

# Sustainable development through Transformative Education Framework

## A structural equation modelling

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Received: 8 December 2025 | Accepted: 25 February 2026 | Published: 10 March 2026

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**Keywords:** sustainable development; transformative education; structural equation modelling; education for sustainability; attitude.

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**Abstract.** *Debates around Education for Sustainable Development (ESD) often presume a shared understanding of “sustainability” yet the concept remains contested across ecological, social, and ethical dimensions, particularly in relation to its association with development, economic growth, and anthropocentric policy frameworks such as the Sustainable Development Goals (SDGs). This study adopts a critical and exploratory stance to examine how schoolteachers in India interpret and internalise sustainability-related values and how these interpretations shape sustainable behaviour within a*

*transformative education framework grounded in the Value–Attitude–Behaviour (VAB) model. Using data from 601 teachers, collected through a purposive sampling strategy, the study examines a set of pedagogical and contextual dimensions constituting a Transformative Education Framework and their collective influence on teachers’ attitudes toward ESD and tests the mediating role of attitudes toward ESD in shaping sustainable behaviour. Structural Equation Modelling was used to evaluate the proposed relationships. The findings indicate considerable heterogeneity in how teachers understand ESD, revealing tensions between normative and technocratic policy discourses and the realities of school practice. Several predictors significantly influence attitudes, which strongly mediate sustainable behaviour. Instead of presenting ESD as a settled paradigm, the study highlights the need for reflexive and context-sensitive transformative pedagogical approaches that emphasise ethical reasoning, reflexivity, and community interdependence. By critically engaging with the limitations of SDG-centred conceptions of sustainability, the study contributes to ongoing debates on how education can more meaningfully support socio-ecological transitions while acknowledging the theoretical and methodological constraints of large-scale empirical modelling.*

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## **1. Introduction**

Sustainable development is often described as a holistic approach that seeks to meet the needs of the present without jeopardising the ability of future generations to meet their own needs (Sakalasoorya, 2021). While this formulation has been influential in shaping global policy discourses, it has also been widely debated for its implicit anthropocentric assumptions, its close association with economic growth, and its tendency to frame sustainability primarily in instrumental and developmental terms. Sustainability is therefore not a concept with a singular or uncontested meaning, but one that is interpreted differently across ecological, social, ethical, and political perspectives. Although it is often articulated through the integration of economic, social, and

environmental dimensions (Clift, 2003; Pawłowski, 2008), the pursuit of balance between progress and preservation remains deeply contested in both theory and practice, particularly in contexts where development imperatives dominate sustainability agendas. Achieving sustainability, therefore, requires not only structural and technological interventions but also critical reflection on societal values, priorities, and assumptions that shape individual and collective action.

Within this contested landscape, education has emerged as a key arena for interpreting, promoting, and operationalising sustainability. Sustainable development in education is often framed as a paradigm shift (Gorana & Kanaujia, 2016) that reorients learning toward environmental, social, and economic concerns (Schröder & Krüger, 2019). However, approaches to Education for Sustainable Development (ESD) are far from uniform, and are frequently shaped by normative policy frameworks, particularly those aligned with the Sustainable Development Goals (SDGs) (UNESCO, 2017). While the integration of sustainability into education is widely advocated (Mahmoudi et al., 2012) critics argue that SDG-centred approaches to ESD can risk becoming technocratic, instrumental, and insufficiently critical of underlying development paradigms (Kopnina, 2020). As a result, educational systems are increasingly challenged not only to impart knowledge but also to engage learners in ethical reasoning, critical reflection, and value-based judgement that enable them to navigate the complexities and contradictions inherent in sustainability discourses (Howlett et al., 2016). Interdisciplinary approaches (Annan-Diab & Molinari, 2017) and engagement with real-world problems (Molderez & Fonseca, 2018) are therefore seen not as neutral pedagogical tools, but as positions where competing interpretations of sustainability are negotiated.

In this context, values assume a central role in shaping how sustainability is understood and enacted in educational practice. Values reflect fundamental beliefs that influence individual judgement and decision-making (Dhar et al., 2008), thereby shaping attitudes and behaviours (Zheng et al., 2023). To examine these dynamics, the present study draws on the Value-Attitude-Behaviour (VAB) theory (Homer & Kahle, 1988), which conceptualises behaviour as emerging from the interaction between underlying values and attitudinal orientations (Olson & Zanna, 1993). Instead of assuming a linear or deterministic relationship, the VAB framework is employed here as an analytical lens to explore how sustainability-related values are internalised and translated into attitudes and practices within educational settings. Such an approach recognises that

educators' responses to sustainability are shaped by contextual, institutional, and cultural influences, rather than by values alone.

Building on this perspective, the study is situated within a Transformative Education Framework (TEF), which foregrounds learning as a process involving shifts in perspectives, values, and behavioural orientations rather than the mere transmission of knowledge (Odell et al., 2020; O'Grady, 2023). In this study, the Transformative Education Framework is conceptualised as a higher-order construct composed of multiple interrelated pedagogical and contextual dimensions rather than as a set of independent predictors. These dimensions collectively constitute TEF and, together, shape educators' orientations toward sustainability in educational practice. Consistent with the Value-Attitude-Behaviour (VAB) framework, attitude towards ESD is examined as a mediating mechanism through which the integrated influence of TEF is translated into sustainable behaviour. Rooted in Transformative Learning Theory (TLT), this approach emphasises critical reflection, questioning of assumptions, and engagement with social realities as central to meaningful learning (Nesbit, 1999). However, transformative education is itself not a monolithic or uncontested concept, and its application within sustainability education varies across contexts. In this study, transformative education is understood as a reflexive and context-sensitive pedagogical orientation that enables educators and learners to critically engage with dominant sustainability narratives, rather than uncritically reproduce them. Such an orientation aligns with broader calls for education that prepares individuals to respond to complex socio-ecological challenges while remaining attentive to issues of ethics, power, and responsibility (Gepp et al., 2023; Vaughter & Yume Yamaguchi, 2023).

Transformative education and sustainable development are thus connected through their shared emphasis on critical thinking, ethical engagement, and social responsibility (Alam, 2022; Salonen & Siirilä, 2019). Responding to the need for educational frameworks capable of supporting transformative change (Manring, 2014), the present study proposes and empirically examines a Transformative Education Framework for Sustainable Development grounded in the VAB model. Within this framework, the exogenous constructs represent pedagogical and contextual dimensions theorised to shape transformative learning processes: Interdisciplinary Learning (IL), Collaboration and Networking (CN), Experiential Learning (EL), Critical Thinking and Reflection (CR), Ethical Citizenship (EC), Community Engagement (CE), Lifelong Learning (LL), Organisational Climate (OC), and Cultural Sensitivity (CS). Ethical Citizenship

integrates value-based ethical reasoning with global and civic responsibility, reflecting the close conceptual relationships among values, ethics, and citizenship orientations in sustainability education. Attitude towards ESD (AT) and Sustainable Behaviour (B) function as the endogenous constructs of the model. Conceptually, TEF is modelled as a higher-order construct that captures the combined influence of multiple pedagogical and contextual dimensions of transformative education.

Teachers are selected as the focal group for this study due to their central role in mediating educational values and translating policy discourses into classroom practice (Leal Filho et al., 2018). Rather than presuming the effectiveness of transformative education approaches, the study seeks to explore how different components of the proposed framework are associated with teachers' attitudes and behaviours related to sustainable development. While sustainability and ESD are acknowledged in this study as contested and normatively charged constructs, the analysis does not seek to resolve these debates or advance a singular definition of sustainability. Instead, the study examines how an integrated configuration of transformative pedagogical and contextual dimensions shapes teachers' attitudes and behaviours within existing ESD-oriented educational contexts. In doing so, the framework is intended as an analytical lens for understanding variation in educators' responses to sustainability discourses, rather than as a prescriptive model for implementing ESD. Based on this framework, the study addresses the following research questions:

#### Research questions

1. How does integrating a TEF influence teachers' awareness, attitudes, and behaviour towards sustainable development?
2. How do the pedagogical dimensions of transformative education function collectively to foster positive attitudes towards sustainable development among educators?
3. What structural relationships exist between the key components of transformative education and the outcomes of sustainable development?

## **2. Literature review and hypothesis development**

### Transformative education

Transformative education has emerged as a key pedagogical approach, particularly within higher education, where it enables profound shifts in

individual understanding and behaviour (Glisczinski, 2007). Beyond merely disseminating knowledge, this framework encourages a deep re-evaluation of assumptions, promoting interconnectedness, valuing ethical principles, and promoting sustainable actions (Moore, 2005; Paul & Quiggin, 2020; Sharma, 2025). These innovations have reshaped the landscape of higher learning, enabling tailored educational experiences that cater to individual needs, subsequently leading to enhanced academic achievements (Akturk et al., 2022). The realm of sustainable practices has also come to the forefront, emphasising education's indispensable role in fostering sustainable Behaviour (Kalsoom & Khanam, 2017), which goes beyond mere knowledge dissemination to include recognising and addressing interconnectedness, valuing principles (Zsóka et al., 2013) over mere facts, listening with respect, leading by exemplary actions, and disseminating success narratives (Middleton, 2018). Ahmed (2010) posits that education serves not only as a means for individual transformation but also as an agent for societal change, particularly in addressing societal inequalities, emphasising that a balanced, state-driven approach underscored by quality, relevance, and equity is essential to harness its full transformative potential.

