Education for Sustainable Development a Methodological Framework and Illustrative Analysis of Teacher Educators' Conceptual Understanding of Education for Sustainable Development (ESD)

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ABSTRACT

Education for Sustainable Development (ESD) has emerged as a central pillar of teacher education reform, yet the term continues to be interpreted in widely divergent ways by the very educators responsible for embedding it in classroom practice. This paper has two aims. First, it proposes and documents a structured methodology — a questionnaire-based elicitation procedure, a five-category coding framework and an inter-rater reliability protocol — for empirically mapping teacher educators' conceptual understanding of ESD. Second, it demonstrates this methodology using an illustrative dataset (N = 100, simulated for demonstration purposes) so that the analytic pipeline, from coding through statistical interpretation, can be reviewed and refined before it is applied to the full field data collected for a broader doctoral study. In the illustrative dataset, responses cluster into five categories — environmental-only, economic-only, social-only, holistic/multidimensional and vague/unclear — with a plurality (34%) reflecting an environmental-only interpretation and just under one-third (31%) reflecting a holistic, multidimensional understanding. The paper discusses the implications such a distribution would carry for curriculum design, teacher training and policy, outlines the limitations of the current illustrative demonstration and specifies the steps required to convert this into a fully empirical study.

INTRODUCTION

Since the Brundtland Report [1] first articulated the principle of meeting the needs of the present without compromising the ability of future generations to meet their own needs, the concept of sustainable development has steadily expanded from an environmental slogan into a comprehensive educational philosophy. Education for Sustainable Development (ESD), as promoted through the UN Decade of ESD (2005–2014) and subsequently the Global Action Programme and Sustainable Development Goal 4.7, calls upon education systems to equip learners with the knowledge, skills, values and attitudes needed to make informed decisions for environmental integrity, economic viability and a just society, for present and future generations [2].

Teacher educators occupy a pivotal position in this reform agenda: it is through their instructional choices, curricular emphases and modeling of sustainability values that pre-service teachers acquire the dispositions to carry ESD into primary classrooms. However, a recurring concern in the literature is that ESD remains a contested and loosely operationalised construct, frequently reduced to environmental awareness or eco-club activities rather than treated as an integrated framework spanning ecological, social and economic dimensions [3], [4]. If teacher educators themselves hold a narrow or fragmented understanding of ESD, this conceptual limitation is likely to be transmitted, whether explicitly or tacitly, to the next generation of primary school teachers.

This paper addresses a single, focused research question that forms one objective of a broader doctoral study on teacher education and sustainable development: In what way do teacher educators understand the term “Education for Sustainable Development”? Because full-scale field data collection for the doctoral study is still

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in progress, this paper's contribution at this stage is primarily methodological: it specifies and pilot-demonstrates the instrument, the coding framework, the inter-rater reliability procedure and the statistical approach that will be used to answer this question empirically. An illustrative dataset is used throughout to make the demonstration concrete.

REVIEW OF RELATED LITERATURE

Scholarly work on ESD conceptualization broadly converges on a three-pillar model comprising environmental, social and economic sustainability, often depicted as three interlocking circles [5]. Tilbury [4] argues that ESD is fundamentally a "process" rather than a fixed body of content, emphasizing participatory, transformative pedagogy over the simple transmission of environmental facts. Sterling [3] similarly distinguishes between "education about sustainability" (an add-on, content-focused approach) and "education for sustainability" (a whole-institution, values-driven reorientation of learning).

Despite this conceptual clarity in the academic literature, empirical studies of practitioner understanding consistently report a persistent environmental bias. Studies conducted with in-service and pre-service teachers in multiple national contexts have found that respondents overwhelmingly associate sustainability with recycling, energy conservation and nature protection, with comparatively little reference to social justice, poverty, gender equity, or economic sustainability [6], [7]. This pattern suggests that even where ESD is formally included in teacher education curricula, its interpretation at the classroom level tends to default to the more familiar and historically established discourse of environmental education.

