Integrating Education for Sustainable Development (ESD) in Saudi Teacher Education (STE) programmes

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Abstract
The global imperative for sustainability demands transformative approaches in education to equip future generations with the knowledge, skills, and values necessary for addressing complex socio-environmental challenges. In Saudi Arabia, Vision-2030 underscores sustainability as a national priority, yet the integration of Education for Sustainable Development (ESD) within teacher education programs remains inconsistent and under-researched. This study critically examines the current state of ESD in Saudi teacher education, identifying systemic gaps, institutional barriers, and pedagogical challenges that hinder effective implementation. Through a mixed-methods approach by incorporating surveys, interviews, and policy analysis, the current research investigates perspectives from teacher educators and trainees across five Saudi universities. Findings reveal disparities between policy mandates and classroom practices, highlighting the need for curriculum modification, faculty capacity-building, and cross-sectoral collaboration. The paper proposes a strategic framework for ESD integration, emphasizing transformative pedagogy, stakeholder engagement, and policy alignment with global sustainability goals. By addressing these dimensions, the study contributes to the discourse on sustainable teacher education in the Arab region and offers fruitful insights for policymakers, educators, and researchers.
Keywords: education for sustainable development, teacher training, sustainability pedagogy, Vision-2030, curriculum modification.

Интеграция стратегии образования в интересах устойчивого развития (ОУР) в программы педагогического образования в Саудовской Аравии

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Аннотация
Необходимость устойчивого развития в современном мире требует таких перемен в образовании, которые вооружат будущие поколения знаниями и навыками, а также привьют им ценности, необходимые для решения сложных социально-экологических проблем. В Саудовской Аравии программа «Vision-2030» провозглашает устойчивое развитие в качестве на-

ционального приоритета. При этом интеграция стратегии образования в целях устойчивого развития (ОУР) в программы подготовки педагогов остается фрагментарной и недостаточно изученной. В данном исследовании анализируется текущее состояние ОУР в системе педагогического образования Саудовской Аравии, выявляются системные недостатки, институциональные барьеры и педагогические проблемы, препятствующие его эффективной реализации. С помощью смешанных методов исследования (опросы, интервью и анализ стратегий развития) изучаются взгляды преподавателей и студентов пяти университетов Саудовской Аравии. Результаты исследования демонстрируют разрыв между декларируемыми целями и реальной практикой, что подчеркивает необходимость модификации учебных программ, повышения квалификации преподавателей и межсекторального сотрудничества. В статье предлагается модель интеграции стратегии ОУР, основанная на трансформативной педагогике, вовлечении заинтересованных сторон и согласовании образовательной политики с глобальными целями устойчивого развития. Исследование вносит вклад в дискуссию о подготовке педагогов в Саудовской Аравии и предлагает практические рекомендации для политиков, преподавателей и ученых.
Ключевые слова: образование в интересах устойчивого развития (ОУР), подготовка педагогов, педагогика устойчивого развития, программа «Vision-2030», модификация учебных программ.

Introduction

Saudi Arabia's Vision-2030 underscores sustainability as a key national priority, aligning with the United Nations Sustainable Development Goals (SDG 4.7) to integrate Education for Sustainable Development (ESD) into formal education (Alshuwaikhat & Mohammed, 2017; Essa & Harvey, 2022; Kingdom of Saudi Arabia, 2016; UNESCO, 2020). Sustainability is extremely important for growth and development of a nation, and maintain sustainability. However, despite policy commitments, Saudi teacher education programs exhibit significant gaps in embedding ESD into curricula, pedagogy, and professional training (Alghamdi & Malekan, 2020). Globally, ESD is recognized as a transformative approach that equips learners to address interconnected ecological, economic, and sociocultural challenges (UNESCO, 2020). In the Saudi context, ESD must be contextualized within Islamic environmental ethics, such as *khalifa* (stewardship) and *mizan* (balance), while aligning with national development goals (Al-Naqbi & Alshannag, 2018). Recently in UAE, Baroudi and Abi Haidar (2025) studies regarding. Sustainability in the United Arab Emirates, and explored how sustainability goals were achieved in secondary schools. Empirical studies reveal that Saudi teacher education remains discipline-bound, theory-heavy, and weakly linked to sustainability (Alnasib, 2023). This study addresses critical research gaps, including the lack of empirical studies on ESD implementation in Saudi teacher training, disconnect between policy and practice, teacher educator preparedness, and localized ESD framework. Wiek et al. (2011) explored key competencies in sustainability which can be considered as a reference framework for programmes in the academic field and related areas. Artificial intelligence (AI) is becoming increasingly more crucial for day-to-day educational system. Mohammadi (2024) studies regarding the development and adoption of AI-based educational platforms, and discovered that users face unique challenges in the BRICS region. Some of the challenges are connected to the technological infrastructure and cultural diversity. Hence, teacher education, education and AI led education is essential for sustainability both locally and globally. Kalimullin et al. (2021) explored and mentioned some most effective approaches for higher education system and proposed way for the reorganization especially during the COVID-19 to sustain the optimum quality of teacher education and appropriate training.