Fundamentally, the TEF is rooted in Jack Mezirow's TLT, which explains how adults critically assess and reframe their beliefs in response to new experiences (Fleming, 2022; Paprock, 1992). Mezirow's original theory argues that learning involves a multi-stage cognitive process of perspective transformation, often triggered by a "disorienting dilemma," leading to a more inclusive, discriminating, open, reflective, and emotionally capable way of being (Paprock, 1992). His emphasis lies on critical reflection and rational discourse (Toka & Gioti, 2023). However, TLT has significantly evolved beyond Mezirow's primarily cognitive focus. Cranton (2023) expanded on the theory by highlighting the educator's crucial role in advancing supportive environments for critical reflection, focusing on individual differences in the learning process. Freire (1970) introduced a powerful socio-political dimension through his concept of "conscientization," advocating for education as a means to empower individuals to critically analyse and act upon oppressive social structures, a departure from the passive "banking concept of education." Building on Freire, Hooks (2014) further broadened the scope by championing "education as the practice of freedom," emphasising the emotional aspects of learning and the creation of inclusive spaces where marginalised voices can challenge existing power dynamics (O'Brien et al., 2022). Further, Dirkx (2001) incorporated psychodynamic perspectives, viewing transformation as a deeper "soul work" that engages emotions and unconscious

processes, arguing for a more holistic view of identity formation in transformation (Walsh et al., 2011). This critical integration demonstrates how the framework has broadened from a rational cognitive process to encompass affective, socio-cultural, and psychodynamic dimensions, offering a more comprehensive understanding of deep learning (Trehan, 2007).

Nevertheless, the journey towards transformative education is not devoid of challenges. While the integration of SDGs into education is gaining momentum through various initiatives like workshops and blended experiences (Lozano-Díaz & Fernández-Prados, 2020), challenges persist (Marouli, 2021). In many developing countries, these challenges are often aggravated by poor funding resource constraints, curriculum rigidity, limited teacher training, and competing developmental priorities (Hossain & Hickey, 2019; Lawrence et al., 2020) school reforms aiming at Education for Sustainable Development [ESD] often encounter resistance, characterised by scepticism, unclear management strategies, and varying local conditions (Gericke & Torbjörnsson, 2022). Furthermore, there is an evident prioritisation of technical knowledge (Hogan & O'flaherty, 2021) over critical discussions around sustainability (Postiglione et al., 2023), leading to a limited understanding of the broader dimensions of sustainable development (Bezjak et al., 2020) The Eco-Schools program (Andreou, 2020) and other initiatives (Madar, 2021; Scalabrino et al., 2022; Whiting et al., 2018) highlight the global commitment to integrating sustainability into education, but their implementation and impact often vary significantly across regions, particularly in developing nations, where contextual factors like poverty, access to education, and cultural norms can profoundly influence outcomes (Affandi et al., 2025; Wei et al., 2023). As the world grapples with pressing challenges, the significance of transformative education in preparing individuals for a sustainable future becomes increasingly evident.

Despite the recognition of transformative education's potential for sustainable development, the existing literature often presents various initiatives and challenges in a descriptive manner, lacking a clear, integrated framework that systematically links specific transformative educational components to their influence on attitudes and behaviours. There is a need for research that moves beyond mere listing of examples to critically analyse the mechanisms by which transformative education fosters sustainability, particularly in diverse contexts. This highlights a key research gap in understanding how specific elements of transformative education shape attitudes and behaviours towards ESD, which this study aims to address.

### Value-Attitude-Behaviour

The VAB model serves as a pivotal lens for understanding the intricate dynamics between personal values, attitudes, and consequent behaviour across various domains (Ajzen, 2001). Kim et al. (2024) elucidated the profound influence of value and AI awareness on individuals' attitudes, subsequently shaping sustainable behaviour, underscoring the model's relevance in emerging technological contexts. Such findings resonate with the insights from Wang et al. (2023), who, drawing upon the VAB model, delineated the pathways through which generative concern propels environmentally responsible Behaviour (ERB), mediated by environmental concern and personal norms, thereby extending its application to specific environmental domains. Moreover, the interplay of personal values, attitudes, and Behaviour extends to societal settings, as evidenced by (Sturges et al., 2023). This research emphasised the significance of adults' risk tolerance in influencing children's engagement in risky play, elucidating how personal values and attitudes shape developmental opportunities for the younger generation. Complementing this, Subramaniam et al. (2023) spotlighted the pivotal role of customer experience and engagement in cultivating loyalty, emphasising the mediating role of value components in contemporary digital platforms, highlighting its applicability in consumer behaviour and digital environments.

In the context of education and competition, Nguyen et al. (2023) underscored the interconnectedness of students' self-efficacy, perceived value, cooperative attitudes, and readiness for STEAM contests. These findings further accentuate the multifaceted relationships posited by the VAB model, wherein values and attitudes precipitate specific behavioural outcomes (Trust & Prestridge, 2021). Drawing parallels, Wang et al. (2023) unravelled the intricate dynamics between trust in green food labelling, Chinese cultural values, and consumers' willingness to pay, further validating the VAB model's applicability across diverse cultural contexts. This study is particularly relevant as it demonstrates how cultural values, often deeply ingrained in developing societies, can significantly moderate the VAB pathway. For instance, in many developing nations, collective values or traditional ecological knowledge systems might influence environmental attitudes and behaviours differently compared to individualistic Western contexts (Ihemezie et al., 2021; X. Wang et al., 2021).

In short, the VAB model offers a robust theoretical framework to elucidate the nuanced relationships between values, attitudes, and Behaviour across varied

contexts (Scalco et al., 2017). When applied to understanding teachers' attitudes towards ESD, this model can illuminate the underlying values and attitudes that shape pedagogical approaches and practices, fostering a holistic understanding of sustainable education paradigms. The empirical evidence presented across studies underscores the model's versatility and relevance, advocating for its integration in educational research to foster sustainable development initiatives. Drawing upon this theoretical orientation, the current study operationalises transformative education as an integrated framework of collaborative pedagogical and contextual dimensions. These components are hypothesised to collectively modulate teachers' attitudes toward ESD, thereby informing their sustainable development practices. The succeeding subsections synthesise extant literature for each dimension to substantiate their integration within the TEF.

#### Pedagogical dimensions underpinning the Transformative Education Framework

##### *Interdisciplinary Learning (IL)*

The utilisation of an interdisciplinary methodology has the potential to enhance students' abilities in addressing challenges related to sustainability and to cultivate strategic competencies such as systems thinking and anticipatory foresight (Alm et al., 2021). It enhances students' proficiency in articulating environmental concerns across various disciplines, cultural contexts, and industrial sectors (Eagan et al., 2002). Within transformative education, interdisciplinary learning contributes to an integrated pedagogical environment that foregrounds complexity, interconnectedness, and holistic understanding.

##### *Collaboration and Networking (CN)*

Collaboration and networking within the realm of ESD programs facilitate individuals in aligning their actions with their intrinsic values (Arbuthnott, 2009). Kolleck (2013) suggests that social networks can engender synergistic effects, amalgamate pivotal resources, and expedite the diffusion of innovation. Learning networks geared towards sustainable development augment the global society's proficiency in addressing and adapting to pervasive global changes (Dlouhá et al., 2013). Consequently, collaboration and networking constitute relational dimensions of transformative education, augmenting collective accountability and distributed agency.

##### *Experiential Learning (EL)*

Experiential learning is instrumental in promoting the knowledge, values, and competencies essential for the sustainability mindset of upcoming leaders, thereby aiding the advancement of the SDGs (Tomasella et al., 2023). This

educational approach is recognised for bolstering critical thinking, collaboration skills, and cultivating a profound understanding of sustainable development (Algurén, 2021). Through non-formal and practice-based activities, experiential learning contributes to the formation of sustainability mindsets that extend beyond abstract knowledge acquisition (Gorghiu & Santi, 2016).

#### *Critical thinking and Reflection (CR)*

Incorporating culturally relevant teaching strategies requires critical reflection (Howard, 2003). According to Brunstein & King (2018), a structured reflection process involving faculty and students addresses shared challenges and promotes transformative learning, potentially leading to sustainability. In the context of ESD, critical reflection supports holistic understanding, inclusivity, and ethical engagement, thereby strengthening the integrative character of transformative education (Avsec & Savec, 2021).

#### *Ethical Citizenship (EC)*

Ethical citizenship synthesises value-based reasoning with global responsibility, positioning actors as morally grounded agents within sustainability education. ESD scholarship suggests ethical orientations drive interpretations of sustainability toward justice and intergenerational equity (Kopnina & Meijers, 2014). Environmental ethics cultivate principles for socially responsible decision-making (Katılmış, 2017; Siddiqui & Aqil, 2014), while Global Citizenship Education fosters democratic participation and collective responsibility (Huckle & Wals, 2015). Integrating these perspectives aligns frameworks with SDG 4 and promotes inclusive societies (Adaspayeva & Parkes, 2021). Ultimately, Ethical Citizenship facilitates a transformative education framework by bridging moral commitment and global awareness to catalyse values-driven practices.