More recent scholarship has extended this line of inquiry specifically to teacher educators. Fischer et al. [8], in a systematic review of the emerging "teacher education for sustainable development" (TESD) field, note that conceptual and empirical work on TESD has grown substantially since the UN Decade of ESD but remains fragmented across disciplines and national contexts, with calls for more comparable, replicable measurement approaches. Using a subjective-theories approach, Lohmann and Goller [9] found that individual teacher educators hold internally coherent but highly varied mental models of sustainability and ESD, ranging from narrowly environmental to broadly transformative conceptions, echoing the category structure adopted in the present study. Similarly, Dittrich [10], drawing on an international teacher-educator sample, reports that institutional culture and policy context strongly mediate how ESD is understood and enacted, reinforcing the case for studies that are explicit about sampling frame and institutional context rather than treating teacher educators as a homogeneous group.

Fewer studies, however, have combined a structured, replicable coding framework with quantitative distributional analysis to categorize teacher educators' self-reported conceptual understanding of the term itself, as opposed to their broader practices or professional identity. This paper aims to contribute to closing that gap by specifying such a framework and demonstrating it on illustrative data, ahead of its application to the full field dataset.

OBJECTIVE AND HYPOTHESES OF THE STUDY

3.1 Objective

To develop and demonstrate a structured coding framework for examining and categorizing the ways in which teacher educators understand and interpret the term "Education for Sustainable Development," and to specify the statistical procedure by which the resulting category distribution will be analyzed once full field data are available.

3.2 Hypotheses

H0: There is no significant variation among teacher educators in their understanding and interpretation of the concept of "Education for Sustainable Development."

H1: There is significant variation among teacher educators in their understanding and interpretation of the concept of "Education for Sustainable Development."

RESEARCH METHODOLOGY

4.1 Research Design

The study employs a descriptive survey design combined with qualitative content analysis. An open-ended questionnaire item — "In what way do you understand the term 'Education for Sustainable Development'?" — is administered to elicit free-text responses, which are subsequently coded into discrete conceptual categories.

4.2 Study Context and Sampling Strategy

The target population is teacher educators employed in institutions offering primary-level (elementary) teacher preparation programmes. A stratified purposive sampling strategy is proposed, stratifying institutions by management type (government vs. private/aided) and locale (urban vs. rural) to guard against the sample over-representing any single institutional context. Within each stratum, teacher educators are to be selected via simple random sampling from institutional faculty rosters. This design is intended to improve representativeness relative to a convenience sample, though it cannot fully eliminate self-selection bias inherent in voluntary participation.

4.3 Sample

For the purpose of this methodological demonstration, illustrative data based on a representative sample of one hundred (N = 100) teacher educators is presented; the coding and analytic procedure described here is designed to be replicated with the full field data collected for the doctoral study. Table 2 summarizes the illustrative demographic profile of this sample.

Characteristic	**Category**	**Illustrative n (%)**
Gender	Female	64 (64%)
	Male	36 (36%)
Teaching experience	0–5 years	28 (28%)
	6–15 years	45 (45%)
	Above 15 years	27 (27%)
Institution type	Government	58 (58%)
	Private/aided	42 (42%)
Locale	Urban	61 (61%)
	Rural	39 (39%)

As Table 2 is illustrative, it should be read only as a template for the demographic reporting that will accompany the full dataset, not as a description of an actual sample.

4.4 Tool and Coding Procedure

Responses are analyzed using thematic content analysis. Two independent coders classify each response into one of five categories — Environmental Dimension Only, Economic Dimension Only, Social Dimension Only, Holistic/Multidimensional Understanding and Vague/Unclear Understanding. Because pilot coding indicated that some responses reference two, but not all three, sustainability pillars (for example, environmental and social

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concerns without any economic reference), a sixth, non-mutually-exclusive descriptive code — Partially Multidimensional — is retained for reporting purposes, while the primary five-category scheme is used for the formal hypothesis test. This addition is intended to reduce the oversimplification that can occur when a rigid five-way forced choice is applied to responses that are multidimensional in a limited sense.

Inter-coder agreement is quantified using Cohen's kappa in addition to simple percentage agreement and disagreements are resolved through discussion with a third, senior coder acting as arbiter where required. In the illustrative demonstration below, an illustrative kappa of $\kappa = 0.82$ (substantial agreement, per Landis and Koch's benchmarks) is reported; this value is a placeholder pending calculation on the actual field data.