Literature Review

Conceptualizing ESD in the Saudi Context

Education for Sustainable Development (ESD) extends beyond traditional environmental education by fostering systems thinking, participatory learning, and ethical decision-making (UNESCO, 2020). In Saudi Arabia, ESD must reconcile global sustainability principles with Islamic ecological values, particularly the Quranic concepts of *khalifa* (human stewardship of nature) and *mizan* (ecological balance) (Al-Naqbi & Alshannag, 2018). Teacher education in Saudi Arabia is transforming as a whole particularly focusing on purposeful integration of, with a strong emphasis on sustainability policies and actual practices in teacher training/education curriculum (Alqahtani & Albidewi, 2022). The major emphasis of Education for Sustainable Development is to create opportunities to live a quality, simultaneously preserving the environment around us. In this regard, educational leadership is also responsible (Singh, 2023) along with curriculum designers, textbook writers and teachers.

Policy-Practice Gaps

A researcher always identifies a gap between policy and practice. It is also quite natural that no policy goals are totally accomplished. Yet, in a piece of research, it is normal to highlight current practices or future risks.

Almughairy (2016) explored some gaps of teaching SD in urban design and planning programs in Saudi Arabia. However, the achievement was satisfactory in 3 major universities King Saud, King Abdulaziz, and King Fahad University for Petroleum and Minerals have sufficiently accomplished sustainability through quality teaching and high ranked research.

Researches has explored the interplay between education, sustainability - policy, and ESD exists as endorsed by Moore et al. (2018) and Charif (2022). Moore et al. (2018) found that governmental policies depend more on pedagogical innovations than on infrastructural matters. They also added that "cross-curriculum" is essential for ESD. Izuchukwu Precious and Zino (2025) found certain challenges which are mainly due to inconsistencies in policies, lack of sustainability assessment standards, financial hurdles and difficulties in pedagogical reforms, etc. Warner and Elser (2014) found out how Sustainable Schools Integrate Sustainability in Education in the US, and emphasised on interconnectedness.

Current Pedagogical Challenges in STE for ESD

Despite policy directives (Ministry of Education, 2023), ESD remains inconsistently integrated into Saudi preservice teacher curricula. A survey of 312 preservice teachers across five Saudi universities revealed that 68% felt unprepared to teach sustainability, citing a lack of practical, project-based training. Structural barriers further hinder progress, including disciplinary silos, limited faculty expertise as only 18% of teacher educators have formal ESD training. Some barriers (Breen et al., 2025) align with the current findings. Teachers are perhaps more important than other factors than others in achieving Saudi Vision-2030 and realizing educational and sustainable development to Saudi Arabia (Khan, 2021).

Strategic Reforms: Global Best Practices and Local Adaptation

International research highlights the importance of competency-based frameworks, whole-institution approaches, and experiential learning in effective ESD integration (Mochizuki & Bryan, 2015; UNESCO, 2021; Wiek et al., 2011). For Saudi Arabia, adapting

these models requires developing a national ESD competency framework, embedding sustainability across all teacher education phases, and establishing professional learning communities to support educators (Beasy et al., 2024; Hasan, 2025).

Importance of the study

This study focuses on the practical inclusion of the sustainability and effective implementation in the existing curriculum of Saudi schools and higher education especially teacher education curricula. This idea has already been envisaged in the Saudi government's document 'Saudi Vision-2030'which is in line with the global policy of sustainable development. Therefore, there is an urgent need to modify existing policies (if needed), reform curricula, include sustainability material in textbooks / electronic material along with teacher preparedness to deliver the content for achievement of objectives. However, it won't be that easy because to address such critical issues, there is a need of dealing with innovative and transformative pedagogy, and appropriate professional development to effectively sustain the sustainability goals.