#### *Community Engagement (CE)*

Community engagement connects educational processes with societal contexts, enabling learners and educators to apply sustainability principles in real-world settings. Service-learning and community-based initiatives have been shown to cultivate leadership, social responsibility, and civic identity (Batchelor et al., 2003). Integrating the Millennium Development Goals into community engagement aligns these efforts with discussions on sustainable development, facilitating the convergence of research, training, and community involvement initiatives (Pienaar-Steyn, 2012).

#### *Lifelong Learning (LL)*

Lifelong learning is increasingly recognised as essential for addressing sustainability challenges characterised by uncertainty and quick change. Continuous learning supports the development of adaptive capacities, value reorientation, and resilience in both individuals and institutions (Wals & Benavot, 2017a). Networks oriented towards lifelong learning have been shown to promote innovative educational practices that enhance societal preparedness for sustainability transitions (Dlouhá et al., 2013). Within transformative education, lifelong learning sustains ongoing engagement with sustainability beyond formal educational settings

#### *Organisational Climate (OC)*

The organisational climate, influenced by factors like contextual support, social norms, and the complexity of actions, significantly impacts attitudes towards ESD (Arbuthnott, 2009). Furthermore, encouraging an ethical atmosphere enhances employees' work attitudes, thereby elevating overall organisational sustainability performance (Lee & Ha-Brookshire, 2017). This alignment between organisational ethos and individual perspectives induces heightened satisfaction, commitment, adaptability, and performance in the workplace (Ostroff, 1993).

#### *Cultural Sensitivity (CS)*

Cultural sensitivity is integral to transformative education, particularly in diverse and pluralistic contexts. Educational approaches that are attuned to cultural, political, and economic conditions facilitate meaningful engagement with sustainability issues and support the integration of indigenous and local knowledge systems (Gu, 2005). Such an approach not only bridges the divide between diverse cultures but also seamlessly amalgamates traditional or indigenous wisdom with modern insights (Vargas, 2000). Culturally responsive pedagogy promotes inclusivity and contributes to the development of a shared global culture grounded in respect for diversity (Thomas, 1997).

#### *Attitude towards education for sustainable development (AT)*

Attitudes, encompassing informational, emotional, and behavioural dimensions, play a pivotal role in influencing sustainable development behaviour within organisations at various hierarchical levels (Lozano, 2008). These attitudes not only guide organisational actions but also have a cascading effect on sustainable initiatives within local communities (Kapsalis & Kapsalis, 2020). This influence can be seen in consumers' purchasing behaviour of sustainable products that are

markedly swayed by their attitudes towards sustainability marketing strategies (Abutaleb & El-Bassiouny, 2020).

While these pedagogical and contextual dimensions are interrelated, each represents a distinct mechanism within the Transformative Education Framework. Interdisciplinary Learning addresses epistemic integration across knowledge domains, whereas Experiential Learning foregrounds practice-based meaning-making through direct engagement. Critical Thinking and Reflection enable a reflexive examination of assumptions and values, whereas Collaboration and Networking emphasise relational learning and collective agency. Ethical Citizenship provides a normative orientation grounded in moral reasoning and global responsibility, while Cultural Sensitivity ensures contextual responsiveness to local cultural and knowledge systems. Community Engagement situates learning within societal contexts beyond institutional boundaries, and Organisational Climate shapes the structural conditions under which these pedagogical processes operate. Together, these constructs capture complementing yet analytically distinct dimensions of transformative education.

#### Conceptual model and hypotheses

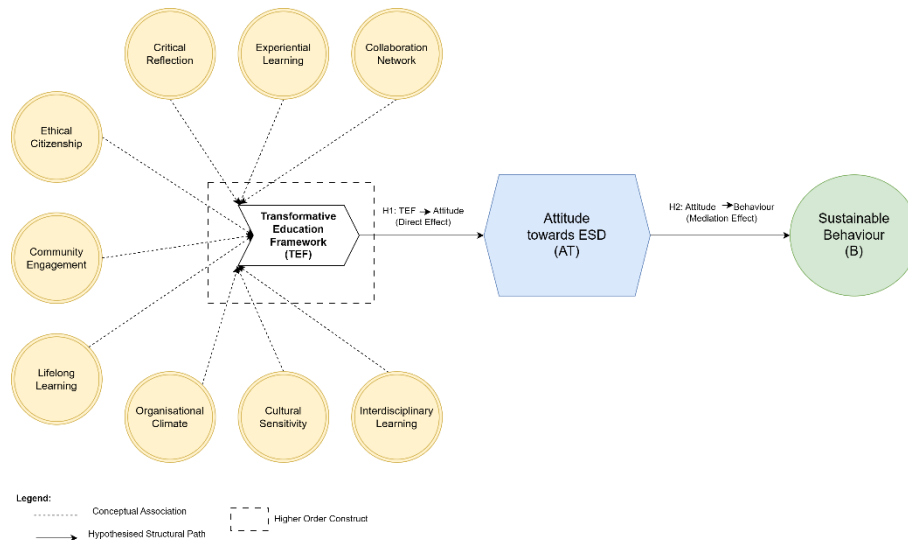
Based on the literature, the present study conceptualises transformative education as an integrated framework comprising interrelated pedagogical and contextual dimensions. By avoiding assumptions about isolated variable effects, the Transformative Education Framework (TEF) is theorised as a synergetic ecosystem that modulates teachers' dispositions toward ESD, thereby mediating sustainable development practices.

Based on this framework, the study advances the following hypotheses:

**H1:** The Transformative Education Framework positively influences teachers' attitudes towards Education for Sustainable Development.

**H2:** Teachers' attitudes towards Education for Sustainable Development positively influence their sustainable development behaviour.

Figure 1 presents the conceptual model of the study, illustrating the relationships among the Transformative Education Framework, teachers' attitudes towards ESD, and sustainable development behaviour



**Figure 1. Conceptual framework of the Transformative Education Framework.** The figure illustrates the theorised integration of pedagogical dimensions within the Transformative Education Framework (TEF) and the hypothesised pathways linking TEF to teachers' attitudes toward Education for Sustainable Development (ESD) and to sustainable behaviour. The nine dimensions are conceptual constituents of TEF; arrows represent hypothesised directional relationships.

### 3. Methodology

#### Research design

This study adopted a quantitative, cross-sectional research design. It was considered essential to examine the structural relationships among the pedagogical dimensions of Education for Sustainable Development (ESD), teachers' attitudes towards ESD, and their self-reported behavioural intentions. The design was appropriate for empirically testing a theoretically grounded framework. To address the study's emphasis on explanation and prediction rather than strict theory confirmation, variance-based Structural Equation Modelling (SEM) was employed. Specifically, a Partial Least Squares (PLS) approach was used to estimate the proposed TEF. PLS-SEM is well-suited for analysing complex framework-level models involving multiple interrelated latent constructs, particularly when the objective is to assess predictive relationships

and explain variance in key endogenous variables (Hair et al., 2019; Hair Jr. et al., 2017). In the present study, PLS-SEM facilitated the empirical assessment of a higher-order TEF by enabling the simultaneous evaluation of measurement properties and structural relationships while maintaining model parsimony and interpretability (Hair et al., 2021).

### Participants

The research comprised a sample of 601 secondary school educators from both government and private institutions all around India. A non-probability purposive sampling method was employed, as it allowed the selection of respondents with specific characteristics relevant to the study (Schillewaert et al., 1998; Tongco, 2007), focusing on school teachers with experience in curricular delivery and potential exposure to sustainability-related educational practices. This method was chosen due to the study's focus on ESD and the need to include participants capable of providing informed and context-specific insights. While purposive sampling supports the depth and relevance of data in targeted research areas, it limits the generalizability of the findings (Memon et al., 2025). Accordingly, the findings are interpreted as analytical rather than population-level inferences. Nevertheless, the sample's geographical and institutional diversity provides a broad, contextually meaningful representation of secondary school teachers within the Indian education system. Table 1 provides the demographic particulars of the survey participants.

### **Data collection and measures**

Three essential steps were included in the data collection process. Figure 2 presents the graphical depiction of the data collection process undertaken during this study. The variables constituting teachers' attitudes towards ESD were identified in the first phase through a thorough literature review. This process ensured that the selected constructs were theoretically grounded in established ESD and transformative education scholarship. In the second phase, a pilot study was conducted among 100 teachers to assess comprehension and completeness and make necessary changes to the questionnaire. In the third and final phase, a questionnaire survey was conducted to determine the importance of teachers' attitudes and their influence on their behaviour towards ESD.

A pivotal tool in our investigation, the questionnaire underwent careful development and segmentation to facilitate the collection of crucial data. The initial section of the questionnaire addressed inquiries about demographic

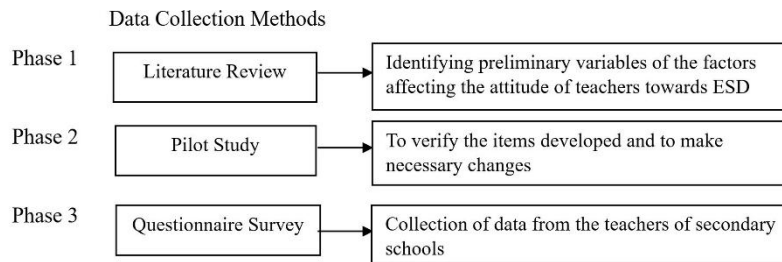
variables such as gender, subject expertise, teaching experience, educational board affiliation, and institutional classification. The second section was dedicated to probing the core subject matter of the study and featured 49 items grounded in both endogenous and exogenous variables. All constructs were operationalised using reflective indicators that captured teachers' perceptions, orientations, and reported pedagogical practices related to ESD and transformative education. Responses were recorded using a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). Participants were instructed to respond based on their professional experiences and classroom practices rather than abstract or idealised beliefs.