4.5 Planned Statistical Analysis

Frequencies and percentages are computed for each of the five primary categories. A one-sample chi-square goodness-of-fit test is one candidate procedure for testing H0, but the assumption of an equal 20% expected distribution across categories has no independent theoretical justification — it merely represents the mathematically neutral baseline of "no category is favoured." Because this baseline is unlikely to reflect any real-world prior distribution of conceptual understanding, the chi-square result is reported here as a descriptive illustration of the technique rather than as confirmatory evidence and it is supplemented with Cramér's V as an effect-size measure, which does not depend on the choice of expected distribution. Where prior studies provide a more defensible expected distribution (for example, based on Summers, Corney and Childs [6] or Kagawa [7]), that distribution will be used as the comparison baseline for the full-data analysis instead of an equal split.

DATA ANALYSIS AND RESULTS

> The figures, statistics and quoted responses in this section are illustrative and are presented solely to demonstrate the reporting format that will be used once full field data are available.

Table 1 presents the distribution of teacher educators' illustrative responses across the five primary conceptual categories (with the supplementary Partially Multidimensional code shown separately for transparency).

Table 1: Distribution of Teacher Educators' Understanding of ESD (N = 100, Illustrative Data)

Category of Understanding	**Frequency (n)**	**Percentage (%)**	**Rank**
Environmental Dimension Only	34	34%	1
Holistic / Multidimensional Understanding	31	31%	2
Partially Multidimensional (two of three pillars)	6	6%	6
Vague / Unclear Understanding	9	9%	4
Social Dimension Only	12	12%	3
Economic Dimension Only	8	8%	5
Total	**100**	**100%**	**—**

Figure 1 (not reproduced here) would present the same distribution as a bar chart; it is omitted from this methodological demonstration pending real data.

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5.1 Statistical Interpretation

A one-sample chi-square goodness-of-fit test was computed against an equal-distribution baseline of 20% per category (df = 4). The obtained value ($\chi^2 = 26.20$, $p < .001$) exceeds the critical value at the 0.05 level of significance, which would lead to rejection of the null hypothesis under this baseline. The associated effect size, Cramér's V = 0.26, indicates a moderate departure from an even distribution. As noted in Section 4.5, because the equal-distribution baseline is not theoretically grounded, this result should be read as illustrating the analytic procedure rather than as evidence that teacher educators' understanding of ESD is, in fact, unevenly distributed. When full field data are analyzed, the same procedure will be repeated against both the equal-distribution baseline and a literature-informed baseline and both results will be reported.

5.2 Descriptive Interpretation, with Illustrative Response Examples

Each category is illustrated below with a short, anonymized example response consistent with the kind of language the coding framework is designed to capture. These examples are constructed for demonstration purposes and do not correspond to any real respondent.

- Environmental Dimension Only (34%): The largest illustrative group of respondents equated ESD primarily or exclusively with environmental conservation, ecological awareness and nature-related activities. Example: “ESD means teaching children to protect the environment — planting trees, saving water and not wasting resources.”

- Holistic/Multidimensional Understanding (31%): Just under one-third of illustrative respondents articulated an integrated understanding of ESD encompassing environmental, social and economic dimensions. Example: “ESD is about preparing learners to think about the environment, fairness in society and how the economy affects both, so that future generations are not disadvantaged.”

- Partially Multidimensional (6%): Responses referencing two of the three pillars. Example: “It is education that connects caring for nature with caring for our community.”

- Vague/Unclear Understanding (9%): Responses that were tautological, superficial, or did not meaningfully engage with the term. Example: “ESD is education that is sustainable.”

- Social Dimension Only (12%): Responses emphasizing social equity, inclusion and community participation without reference to environmental or economic sustainability. Example: “ESD means preparing children to be responsible, inclusive citizens who respect others.”

- Economic Dimension Only (8%): Responses framing ESD primarily in terms of resource efficiency, economic viability, or livelihood-related concerns. Example: “ESD is teaching students to use resources wisely so that livelihoods can be sustained long-term.”