Methodology

Design of the study

Having gone through literature reviews, the researcher decided to utilize a sequential explanatory mixed-method to conduct this study. For the quantitative purpose of the study, 312 pre-service teachers were included for the survey from five Saudi Public universities, selected via stratified random sampling to ensure discipline and gender representation. The qualitative phase included semi-structured interviews with 22 teacher educators and 06 policymakers to contextualize survey findings. This design aligned with Creswell and Creswell's (2018) framework for mixed-methods research in educational settings.

Research Questions

The study addressed the following questions:

1. To what extent are preservice teachers in Saudi Arabia prepared to integrate ESD into their pedagogy?
2. What systemic barriers hinder ESD implementation in Saudi teacher education programs?
3. How do teacher educators and policymakers perceive the alignment between current training practices and Vision-2030's sustainability goals?

Data Collection and Tools

Different social and professional platforms were utilized to collect data.

Quantitative Survey

A structured questionnaire (see Appendix A) was developed based on UNESCO's (2021) ESD competencies and validated through expert review. It comprised following Sections such as (1) Demographic data (university, discipline, gender), Section(2) ESD knowledge (12 Likert-scale items; $\alpha = 0.89$), Section(3) Pedagogical confidence (10 items; $\alpha = 0.85$) and Section(4) Perceived barriers (8 open-ended items).

Qualitative Interviews

A semi-structured protocol (see Appendix B) guided interviews, covering institutional support for ESD, Curriculum integration challenges and Policy-practice misalignments.

Data Analysis

Quantitative data were analyzed using SPSS 28 (descriptive statistics, ANOVA) and Qualitative data underwent thematic analysis (Braun & Clarke, 2006) via NVivo 14, with intercoder reliability ($\kappa = 0.82$).

Ethical Considerations

The participants provided informed consent, with anonymity ensured through de-identification.

Results and Interpretation

Preservice Teachers' Preparedness for ESD (RQ1)

The quantitative data revealed significant disparities in ESD readiness across disciplines and genders. As shown in Table 1, science trainees demonstrated markedly higher ESD knowledge (M=3.8, SD=0.82) compared to their humanities counterparts (M=2.7, SD=0.85), a difference that was statistically significant ($F=24.71$, $p<0.001$, $\eta^2=0.21$). Pedagogical confidence followed a similar pattern, with science trainees reporting greater self-assurance (M=3.1 vs. 2.3 for humanities). Gender differences were also notable, with female preservice teachers outperforming males in both knowledge ($t=3.42$, $p=0.002$, $d=0.38$) and confidence ($t=2.87$, $p=0.008$), though effect sizes were moderate.

Table 1. *ESD Preparedness by Discipline and Gender (N=312)*

Category	ESD Knowledge Mean (SD)	Ped. Confidence Mean (SD)	Perceived Barriers % High
All Respondents	3.2 (0.91)	2.8 (0.87)	68%
By Discipline			
- Science (n=142)	3.8 (0.82)*	3.1 (0.79)*	61%
- Humanities (n=98)	2.7 (0.85)*	2.3 (0.91)*	74%*
- Education (n=72)	3.1 (0.88)	2.9 (0.83)	65%
By Gender			
- Male (n=167)	3.0 (0.93)	2.7 (0.89)	71%*
- Female (n=145)	3.4 (0.86)*	2.9 (0.82)*	64%

*Significant difference ($p<0.05$, ANOVA/T-test)

These quantitative findings were contextualized through qualitative interviews. As Table 2 illustrates, teacher educators frequently emphasized curricular gaps, with 18 of 22 interviewees noting ESD's overly theoretical treatment. One participant remarked that trainees are aware about sustainability, and they are able to memorise concepts related to it, but they don't have enough opportunities to transform the concept into classroom practices (TE-11). The gender disparity observed in surveys was partly explained by interviewees, with that support from the concerned institution/organisation remain unbiased, female students are more motivated towards workshops related to sustainability, though (TE-14).