**Table 1:** Demographic details of the participants

Participant Profile	Number	Percentage
Type of Management		
Government	374	62.22
Management	227	37.77
Board		
Kerala State	363	60.39
CBSE	184	30.61
Others	54	8.98
Teaching Experience		
0 to 3 years	284	47.25
3 to 8 years	202	33.61
8 years and above	115	19.13
Subject		
Languages	208	34.60
Science	167	27.78
Mathematics	106	17.63
Social Science	86	14.30
Others	34	5.65
Gender		
Male	200	33.27
Female	401	66.72
Others	0	0

Data collection was conducted using a combination of online and in-person survey administration methods. Google Form was employed to facilitate efficient data collection across geographically dispersed regions, while in-person administration of the same structured questionnaire enabled clarification of item meanings where required and improved response completeness. The use of

mixed administration modes supported broader participation while maintaining consistency in instrument delivery and measurement conditions.



**Figure 2. Phases of the data collection process.** The figure presents the three-stage data collection procedure employed in the study. Phase one involved identification of constructs through an extensive literature review. Phase two consisted of a pilot study conducted with 100 teachers to assess clarity and reliability of the questionnaire. Phase three involved the administration of the final structured survey to 601 secondary school teachers across India using both online and in-person modes.

#### List of factors in the preliminary stage

Following an extensive assessment of the literature, Table 2 illustrates the factors that influence teachers' attitudes towards ESD. A set of pedagogical and contextual factors relevant to teachers' engagement with Education for Sustainable Development (ESD) was identified. The selection was theory-led. It prioritised dimensions repeatedly linked to transformative and sustainability-oriented pedagogy. The factors capture interrelated pedagogical practices, professional orientations, and institutional conditions recognised in the ESD literature. These include interdisciplinary learning, collaboration and networking, experiential learning, critical thinking and reflection, ethical citizenship, community engagement, lifelong learning, organisational climate, and cultural sensitivity. Each factor was operationalised using reflective indicators to represent teachers' perceived classroom practices and professional orientations. Conceptual proximity among several factors was anticipated rather than treated as an error. This reflects the integrated character of ESD pedagogy, where values, civic orientations, and community-facing practices often co-occur in teachers' work. Accordingly, the analytical model was specified to capture this integration at the framework level, rather than forcing strict separation among highly related dimensions.

**Table 2.** Pedagogical and contextual dimensions constituting the TEF

Code	Factors
	Interdisciplinary Learning (IL)
IL1	Inclusion of sustainability concepts into lesson plans
IL2	Integration of various academic fields
IL3	openness to collaborate with teachers
IL4	employing interdisciplinary content and methods in teaching
	Collaboration and Networking (CN)
CN1	Community engagement for sustainable development in education
CN2	Students' collaboration on local sustainability projects
CN3	Partnership with Local organisations
	Experiential Learning (EL)
EL1	Promoting classroom sustainability
EL2	Use of real-world experiences in the classroom
EL3	designing hands-on classroom activities
EL4	experiential learning to engage students
EL5	optimising student's classroom experience
	Critical Thinking and Reflection (CR):
CR1	critical thinking on long-term environmental impact of human actions
CR2	Integration of activities that promote problem-solving skills
CR3	Encouragement given to students to ask questions
CR4	critical thinking and students to contribution to the society
	Ethical Citizenship (EC):
EC1	Integration of life-centred topics into the curriculum
EC2	Instilling a sense of responsibility for the planet
EC3	Equal access to education for all students as a moral necessity
EC4	Responsible consumption and promotion of sustainability
EC5	Global perspectives and cultural understanding
EC6	empowering students as responsible global citizens
EC7	themes promoting global responsibility in students
EC8	Empathy and respect to foster global citizenship
	Community Engagement (CE)
CE1	Sense of belongingness and togetherness
CE2	responsibility for both local and global populations
CE3	Community collaboration and grasp of sustainable development
CE4	Encouraging student exploration and contribution to sustainability initiatives
	Lifelong Learning (LL):
LL1	Creative methods to inspire lifelong learning in students
LL2	Explore and pursue knowledge beyond the curriculum
LL3	Initiatives promoting students' self-directed learning
LL4	Importance of lifelong learning in a rapidly changing world
LL5	Curiosity for lifelong learning
	Organisational Climate (OC):
OC1	Our institutional support for teaching resources
OC2	Training on ESD
OC3	Appreciation from the institution
OC4	administrative support in ESD
	Cultural sensitivity (CS)
CS1	Inclusion of diverse cultural perspectives in teaching
CS2	Customisation of the curriculum to local culture
CS3	Cultural understanding for global peace
CS4	Sharing cultural perspectives in the classroom
	Attitude (AT)
AT1	Awareness about the principles and goals of ESD
AT2	Environmental and social concerns of ESD
AT3	ESD practices in daily life
AT4	Promotion of ESD for a sustainable future
	Behaviour (B)
B1	Incorporation of sustainable practices in my daily life
B2	Preference for eco-friendly options
B3	learning and promoting sustainable solutions for a better future.
B4	participation in activities and initiatives that promote ESD

### Data analysis

All analyses were conducted using variance-based Structural Equation Modelling implemented in R. The analytical strategy followed a two-stage PLS-SEM procedure (Henseler et al., 2009), with an explicit separation between measurement evaluation and structural inference. In Stage 1, the first-order constructs were estimated using their respective reflective indicators to obtain reliable construct scores. In Stage 2, these first-order construct scores were used as indicators of a higher-order TEF, and the structural relations TEF → Attitude (AT) → Behaviour (B) were estimated. This two-stage higher-order approach was adopted to accommodate conceptual proximity among pedagogical dimensions. Thus, reduce multicollinearity and suppression effects in the structural model, and enable a parsimonious test (Huang et al., 2017) of framework-level influence on teachers' attitudes and behavioural outcomes.

Measurement quality was assessed using standard PLS-SEM criteria. Indicator reliability was examined through outer loadings. Internal consistency was evaluated using Cronbach's alpha and composite reliability (Hair Jr. et al., 2017). Convergent validity was assessed using average variance extracted (AVE). Discriminant validity was examined using the heterotrait–monotrait ratio (HTMT). HTMT values were interpreted with explicit reference to established threshold logic (0.85 as conservative; 0.90 as permissible for theoretically related constructs), and all threshold decisions were reported consistently with the corresponding tables.

For the structural model, path coefficients were evaluated using non-parametric bootstrapping (5,000 resamples) with confidence intervals to delineate structural relationships (Chin et al., 2020). Model explanatory power was assessed using  $R^2$  for endogenous constructs. Effect sizes ( $f^2$ ) and predictive relevance ( $Q^2$  via blindfolding) were used to support the interpretation of substantive contribution. Out-of-sample predictive performance was examined using PLSpredict, benchmarked against a linear model, to assess out-of-sample predictions (Hair et al., 2019). Global fit indices were treated as diagnostic and complementary. SRMR was interpreted as an approximate indicator of model adequacy rather than a confirmatory test of fit. The  $d_{\text{ULS}}$  and  $d_{\text{G}}$  values were interpreted only relative to their bootstrap-based quantiles. The NFI value was reported with explicit acknowledgement of its limitations in variance-based SEM - where PLS-SEM often accommodates non-normal data and small sample sizes (F. Hair Jr et al., 2014) and of the model's exploratory, framework-oriented purpose.

## 4. Results

### Measurement model analysis

The psychometric properties of the measurement model were evaluated using a disjoint two-stage approach (Becker et al., 2012; Sarstedt et al., 2019) implemented within the R software environment using the *semnr* package. In Stage 1, the analysis focused on assessing the reliability and validity of the lower-order pedagogical dimensions and the outcome constructs. Given the conceptual breadth of several pedagogical dimensions and the limitations in internal consistency observed in preliminary analyses, a mixed-methods measurement strategy was adopted. Specifically, while some constructs were retained as multi-item reflective measures, others were operationalised as single-item measures. This decision reflects a trade-off between theoretical scope and empirical precision and is explicitly treated as a measurement limitation rather than a methodological optimisation.

For multi-item reflective constructs, internal consistency reliability was assessed using Cronbach's alpha and composite reliability (CR), and convergent validity was examined using average variance extracted (AVE). As reported in Table 3, the multi-item constructs demonstrated acceptable reliability and convergent validity, with composite reliability values exceeding recommended thresholds and AVE values meeting or exceeding the 0.50 criterion. Although the Cronbach's alpha value for Critical Reflection was marginally below 0.70, it remains acceptable within exploratory educational research contexts (Hair et al., 2019). Several pedagogical dimensions (Interdisciplinary Learning, Collaboration and Networking, Experiential Learning, Ethical Global Citizenship, Organisational Climate, Cultural Sensitivity, and Sustainable Behaviour) were operationalised using single-item measures. For these constructs, Cronbach's alpha and composite reliability values of 1.000 reflect a mathematical property of single-indicator latent variables rather than perfect reliability. Accordingly, convergent validity indices are not interpreted substantively for these measures, and the reduced content validity associated with single-item operationalisation is acknowledged as a limitation of the empirical model.