DISCUSSION

If the pattern in the illustrative dataset were to hold in the full field data, it would corroborate earlier findings in the international literature [6], [7] that practitioner understanding of ESD tends to gravitate toward its environmental dimension at the expense of its social and economic components. A holistic understanding confined to roughly one in three teacher educators would be a matter of considerable interest for teacher education policy, since a narrow environmental framing risks producing primary school teachers who, in turn, present ESD to children as closer to nature study than to an integrated framework for critical, values-based decision-making. This concern is consistent with the more recent teacher-educator literature: Lohmann and Goller [9] similarly find wide variation in individual teacher educators' subjective theories of ESD and Dittrich [10] links such variation to differences in institutional and policy context rather than to teacher educators' capability per se — a nuance the present framework is designed to capture through the demographic and institutional variables specified in Section 4.3.

The proportion of vague or unclear illustrative responses (9%) would, if replicated in real data, suggest that for a meaningful minority of teacher educators, ESD functions more as institutional or policy rhetoric than as an internalized pedagogical construct — a pattern consistent with Sterling's [3] distinction between superficial "bolt-on" engagement with sustainability language and genuine transformative reorientation of teaching philosophy.

The comparatively low proportion of economic-dimension illustrative responses (8%) is also noteworthy as a hypothesis to test with real data. Economic sustainability — including concerns such as equitable resource distribution, sustainable livelihoods and responsible consumption — may be the least salient of the three ESD pillars in teacher educators' conceptual repertoire, possibly reflecting the relative absence of economics-related content in teacher education curricula as compared to environmental science content. This remains speculative until tested against actual field data.

LIMITATIONS

- Illustrative data: the results reported in Section 5 are simulated for demonstration purposes and must not be interpreted as empirical findings; all substantive conclusions are conditional on replication with real field data.

- Coding scheme: even with the added Partially Multidimensional code, a categorical scheme necessarily compresses some nuance in open-ended responses; richer multidimensional coding (e.g., multi-label coding permitting more than one code per response) may be considered for the full analysis.

- Self-report bias: questionnaire responses reflect what teacher educators say they understand ESD to mean, which may not fully correspond to how they enact ESD in their teaching practice.

- Generalizability: even with stratified sampling, findings from any single national or regional context may not generalize to teacher educators elsewhere.

- Statistical baseline: as discussed in Section 4.5, the equal-distribution chi-square baseline is a methodological convenience rather than a theoretically derived expectation and results based on it should be interpreted with corresponding caution.

ETHICS STATEMENT

The doctoral study underlying this paper will be conducted in accordance with standard human-subjects research ethics: informed consent will be obtained from all participating teacher educators, participation will be voluntary and confidential, responses will be anonymized prior to coding and analysis and the study protocol will be reviewed by the researcher's institutional ethics review board prior to field data collection. No identifying information about individual respondents will be reported. The illustrative response examples in Section 5.2 are constructed for demonstration purposes and do not describe real individuals.

CONCLUSION AND RECOMMENDATIONS

This paper set out to develop and demonstrate a structured methodology for examining how teacher educators understand the term "Education for Sustainable Development," pending completion of full field data collection for a broader doctoral study. The illustrative demonstration suggests — provisionally and subject to confirmation with real data — that understanding may be neither uniform nor, in most cases, holistic: teacher educators may commonly reduce ESD to its environmental dimension, while integrated, multidimensional understanding could remain less common than narrower interpretations. Under the illustrative data, the null hypothesis of no significant variation in understanding would be rejected; whether this holds for the actual teacher-educator population sampled remains to be established empirically.

On the basis of this methodological framework and its illustrative demonstration, the study recommends: (i) proceeding to full-scale field data collection using the stratified sampling strategy and instrument specified in

Section 4; (ii) applying the dual-baseline statistical approach specified in Section 4.5, reporting both the equal-distribution and literature-informed chi-square results alongside Cramér's V; (iii) reporting inter-coder reliability (Cohen's kappa) for the real dataset, together with a random sample of anonymized illustrative-style response excerpts, to make the coding process transparent and auditable; and, contingent on the empirical findings, (iv) considering the introduction of dedicated ESD orientation modules within teacher education curricula that explicitly address the social and economic and not only the environmental, pillars of sustainability, together with sustained in-service professional development as recommended in [3]. These measures, taken together, are intended to ensure that any future empirical claims about teacher educators' understanding of ESD rest on a transparent, reliable and theoretically grounded methodology.

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