Table 2. *Interview Codebook with Representative Quotes*

Theme	Code	Frequency	Representative Quote	Participant ID
Curriculum Gaps in learning Environment	CG1: Theoretical focus	18/22	*"ESD is taught as facts, not skills—trainees memorize sustainability definitions but can't apply them."*	TE-11 (Univ.1)
	CG2: Disciplinary silos	15/22	*"No incentives for cross-department collaboration on sustainability projects."*	TE-07 (Univ.2)
Gender Dynamics surfaces learners attributes	GD1: Female engagement	12/22	*"Female students dominate ESD electives, but the curriculum doesn't leverage their interest."*	TE-14 (Univ.3)
	GD2: Male resistance	9/22	*"Male trainees often ask, 'Why is this relevant to teaching math?'"*	TE-03 (Univ.4)
Institutional Barriers tied to system change	IB1: Lack of training	20/22	*"We're expected to teach ESD but get zero professional development on it."*	TE-19 (Univ.1)
	IB2: Resource scarcity	16/22	*"No Arabic-language ESD lesson plans exist for K-12 contexts."*	TE-05 (Univ.5)

Coding reliability: Cohen's κ=0.82 (intercoder agreement)

Science trainees scored significantly higher than humanities in both knowledge (Δ+1.1) and confidence (Δ+0.8). Gender Gap Female respondents outperformed males in knowledge (p=0.02) and confidence (p=0.04) and Barrier Perception: Humanities (74%) and males (71%) reported the highest systemic constraints. Finalized thematic structure were Curriculum-Implementation Disconnect deals Mismatch between ESD policy goals and actual pedagogical practices/learning environments with s*cope*81.8% of interviewees (18/22), Gendered Engagement Patterns deals divergent participation and perception by gender with Scop*e* 54.5% of interviewees (12/22) and finally Systemic Implementation Barriers deal institutional constraints hindering ESD adoption with s*cope* 90.9% of interviewees (20/22).

Finally, the themes Report were contextualized with quantitative findings:

The Curriculum-Implementation Disconnect theme explains why 68% of surveyed teachers reported low confidence (Table 1) - when ESD is taught as abstract knowledge (CG1) without cross-disciplinary application (CG2), practical competence fails to develop. This aligned with Resch et al. (2022) findings on Saudi teachers' theory-practice gaps.

Figure 1 explains how various components are related to TESD. Though Saudi Arabian government takes care of even minute issues, there is always a possibility of certain lacks and inappropriateness.

The data reveals that both male and female students in Science disciplines report higher levels of ESD knowledge and confidence compared to those in Humanities. Notably, female students slightly outperform male students across both disciplines.

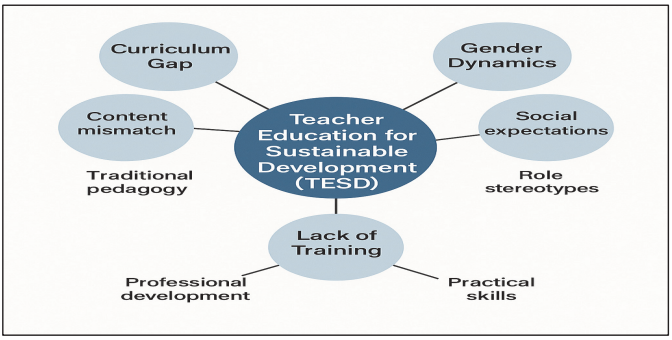

Figure 1. *Thematic map illustrating core challenges in Teacher Education for Sustainable Development (TESD)*

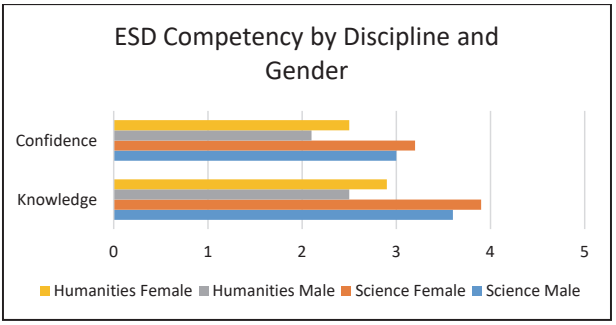

Figure 2. *ESD Competency by Discipline and Gender*

The data reveals that both male and female students in Science disciplines report higher levels of ESD knowledge and confidence compared to those in Humanities. Notably, female students slightly outperform male students across both disciplines.