Discriminant validity at the lower-order level was assessed using the heterotrait–monotrait (HTMT) ratio of correlations (Henseler et al., 2015). HTMT values were interpreted using a conservative threshold of 0.85. All reported HTMT ratios remained below this threshold, indicating that the constructs retained sufficient empirical distinctiveness despite their theoretical relatedness. These

results support the adequacy of the measurement model for subsequent higher-order analysis.

**Table 3:** Reliability and convergent validity of first-order constructs

Construct	$\alpha$	CR	AVE
Interdisciplinary Learning (IL)*	1.000	1.000	1.000
Collaboration and Networking (CN)*	1.000	1.000	1.000
Experiential Learning (EL)*	1.000	1.000	1.000
Critical Reflection (CR)	0.672	0.672	0.505
Ethical Global Citizenship (EGC)*	1.000	1.000	1.000
Community Engagement (CE)	0.746	0.748	0.503
Lifelong Learning (LL)	0.819	0.817	0.529
Organisational Climate (OC)*	1.000	1.000	1.000
Cultural Sensitivity (CS)*	1.000	1.000	1.000
Attitude toward ESD (AT)	0.839	0.836	0.564
Sustainable Behaviour (B)*	1.000	1.000	1.000

### Assessment of the higher-order Transformative Education Framework

In Stage 2, the TEF was specified as a formative higher-order construct (Type II reflective–formative model). This specification is theoretically grounded in the assumption that the nine pedagogical dimensions represent distinct yet complementary components that collectively constitute a transformative educational environment, rather than interchangeable reflections of a single latent trait (Becker et al., 2012; Sarstedt et al., 2019). As TEF was modelled formatively, its evaluation focused on assessing collinearity among indicators and the contribution of each lower-order construct to the higher-order framework. Variance Inflation Factors (VIF) were examined to assess potential multicollinearity. As shown in Table 4, all VIF values ranged well below the conservative threshold of 3.3, indicating the absence of problematic collinearity and confirming that each pedagogical dimension contributes unique variance to the formative construct.

### Structural model assessment

Following validation of the measurement and higher-order framework specifications, the structural model was assessed to examine the hypothesised relationships among the Transformative Education Framework, teachers' attitudes towards ESD, and sustainable behavioural intentions. Path coefficients

were estimated using a non-parametric bootstrapping procedure with 5,000 resamples. The model's explanatory power was evaluated using the coefficient of determination ( $R^2$ ) for the endogenous constructs. As illustrated in Figure 3, the model explains a substantial proportion of variance in Attitude toward ESD ( $R^2 = 0.409$ ) and Sustainable Behaviour ( $R^2 = 0.310$ ). These values indicate meaningful explanatory power for an integrated educational framework model within a complex social science context.

**Table 4.** Collinearity assessment (VIF) for the Formative Higher-Order Framework

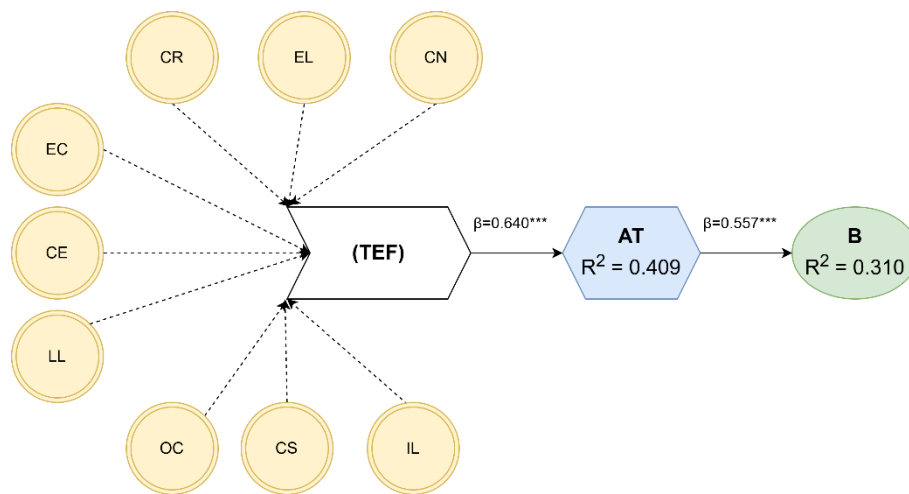
Formative Indicator	VIF
Interdisciplinary Learning (IL)	1.205
Collaboration (CN)	1.318
Experiential Learning (EL)	1.213
Critical Reflection (CR)	1.631
Ethical Global Citizenship (EGC)	1.547
Community Engagement (CE)	2.051
Lifelong Learning (LL)	2.290
Organisational Climate (OC)	1.298
Cultural Sensitivity (CS)	1.463

The structural path estimates are summarised in Table 5. The Transformative Education Framework exerted a strong, positive, and statistically significant effect on Attitude toward ESD ( $\beta = 0.640$ ,  $t = 23.097$ ,  $p < 0.001$ ), supporting the proposition that an integrated configuration of pedagogical dimensions is associated with teachers' sustainability-oriented attitudes. Attitude toward ESD, in turn, demonstrated a strong and statistically significant relationship with Sustainable Behaviour ( $\beta = 0.557$ ,  $t = 12.638$ ,  $p < 0.001$ ). These results confirm the mediating role of attitudes in translating transformative educational conditions into behavioural intentions.

#### Summary of key results

Overall, the results provide empirical support for the Transformative Education Framework as an integrated pedagogical configuration that influences teachers' attitudes towards ESD, which, in turn, shape sustainable behavioural intentions. By modelling the framework at a higher-order level, the analysis avoids over-interpretation of individual pedagogical dimensions and instead highlights the systemic nature of transformative education processes. This framework-level

perspective offers a parsimonious and theoretically coherent account of how complex educational practices relate to sustainability-oriented outcomes.



**Figure 3. Structural model assessment of the Transformative Education Framework.**

The figure illustrates the two-stage higher-order partial least squares structural equation model (PLS-SEM). The Transformative Education Framework (TEF) is specified as a formative higher-order construct composed of nine pedagogical dimensions: Interdisciplinary Learning (IL), Collaboration (CN), Experiential Learning (EL), Critical Reflection (CR), Ethical Global Citizenship (EGC), Community Engagement (CE), Lifelong Learning (LL), Organisational Climate (OC), and Cultural Sensitivity (CS). TEF predicts Attitude toward Education for Sustainable Development (AT), which in turn predicts Sustainable Behaviour (B). Standardised path coefficients ( $\beta$ ) are reported on the arrows, and coefficients of determination ( $R^2$ ) are shown inside endogenous constructs. All structural paths are statistically significant at  $p < .001$  based on 5,000 bootstrap resamples.

**Table 5.** Structural model results and hypothesis testing

Hypothesis	Relationship	Beta	T_Statistics	P_Values	Decision
H1	TEF -> Attitude towards ESD	0.640	23.097	< 0.001	Supported
H2	Attitude toward ESD -> Sustainable Behaviour	0.557	12.638	< 0.001	Supported

## 5. Discussion

This study empirically examined the factors of transformative education that influence teachers' attitudes towards ESD. The findings demonstrate that TEF exerts a strong, statistically robust influence on teachers' attitudes toward Education for Sustainable Development (ESD), which, in turn, significantly predicts sustainability-oriented behaviour. This pattern suggests that transformative education operates primarily through attitudinal internalisation, whereby pedagogical environments shape how educators interpret, value, and prioritise sustainability before such orientations are translated into practice. This mediated logic is consistent with recent PLS-SEM evidence from adjacent sustainability-learning domains, which demonstrates that systemic learning environments influence sustainable outcomes indirectly through cognitive and attitudinal mechanisms rather than through direct behavioural pathways (Ranjan et al., 2024).

This result advances current debates in ESD by moving beyond technocratic and implementation-oriented accounts that treat sustainability as a predefined objective to be transmitted through discrete pedagogical interventions. Instead, the findings support perspectives that conceptualise sustainability education as a meaning-making and value-mediating process, in which learning environments cultivate ethical reasoning, reflexivity, and social responsibility as interrelated dispositions. In this sense, transformative education appears less concerned with the direct prescription of sustainable behaviours and more focused on shaping the interpretive frameworks through which educators engage with sustainability challenges. Importantly, the model's structural configuration indicates that attitudes toward ESD function as a central mediating mechanism between pedagogical environments and behavioural outcomes. This reinforces theoretical accounts suggesting that sustainability-related behaviour in educational contexts is unlikely to emerge solely from exposure to sustainability-oriented content or practices. Rather, behavioural change depends on the extent to which educators internalise sustainability as a normative and professional commitment. The TEF, as an integrated framework, appears to create the conditions for such internalisation by aligning pedagogical practices, institutional climate, and ethical orientations into a coherent educational experience.

### Influence of the TEF on Teachers' Attitudes and Behaviour (RQ1)

RQ1 asked how integrating the Transformative Education Framework (TEF) influences teachers' attitudes and behaviour towards sustainable development.

