional 95% CI for pooled r	0.49659 to 0.74202
Hartung–Knapp 95% CI for pooled r	0.30973 to 0.82729
Conventional two-sided z-test p	< 0.001 (exploratory; use HK inference below)
Hartung–Knapp t(2) test p	0.0173
Cochran Q (df = 2), p	3.64676; p = 0.16148
I^2 (%)	45.16
Between-study variance tau^2, REML (Fisher-z scale)	0.01513
Leave-one-out pooled r range	0.569 to 0.693
Funnel asymmetry / subgroup / meta-regression analysis	Not performed: k = 3; statistically inappropriate

4.4 Individual Effects, Eligibility, and Sensitivity

Individual estimates were r = 0.543 (95% CI 0.373–0.678), r = 0.734 (0.590–0.833), and r = 0.621 (0.387–0.780) [21]–[23]. Leave-one-out pooled values ranged from 0.569 to 0.693. This range does not establish stability, because only two studies remain after each omission. The squared pooled correlation (≈0.403) is not a pooled R^2 nor a causal proportion of variance explained.

Table 4. Targeted Primary-Study Eligibility and Non-Pooling Reasons

Primary source / institution	n	Reported statistic / original 95% CI	Decision / analytical interpretation
Ayustina et al. [21], MAN 1 Bandung Regency [21]	85	r = 0.543; CI [0.373, 0.678]	Included; Adiwiyata versus environmental care
Alfiah et al. [22], boarding school Bangkinang [22]	60	r = 0.734; CI [0.590, 0.833]	Included; Adiwiyata versus environmental-care attitudes
Amelia (2021), SMPIT Insan Madani [23]	41	r = 0.621; CI [0.387, 0.780]	Included; Adiwiyata versus environmental-care behavior
Abrory & Miftahusyai'an (2025), MAN 1 Gresik [24]	85	partial r ≈ 0.231 from t=2.151, df=82	Excluded from zero-order pool: adjusted regression
Jannah & Purwono (2020), MI Dwi Dasa Warsa (unverified source)	unverified	Reported r = 0.831 (unverified)	Not pooled: n and bibliographic source not independently verified
Ihyauddin et al. [23], MTs Al-Hikam [23]	46	t = 8.836; reported p = 0.048 (inconsistent)	Excluded: composite character outcome, statistical reporting conflict
Yusuf et al. [24], two Madrasah Aliyah [24]	82	r = 0.438	Excluded: environmental citizenship, not institutional program
Herlina et al. (2021), MAN Tasikmalaya	62	F = 6.279; p = 0.014	Excluded: group-comparison/mixed outcome; not a zero-order r
Mutia et al. (2025), SDN 1 Sawojajar	75	r = 0.435	Excluded: non-Islamic school population

4.5 Model Diagnostics and Limitations

The nonsignificant Q test lacks statistical power with only three studies. Crucially, REML τ^2 is highly unstable when k = 3: small changes in eligible studies can alter τ^2, random-effects weights, and the pooled correlation. The Hartung–Knapp interval has two degrees of freedom and remains imprecise [43], [37]. Funnel-plot asymmetry tests and moderator analyses were inappropriate at this study count. The pooled r = 0.635 must not be treated as a stable population parameter or as a madrasah-specific policy benchmark.

5. Discussion

The exploratory estimate (r = 0.635) is consistent with a positive association between institutional Adiwiyata-related implementation and student environmental care in three Islamic educational settings [21]–[23]. It does not establish causal effects. Unlike pooled intervention contrasts in external reviews [1], [2], [3], the present estimate combines observational zero-order correlations. Schoolwide sustainability organization [6], green-school certification [4], and student waste-related practices [5] are potentially relevant mechanisms, but they are not interchangeable measures of student environmental management.

The decision to pool the three outcomes requires explicit qualification. One study measured environmental-care attitudes, one environmental-care behavior, and one environmentally caring behavior or disposition [21]–[23]. All three were provisionally grouped under the broader family of student environmental care because the institutional exposure concerned Adiwiyata and all three effects were unadjusted correlations. This supports an exploratory descriptive aggregation, not evidence that attitudes and behaviors constitute an identical construct. In a wider synthesis [1], standardized effects differed for environmental attitudes (g = 0.384) and behavior (g = 0.410), illustrating that these outcomes should normally be analyzed separately. Those g estimates employ a different effect-size metric and therefore cannot establish direct equivalence with the present r. The pooled correlation is therefore an aggregate of heterogeneous related outcomes; with k = 3, outcome-specific subgroup estimates are not defensible.