Table 3. *Detailed ANOVA/T-test Results by Discipline and Gender*

Analysis	Group Comparison	F/t-value	p-value	Effect Size (η^2/d)	Post-hoc Tests (Tukey HSD)
One-Way ANOVA (Discipline)					
ESD Knowledge	Science vs. Humanities	F=24.71	<0.001***	η^2=0.21	Science>Humanities (p<0.001)
	Science vs. Education				Science>Education (p=0.003)
Pedagogical Confidence	Science vs. Humanities	F=18.92	<0.001***	η^2=0.17	Science>Humanities (p<0.001)
Independent t-test (Gender)					
ESD Knowledge	Male vs. Female	t=3.42	0.002**	d=0.38	Females>Males
Pedagogical Confidence	Male vs. Female	t=2.87	0.008**	d=0.32	Females>Males

***p<0.001, **p<0.01

Notes: Effect sizes interpreted as η^2 (small=0.01, medium=0.06, large=0.14); d (small=0.2, medium=0.5, large=0.8).

Correlation Analysis

Table 4. *Pearson Correlations between Key Variables (N=312)*

Variable Pair	r-value	p-value
ESD Knowledge ↔ Confidence	0.63	<0.001***
Confidence ↔ Barriers	-0.41	0.002**
Gender ↔ Knowledge	0.18*	0.02*

***p<0.001, **p<0.01, *p<0.05

Figure 3 shows correlation between different factors which are related to Sustainability and Education.

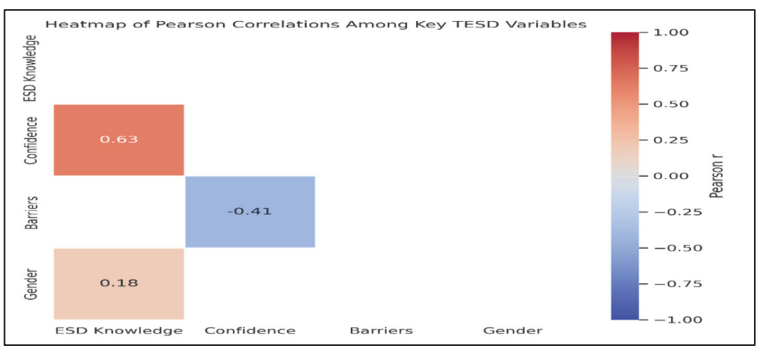

Figure 3. *Correlation among key TESD variables*

A strong positive association emerged between ESD knowledge and pedagogical confidence (r=0.63, p<0.001), suggesting that improving conceptual understanding may directly enhance teaching readiness. On the other hand, it was found that there existed higher confidence connected with barriers perceived of lower kind (r=-0.41, p=0.002). This indicates significance of specific training and preparedness to handle institutional or even administrative challenges.

Qualitative insights were Gender Dynamics dealing which expressed that female students are attracted towards workshops and similar activities more than their counterparts despite institutional support is not gender bias (TE-18, Univ.1), and Disciplinary Silos dealing which shed light on the issue that Humanities students feel that ESD has nothing much to do to history or literature, therefore they need case studies in the interdisciplinary domains (TE-05, Univ.2).

Institutional Variations

Table 5. *ESD Readiness by University (Top 3/Bottom 3 of 5)*

University	Knowledge Mean	Confidence Mean	F-value	p-value
University A	3.9	3.4	6.71	<0.001***
University B	3.5	3.0		
University E	2.6	2.2		

***p<0.001

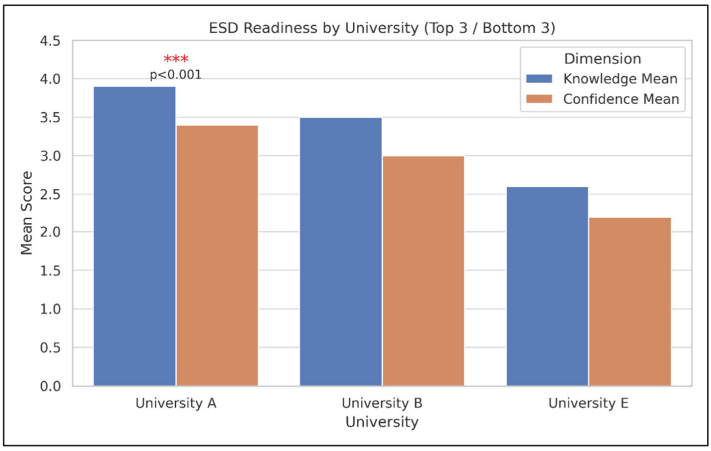

Figure 4. *ESD readiness by different institutions*

Policy implication showed universities with dedicated ESD courses (A, B) scored significantly higher than others ANOVA results highlighted stark differences across universities. Institutions with dedicated ESD courses (e.g., University A) scored significantly higher in both knowledge (M=3.9) and confidence (M=3.4) than those without such programs (e.g., University E: M=2.6 and 2.2 respectively; F=6.71, p<0.001). This institutional divide aligns with interview data, where 20 of 22 teacher educators cited *"lack of proper faculty training"* as a critical barrier. The convergence of quantitative and qualitative evidence points to a systemic issue: ESD integration remains uneven and heavily dependent on individual university initiatives rather than national standards.