The results indicate a clear sequence. TEF strongly and positively predicts teachers' attitudes towards ESD. Attitude, in turn, strongly and positively predicts sustainable behaviour. This pattern positions attitude as the key proximal mechanism through which an integrated pedagogical environment is translated into behavioural orientation (Ranjan et al., 2024). It is consistent with contemporary scholarship that treats sustainability-oriented educational practice as an attitudinal and agentic achievement rather than a simple implementation task. This finding also aligns with recent evidence that teachers' sustainability-related dispositions and professional orientations matter for educational change. Large-scale, mixed-method work continues to show that teachers' beliefs, perceived meaning, and value alignment shape whether ESD is taken up as substantive practice rather than symbolic compliance. The TEF → Attitude effect therefore has a plausible educational interpretation: the framework operates as a coherent set of pedagogical conditions that supports sense-making and commitment, thereby increasing the likelihood of sustained behavioural follow-through. The mediation pattern is theoretically important for ESD debates. It implies that a school or teacher education environment can be "ESD-aligned" in its design, yet still fail to produce behavioural change if it does not shift educators' interpretive frames and professional commitments. This is congruent with transformative education perspectives that emphasise reflexivity and reassessment of assumptions as central to sustainability learning. It is also consistent with wider sustainability-education evidence suggesting that teacher dispositions are consequential for learning and practice, and that change tends to be realised through psychological and professional mechanisms rather than direct exposure to content or policy signals.

#### Transformative Education as an integrated pedagogical system (RQ2)

The empirical configuration observed in this study suggests that the pedagogical dimensions of transformative education are theoretically and functionally interdependent rather than separable instructional levers. Transformative education literature has consistently emphasised that practices such as ethical engagement, reflexive learning, interdisciplinarity, and community orientation are mutually constitutive elements of educational change, shaping professional meaning-making through their combined presence rather than through isolated effects (Mezirow, 2018). Treating these dimensions as components of a unified framework, therefore, reflects the systemic character of transformative learning processes, in which coherence across pedagogical practices and institutional conditions is central to attitudinal formation.

Recent studies in Education for Sustainable Development further support this interpretation by demonstrating that sustainability-oriented attitudes among educators are more strongly associated with whole-institutional alignment and pedagogical coherence than with individual instructional strategies or competencies (Mogren et al., 2019). This emphasis on integration resonates with bibliometric analyses of contemporary education research, which reveal a growing fragmentation of pedagogical constructs and a relative scarcity of system-level theorisation, particularly in digitally mediated learning fields (Krishnan et al., 2025). From this perspective, the influence of the Transformative Education Framework lies not in the relative strength of particular pedagogical elements but in their collective orchestration within an educational environment that consistently reinforces sustainability-related values, reflexivity, and social responsibility. Such an interpretation aligns with systems-oriented approaches to sustainability education, which conceptualise educational change as an emergent property of integrated pedagogical, cultural, and organisational dynamics rather than as the outcome of discrete interventions (Wals & Benavot, 2017).

#### Structural relationships within transformative education and sustainability outcomes (RQ3)

RQ3 examined the structural relationships between the components of transformative education and sustainability-related outcomes. The final model reveals a clear and theoretically coherent pathway in which the Transformative Education Framework (TEF) exerts its influence on sustainable behaviour indirectly, through teachers' attitudes toward ESD. This configuration indicates that transformative education functions as a context-shaping system rather than as a set of direct behavioural drivers. Such a structure is consistent with systems-oriented interpretations of educational change, which emphasise mediation, emergence, and alignment over linear causation (Sterling, 2021; Wals & Benavot, 2017). The absence of direct structural paths from individual pedagogical dimensions to behaviour is theoretically meaningful. Contemporary ESD scholarship has increasingly cautioned against assuming direct instructional-behavioural linkages, noting that sustainability practices in educational settings are mediated by educators' professional identities, values, and interpretive orientations (Vare et al., 2019). The present findings reinforce this position by demonstrating that behavioural engagement with sustainability is contingent upon prior attitudinal internalisation. In this sense, TEF shapes the conditions of possibility for sustainable practice by cultivating dispositions that render such

behaviour meaningful and professionally legitimate. From a transformative learning perspective, this mediated structure aligns with the proposition that educational change occurs through shifts in frames of reference rather than through compliance with externally prescribed actions (Mezirow, 2018). Attitudes toward ESD represent a critical juncture at which pedagogical experiences are translated into professional commitments. The strong Attitude → Behaviour relationship observed in the model suggests that once educators adopt sustainability as a valued orientation, behavioural enactment follows with relative consistency. These findings echo recent empirical work showing that educators' sustainability-related practices are closely linked to their value alignment and sense of agency, rather than to isolated pedagogical exposures (Bourn & Soysal, 2021; Mogren et al., 2019).

The higher-order structural configuration also contributes to ongoing theoretical debates regarding how ESD outcomes should be modelled. By situating TEF as an antecedent to attitudinal change, the model avoids both methodological reductionism and normative overreach. It neither assumes that pedagogical practices automatically yield sustainable behaviour nor reduces transformative education to a symbolic discourse. Instead, it empirically supports a relational and process-oriented understanding of sustainability education, in which pedagogical coherence, institutional context, and ethical orientation interact to shape educators' engagement with sustainability over time (Kopnina, 2020; Sterling, 2021). Taken together, the structural relationships identified in this study suggest that the effectiveness of transformative education lies in its capacity to align pedagogical practices with deeper professional meanings. This has important implications for ESD research and practice. For researchers, it underscores the value of modelling higher-order educational frameworks that capture systemic influence rather than isolated effects. For educational leaders and policymakers, it highlights the need to prioritise coherent pedagogical environments that support attitudinal transformation as a precursor to sustainable action, rather than relying on fragmented initiatives or prescriptive behavioural mandates.

#### Theoretical implications

The findings of this study contribute to contemporary ESD theory by advancing a systemic conceptualisation of transformative education. By modelling the Transformative Education Framework (TEF) as a higher-order construct, the study departs from dominant variable-centred approaches that fragment

pedagogical processes into isolated competencies or strategies. Instead, the results support theoretical positions that frame transformative education as an integrated configuration of pedagogical, ethical, and organisational dimensions, whose influence emerges through coherence and alignment rather than through additive or independent effects (Sterling, 2021; Wals & Benavot, 2017). This systemic interpretation refines existing transformative learning theory by empirically demonstrating the mediating role of attitudes in sustainability-oriented educational change. While transformative learning scholarship has long emphasised perspective transformation and shifts in frames of reference (Mezirow, 2018), empirical models often struggle to capture how such transformations translate into practice. The TEF → Attitude → Behaviour pathway identified here provides structural support for the proposition that pedagogical environments shape professional action primarily by reconfiguring educators' interpretive orientations. Attitudes toward ESD thus function as a theoretical bridge between pedagogical context and behavioural enactment, clarifying a mechanism that is frequently assumed but rarely modelled explicitly in ESD research (Bourn & Soysal, 2021; O'Flaherty & Liddy, 2018)

The study also contributes to ongoing debates about the conceptual status of sustainability-related educational constructs. Prior frameworks often treat elements such as ethical citizenship, interdisciplinarity, and community engagement as distinct predictors, despite their shared normative and epistemic foundations (Kopnina, 2020; Vare et al., 2019). By demonstrating that these dimensions operate most coherently within a unified framework, the present findings support calls for theoretical consolidation in ESD. This does not imply conceptual redundancy but rather recognises that transformative educational processes are constituted through interdependence, in which meaning making arises from the convergence of pedagogical practices and institutional conditions. More broadly, the higher-order modelling of TEF aligns with systems-oriented theories of education for sustainability, which conceptualise educational change as an emergent property of interacting social, cultural, and organisational forces (Sterling, 2021). Theoretically, this challenges linear models that presume direct causal links between pedagogical inputs and sustainability outcomes. Instead, the findings reinforce the view that sustainability education is best understood as a relational and processual phenomenon, in which coherence across educational practices enables the internalisation of sustainability values that subsequently guide professional behaviour.

### Methodological implications

The findings of this study have important methodological implications for the empirical investigation of Education for Sustainable Development (ESD) and transformative education. First, the results underscore the limitations of variable-isolated modelling strategies for capturing complex educational phenomena. When pedagogical constructs that are theoretically interdependent are treated as independent predictors, models risk producing unstable coefficients, inflated explanatory power, or misleading interpretations. The higher-order specification adopted in this study demonstrates that modelling pedagogical integration explicitly offers a more theoretically faithful and statistically stable representation of transformative educational processes (Becker et al., 2012; Sarstedt et al., 2019).

Second, the use of a two-stage higher-order PLS-SEM approach illustrates a viable methodological pathway for reconciling theoretical complexity with empirical constraints. ESD research frequently relies on instruments that capture broad pedagogical orientations using limited indicators, which can create tension between conceptual ambition and measurement precision. By separating the estimation of lower-order constructs from the structural assessment of the higher-order framework, the two-stage approach enables researchers to retain theoretically meaningful dimensions while avoiding over-fragmentation and multicollinearity at the structural level (Hair et al., 2019). This approach is particularly appropriate for framework-based research, where the objective is to assess systemic influence rather than to rank individual predictors.