An additional descriptive comparison from [1] yields a knowledge–behavior difference of 0.543 (g = 0.953 versus g = 0.410). This arithmetic contrast is neither a formal statistical comparison nor an estimate derived from the current data; no separate table is warranted. Literature on pro-environmental behavior and self-regulation [12], [13], identity [14], and attitudes-to-action pathways [38] reinforces the conceptual importance of distinguishing reported intention, attitudes, and observed practice. Broader

sustainability competency and climate-literacy syntheses [7], [8], [9], [10], [11] also involve distinct constructs, as do environmental justice and agency [15], [16], [17].

Context restricts generalization. The evidence derives from a formal madrasah, an Islamic boarding school, and an integrated Islamic junior school; accordingly, the estimate is not madrasah-specific. Different implementation measures, school levels, and likely self-report outcomes could account for heterogeneity. School practices and assessment [18], [19], [20], parental involvement [25], [35], student identity [31], and youth participation [33] are potential moderators that were not measured in the meta-analysis. Intergenerational environmental behavior [34], locally situated human–nature relationships [36], moral determinants [39], and adolescent environmental action prediction [40] similarly offer context rather than confirming the present mechanism.

The targeted synthesis does not justify broad claims about all management functions. Environmental games, digital activities, augmented reality, and values education [26], [27], [28], [29], [30] represent substantively different interventions, while whole-school organizational factors [32], student sustainability practice [41], and educational participation syntheses [42] identify research questions beyond the included correlations. Research on community-oriented education [43] and the interaction between environmental identity and schooling [31] further suggest that program mechanisms should be tested rather than assumed.

Inferential uncertainty is substantial. The estimate of τ^2 is especially unstable with k = 3, and leave-one-out pooling cannot establish model stability when each refit has only two studies. The Hartung–Knapp interval is wide (0.310–0.827), and its t-based degrees of freedom remain minimal [43], [37]. Observational cross-sectional correlations, construct mismatch, possible common-method bias, and a targeted rather than systematic search preclude definitive causal inference or publication-bias diagnosis. Defensible next steps include preregistered database searching, transparent extraction, formal critical appraisal, independently observed behavioral endpoints, and separate pools for attitudes and behavior where sufficient studies exist [39], [40].

6. Conclusion

Across three heterogeneous Islamic educational settings (N = 186), Adiwiyata-related program implementation was positively associated with reported environmental-care outcomes (REML pooled r = 0.635; Hartung–Knapp 95% CI 0.310–0.827). These outcomes combine attitudes and behaviors; neither construct equivalence nor causality is established. Between-study variance is unstable at k = 3, precluding interpretation of the pooled value as a transferable madrasah policy benchmark. Additional preregistered systematic searches and construct-specific, independently observed outcomes are necessary before generalisable conclusions can be drawn.

Declarations

AUTHOR CONTRIBUTIONS (CREDIT)

CONTRIBUTOR	CREDIT ROLES
Samsul Hadi	Writing – review & editing Writing – original draft Visualization Validation Methodology Conceptualization

FUNDING

Internal Funding

CONFLICT OF INTEREST

no conflict of interest

ETHICS STATEMENT

Data collection, including observations and video recordings, adhered strictly to the institution's academic and ethical standards

DATA AVAILABILITY STATEMENT

-

DECLARATION OF GENERATIVE AI USE

-

ACKNOWLEDGMENTS

-

EDITORIAL RECORD · completed by the Desk Editorial from OJS

SUBMISSION HISTORY

6 November 2026	Submitted
7 November 2026	Sent to peer review
8 November 2026	Revision requested (round 1)
9 November 2026	Revised manuscript received (round 1)
9 November 2026	New review round
9 November 2026	Revision requested (round 2)
9 November 2026	Revised manuscript received (round 2)
9 November 2026	Accepted
9 November 2026	Sent to production

Submission ID 587

CERTIFICATE OF ACCEPTANCE

No. CA-587-54104E
9 November 2026
Scan to verify and download
https://assets.jurnalilmiah.co.id/MJPJETL/generated/Certificate_Author_sub-587_20261109.pdf

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