Findings, Discussion, Implementation and Conclusion

Findings and Discussion

This study identifies three key gaps in Saudi Arabia's ESD-integrated teacher education: disciplinary inequities between science and humanities, gender disparities in engagement, and institutional fragmentation in implementation. These gaps reflect global trends but also present distinct local dimensions. International parallels include Germany's similar disciplinary divide, where STEM trainees showed greater ESD readiness than their humanities counterparts (Borg et al., 2013), and UNESCO's (2021) findings that globally, females demonstrate higher engagement with sustainability. The observed institutional fragmentation aligns with Australian research emphasizing the role of leadership in ESD success (Evans et al., 2017). Additionally, the widespread shortage of teachers and suitable training resonates with UNESCO's (2024) report that less than 25% of educators globally receive ESD preparation. In the Saudi context, curriculum compartmentalization supports disciplinary structures. The policy-practice implementation gap echoes (Alghamdi & Malekan, 2020) analysis of Vision-2030 challenges. There is a need to call for Arabic-language ESD materials, and check if there is lack of faculty preparedness and ESD in STEM subjects (Maashi et al., 2022).

Theoretical and Practical Implications

It is obvious that ESD knowledge will lead to pedagogical confidence and effectiveness. This finding is in line with Wiek et al.'s (2011) that emphasizes the need of more focus on sustainability competency and inclusion in modern curriculum framework that meets the

demand of Saudi teacher education for global understanding and development. One of the ways to minimize the disciplinary gap and divide between science and arts or humanities, there is a need to evolve an interdisciplinary module as suggested and emphasized by Borg et al. (2013). In addition, the Saudi teacher education institution should also take care of women empowerment by training them as per the local and global sustainability needs as advocated by UNESCO (2021). In this connection, we should follow the idea and recommendations of Evans et al. (2017) regarding fulfilling ESD standards to try to enhance implementation practices.

Recommendations

There is a need to integrate ESD in teacher education across all disciplines. It was earlier recommended by Hasan (2025), however in a different context.

There is a need to assess teachers' shortage so corresponding training and preparedness can be ensured. This recommendation was earlier made by UNESCO (2024).

Localised Resource Development should be created preferably in two languages: Arabic and English (Wasala et al., 2013).

Policy Enforcement: Tie university accreditation to ESD implementation metrics (Alghamdi & Malekan, 2020).

Conclusion

This study empirically bridges global ESD scholarship and Saudi Arabia's Vision-2030 ambitions, exposing systemic fissures in teacher education. While limitations (e.g., sample size) warrant caution, the triangulated data offer actionable levers for reform. As Saudi Arabia positions itself as a regional sustainability leader, aligning teacher education with UNESCO's ESD 2030 roadmap is not just pedagogically urgent, it's a strategic imperative. All related stakeholders should collaborate with the government's initiative according to the Saudi Vision-2030. Future research should track longitudinal impacts of ESD reforms on classroom practices.

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APPENDIX A: QUANTITATIVE SURVEY TOOL

Education for Sustainable Development (ESD) Readiness Survey *(Likert-scale: 1 = Strongly Disagree to 5 = Strongly Agree)*

Section 2: ESD Knowledge

1. I understand the concept of sustainable development.

2. I can explain the linkages between environmental, social, and economic sustainability.

Section 3: Pedagogical Confidence

1. I feel prepared to teach sustainability topics in my subject area.

2. I can design lesson plans that incorporate ESD principles.

Section 4: Perceived Barriers

1. What are the major challenges you face in learning about ESD? (Open-ended).

APPENDIX B: QUALITATIVE INTERVIEW PROTOCOL

1. Institutional Readiness:

"How does your institution support ESD in teacher training?"

2. Curriculum Challenges:

"What gaps exist in current curricula regarding sustainability?"

3. Policy Alignment:

"How can Vision-2030's ESD goals be better operationalized?"