The findings also highlight the importance of attitudinal constructs as mediating variables in ESD modelling. Rather than positioning attitudes as secondary outcomes or simple correlates, the present study demonstrates their central role in linking pedagogical environments to behavioural orientations. Methodologically, this suggests that future ESD studies should give greater attention to mediational structures that reflect meaning-making and internalisation processes, rather than privileging direct effects that may oversimplify educational change dynamics (Bourn & Soysal, 2021; O'Flaherty & Liddy, 2018). In addition, the study reinforces the need for cautious interpretation of measurement quality indicators in sustainability education research. While reliability and validity metrics remain essential, their interpretation must be sensitive to the nature of the constructs under investigation. Broad pedagogical concepts often encompass heterogeneous practices and values that may not neatly conform to narrow psychometric

expectations. As such, methodological transparency regarding trade-offs in operationalisation-rather than attempts to optimise metrics through excessive scale purification- should be regarded as good practice in ESD research (Hayduk & Littvay, 2012; Sarstedt et al., 2019).

Taken together, these methodological implications point toward a shift in ESD research from narrowly specified causal models toward system-oriented analytical designs that foreground integration, mediation, and coherence. Such approaches are better suited to capturing the complexity of transformative education and offer a more robust basis for theoretical advancement and cumulative knowledge building in the field.

#### Practical and educational implications

The findings of this study carry important implications for educational practice and policy in the context of Education for Sustainable Development (ESD), particularly for teacher education and institutional design. The results suggest that sustainability-oriented change is most likely to occur when pedagogical practices are aligned and mutually reinforcing, rather than implemented as isolated initiatives. From a practical standpoint, this implies that efforts to promote ESD should prioritise the coherence of educational environments, ensuring that curriculum design, pedagogical approaches, institutional culture, and professional development communicate consistent sustainability-related values and expectations (Sterling, 2021).

For teacher education, the mediated relationship between the Transformative Education Framework (TEF) and sustainable behaviour underscores the central role of attitudinal formation. Professional learning programmes that focus narrowly on techniques or content related to sustainability may have limited impact if they do not also engage teachers' ethical reasoning, reflexivity, and professional identity. Recent studies highlight that educators are more likely to adopt sustainability-oriented practices when they perceive alignment between institutional priorities and their own values and sense of agency (Bourn & Soysal, 2021; Mogren et al., 2019). Accordingly, teacher education initiatives may benefit from creating spaces for critical reflection, dialogue, and community engagement that allow educators to internalise sustainability as a meaningful professional commitment rather than as an externally imposed requirement. At the institutional level, the results point to the importance of organisational climate and cultural conditions in enabling transformative education. Schools and teacher education institutions seeking to advance ESD should consider how

policies, leadership practices, and organisational norms support or constrain pedagogical coherence. Whole-institution approaches to sustainability, which integrate governance, curriculum, and community partnerships, have been shown to foster more enduring educational change than fragmented or project-based interventions (Wals & Benavot, 2017b). The present findings lend empirical support to such approaches by demonstrating that integrated pedagogical environments are more likely to shape educators' attitudes in ways that translate into sustainable practice.

From a policy perspective, the study cautions against instrumental or compliance-driven interpretations of ESD implementation. Policies that emphasise measurable outputs or the adoption of discrete sustainability competencies may overlook the deeper educational processes through which sustainability-oriented behaviour emerges. Instead, the findings suggest that policy frameworks should encourage flexibility, contextual sensitivity, and pedagogical alignment, allowing institutions to develop coherent approaches that resonate with their educational cultures and communities (Kopnina, 2020; Sterling, 2021). Such an orientation aligns with critical perspectives on ESD that advocate moving beyond technocratic and SDG-centred narratives toward more reflexive and ethically grounded educational practices. Overall, the practical implications of this study emphasise that fostering sustainability-oriented behaviour among educators is less about prescribing specific actions and more about cultivating enabling conditions. By supporting coherent pedagogical environments that integrate ethical, reflective, and community-oriented dimensions, educational systems can create the foundations for transformative engagement with sustainability that is both contextually meaningful and professionally sustainable.

#### Limitations and future research

Despite its contributions, this study is subject to several limitations that should be acknowledged to contextualise the findings and guide future research. First, the study relies on self-reported survey data, which may be influenced by social desirability bias or respondents' subjective interpretations of sustainability-related practices. Although self-reports are common in ESD research and appropriate for capturing attitudes and professional orientations, future studies could strengthen inference by incorporating behavioural observations, document analysis, or multi-informant data to triangulate findings. Second, the cross-sectional design limits the ability to draw causal conclusions about the temporal

dynamics of transformative education. While the structural model identifies theoretically coherent pathways between pedagogical environments, attitudes, and behaviour, it cannot capture how these relationships evolve over time. Longitudinal and mixed-methods designs would be valuable for examining whether sustained exposure to coherent pedagogical environments leads to deeper attitudinal change and more stable behavioural engagement with sustainability. Third, several pedagogical dimensions were operationalised using single-item or reduced-indicator measures, reflecting practical constraints in instrument design and administration. While this approach retained theoretically important constructs within the higher-order framework, it necessarily entails trade-offs in content validity. Future research should aim to develop and validate richer multi-item scales that more fully capture the complexity of transformative education dimensions while maintaining conceptual clarity and empirical tractability.

In addition, the study focused on modelling the Transformative Education Framework as a unified higher-order construct, which precludes detailed examination of potential contextual variations in how individual pedagogical dimensions interact. Future studies could explore configurational or comparative approaches, such as multi-group analyses or qualitative comparative analysis, to examine how different institutional or cultural contexts shape the composition and functioning of transformative educational environments. Finally, while the present study contributes to theoretical consolidation in ESD research, further work is needed to examine the transferability and generalisability of the framework across educational levels, subject domains, and sociocultural settings. Comparative and cross-national studies would be particularly valuable in assessing how transformative education frameworks operate under differing policy regimes and sustainability discourses. Taken together, these directions suggest that future research should continue to move beyond fragmented modelling approaches toward designs that capture the systemic, contextual, and process-oriented nature of transformative education, while also refining measurement strategies and expanding empirical scope.

## 6. Conclusions

This study examined how a Transformative Education Framework shapes teachers' engagement with sustainable development. By modelling transformative education as an integrated pedagogical system, the findings

demonstrate that sustainability-oriented behaviour is most effectively understood as an outcome of attitudinal internalisation rather than direct instructional influence. The strong mediated pathway from pedagogical coherence to attitude and, subsequently, to behaviour highlights the central role of meaning-making and professional commitment in sustainability education. The study advances ESD scholarship by providing empirical support for system-oriented and higher-order conceptualisations of transformative education. In doing so, it moves beyond technocratic and implementation-focused narratives toward a more reflexive understanding of how educational environments enable sustainable engagement. The Transformative Education Framework offers a theoretically grounded lens for understanding how pedagogical, ethical, and organisational dimensions interact to shape educators' orientations toward sustainability. Overall, the findings suggest that meaningful progress in sustainability education depends less on isolated pedagogical interventions and more on the coherent alignment of educational practices and institutional conditions. By foregrounding integration, mediation, and coherence, this study contributes to ongoing efforts to reconceptualise Education for Sustainable Development as a transformative and context-sensitive educational endeavour

## Acknowledgements

The authors would like to express their gratitude to those people who responded to the survey. Additionally, we sincerely acknowledge the anonymous reviewers for their valuable feedback

## References

- Abutaleb, S., & El-Bassiouny, N. (2020). Assessing sustainability marketing from macromarketing perspective: a multistakeholder approach. *World Journal of Entrepreneurship, Management and Sustainable Development*, 16(4), 287–305. <https://doi.org/10.1108/WJEMSD-02-2019-0017>
- Adaspayeva, N., & Parkes, S. (2021). Global Citizenship Education conceptualisation in curriculum guidelines of the New Zealand Curriculum. *The New Zealand Annual Review of Education*, 25, 57–75. <https://doi.org/10.26686/NZAROE.V25.6935>
- Affandi, Purwaningsih, Y., Hakim, L., & Mulyaningsih, T. (2025). Interplay between poverty, poverty eradication and sustainable development: A semi-systematic literature review. *Global Transitions*, 7, 1–20. <https://doi.org/10.1016/J.GLT.2024.11.001>

- Ahmed, M. (2010). Education as transformation - Education for transformation. *Development*, 53(4), 511–517. <https://doi.org/10.1057/DEV.2010.70/METRICS>
- Ajzen, I. (2001). Nature and operation of attitudes. *Annual Review of Psychology*, 52, 27–58. <https://doi.org/10.1146/ANNUREV.PSYCH.52.1.27>
- Akturk, C., Talan, T., & Cerasi, C. C. (2022). Education 4.0 and University 4.0 from Society 5.0 Perspective. *2022 12th International Conference on Advanced Computer Information Technologies, ACIT 2022*, 577–582. <https://doi.org/10.1109/ACIT54803.2022.9913099>
- Alam, A. (2022). Mapping a Sustainable Future Through Conceptualization of Transformative Learning Framework, Education for Sustainable Development, Critical Reflection, and Responsible Citizenship: An Exploration of Pedagogies for Twenty-First Century Learning. *ECS Transactions*, 107(1), 9827–9840. <https://doi.org/10.1149/10701.9827ECST/XML>
- Algurén, B. (2021). How to Bring About Change – A Literature Review About Education and Learning Activities for Sustainable Development. *Discourse and Communication for Sustainable Education*, 12(1), 5–21. <https://doi.org/10.2478/dcse-2021-0002>
- Alm, K., Melén, M., & Aggestam-Pontoppidan, C. (2021). Advancing SDG competencies in higher education: exploring an interdisciplinary pedagogical approach. *International Journal of Sustainability in Higher Education*, 22(6), 1450–1466. <https://doi.org/10.1108/IJSHE-10-2020-0417>
- Andreou, N. (2020). Towards a Generation of Sustainability Leaders: Eco-Schools as a Global Green Schools Movement for Transformative Education. In *International Explorations in Outdoor and Environmental Education* (pp. 31–45). Springer Science and Business Media B.V. [https://doi.org/10.1007/978-3-030-46820-0\\_3](https://doi.org/10.1007/978-3-030-46820-0_3)
- Annan-Diab, F., & Molinari, C. (2017). Interdisciplinarity: Practical approach to advancing education for sustainability and for the Sustainable Development Goals. *The International Journal of Management Education*, 15(2), 73–83. <https://doi.org/10.1016/J.IJME.2017.03.006>
- Arbuthnott, K. D. (2009). Education for sustainable development beyond attitude change. *International Journal of Sustainability in Higher Education*, 10(2), 152–163. <https://doi.org/10.1108/14676370910945954>
- Avsec, S., & Savec, V. F. (2021). Pre-Service Teachers' Perceptions of, and Experiences with, Technology-Enhanced Transformative Learning towards Education for Sustainable Development. *Sustainability*, 13(18). <https://doi.org/10.3390/SU131810443>
- Batchelor, H., Lindell, D., & Chen, Y. (2003). Developing Personal and Community Learning IN GRADUATE NURSING EDUCATION Through Community Engagement. *Nursing Education Perspective*, 24, 300–305. [https://doi.org/10.1043/1094-2831\(2003\)024](https://doi.org/10.1043/1094-2831(2003)024)

- Becker, J. M., Klein, K., & Wetzels, M. (2012). Hierarchical Latent Variable Models in PLS-SEM: Guidelines for Using Reflective-Formative Type Models. *Long Range Planning*, 45(5–6), 359–394. <https://doi.org/10.1016/J.LRP.2012.10.001>
- Bezjeljak, P., Scheuch, M., & Torkar, G. (2020). Understanding of sustainability and education for sustainable development among pre-service biology teachers. *Volume 12, Issue 17, 12(17)*. <https://doi.org/10.3390/SU12176892>
- Bourn, D., & Soysal, N. (2021). Transformative Learning and Pedagogical Approaches in Education for Sustainable Development: Are Initial Teacher Education Programmes in England and Turkey Ready for Creating Agents of Change for Sustainability? *Sustainability 2021, Vol. 13, Page 8973, 13(16)*, 8973. <https://doi.org/10.3390/SU13168973>
- Brunstein, J., & King, J. (2018). Organizing reflection to address collective dilemmas: Engaging students and professors with sustainable development in higher education. *Journal of Cleaner Production*, 203, 153–163. <https://doi.org/10.1016/J.JCLEPRO.2018.08.136>
- Chin, W., Cheah, J.-H., Liu, Y., Ting, H., Lim, X.-J., & Cham, T. H. (2020). Demystifying the role of causal-predictive modeling using partial least squares structural equation modeling in information systems research. *Industrial Management & Data Systems*, 120(12), 2161–2209. <https://doi.org/10.1108/IMDS-10-2019-0529>
- Clift, R. (2003). Metrics for supply chain sustainability. *Clean Technologies and Environmental Policy*, 5(3–4), 240–247. <https://doi.org/10.1007/S10098-003-0220-0>
- Cranton, P. (2023). *Understanding and Promoting Transformative Learning*. Routledge. <https://doi.org/10.4324/9781003448433>
- Dhar, U., Parashar, S., & Tiwari, T. (2008). Profession and Dietary Habits as Determinants of Perceived and Expected Values. *Journal of Human Values*, 14(2), 181–190. <https://doi.org/10.1177/097168580801400208>
- Dirkx, J. M. (2001). The Power of Feelings: Emotion, Imagination, and the Construction of Meaning in Adult Learning. *New Directions for Adult and Continuing Education*, 2001(89), 63–72. <https://doi.org/10.1002/ace.9>
- Dlouhá, J., Macháčková-Henderson, L., & Dlouhý, J. (2013). Learning networks with involvement of higher education institutions. *Journal of Cleaner Production*, 49, 95–104. <https://doi.org/10.1016/J.JCLEPRO.2012.06.009>
- Eagan, P., Cook, T., & Joeres, E. (2002). Teaching the importance of culture and interdisciplinary education for sustainable development. *International Journal of Sustainability in Higher Education*, 3(1), 48–66. <https://doi.org/10.1108/14676370210414173>
- F. Hair Jr, J., Sarstedt, M., Hopkins, L., & G. Kuppelwieser, V. (2014). Partial least squares structural equation modeling (PLS-SEM). *European Business Review*, 26(2), 106–121. <https://doi.org/10.1108/EBR-10-2013-0128>

- Fleming, T. (2022). Mezirow's Theory of Transformative Learning and Freire's Pedagogy. *Adult Education Critical Issues*, 2(2), 7–19. <https://doi.org/10.12681/haea.32302>
- Freire, P. (1970). Cultural Action and Conscientization. *Harvard Educational Review*, 40(3), 452–477. <https://doi.org/10.1177/3/haer.40.3.h76250x720j43175>
- Gepp, S., Jung, L., Wabnitz, K., Schneider, F., v Gierke, F., Otto, H., Hartmann, S., Gemke, T., Schulz, C., Gabrysch, S., Fast, M., & Schwienhorst-Stich, E. M. (2023). The Planetary Health Academy—a virtual lecture series for transformative education in Germany. *The Lancet Planetary Health*, 7(1), e68–e76. [https://doi.org/10.1016/S2542-5196\(22\)00253-4](https://doi.org/10.1016/S2542-5196(22)00253-4)
- Gericke, N., & Torbjörnsson, T. (2022). Supporting local school reform toward education for sustainable development: The need for creating and continuously negotiating a shared vision and building trust. *The Journal of Environmental Education*, 53(4), 231–249. <https://doi.org/10.1080/00958964.2022.2102565>
- Gliszinski, D. J. (2007). Transformative Higher Education. *Journal of Transformative Education*, 5(4), 317–328. <https://doi.org/10.1177/1541344607312838>
- Gorana, R. N., & Kanaujia, P. R. (2016). A New Paradigm of Education Towards Sustainable Development. *Reorienting Educational Efforts for Sustainable Development*, 21–34. [https://doi.org/10.1007/978-94-017-7622-6\\_2](https://doi.org/10.1007/978-94-017-7622-6_2)
- Gorghiu, G., & Santi, E. A. (2016). *Applications of Experiential Learning in Science Education Non-Formal Contexts*. 320–326. <https://doi.org/10.15405/EPSBS.2016.11.33>
- Gu, Q. (2005). The perception gap in cross-cultural training: an investigation of British Council English language teaching projects in China. *International Journal of Educational Development*, 25(3), 287–304. <https://doi.org/10.1016/j.ijedudev.2004.10.001>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*. Springer International Publishing. <https://doi.org/10.1007/978-3-030-80519-7>
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>
- Hair Jr., J. F., Matthews, L. M., Matthews, R. L., & Sarstedt, M. (2017). PLS-SEM or CB-SEM: updated guidelines on which method to use. *International Journal of Multivariate Data Analysis*, 1(2), 107. <https://doi.org/10.1504/IJMDA.2017.10008574>
- Hayduk, L. A., & Littvay, L. (2012). Should researchers use single indicators, best indicators, or multiple indicators in structural equation models? *BMC Medical Research Methodology* 2012 12:1, 12(1), 159-. <https://doi.org/10.1186/1471-2288-12-159>

- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/S11747-014-0403-8/FIGURES/8>
- Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). *The use of partial least squares path modeling in international marketing* (pp. 277–319). [https://doi.org/10.1108/S1474-7979\(2009\)0000020014](https://doi.org/10.1108/S1474-7979(2009)0000020014)
- Hogan, D., & O’flaherty, J. (2021). Addressing Education for Sustainable Development in the Teaching of Science: The Case of a Biological Sciences Teacher Education Program. *Sustainability* 2021, Vol. 13, Page 12028, 13(21), 12028. <https://doi.org/10.3390/SU132112028>
- Homer, P. M., & Kahle, L. R. (1988). A structural equation test of the value-attitude-behavior hierarchy. *Journal of Personality and Social Psychology*, 54(4), 638–646. <https://doi.org/10.1037/0022-3514.54.4.638>
- Hooks, B. (2014). *Teaching To Transgress*. Routledge. <https://doi.org/10.4324/9780203700280>
- Hossain, N., & Hickey, S. (2019). The Problem of Education Quality in Developing Countries. *The Politics of Education in Developing Countries*, 1–21. <https://doi.org/10.1093/OSO/9780198835684.003.0001>
- Howard, T. C. (2003). Culturally Relevant Pedagogy: Ingredients for Critical Teacher Reflection. *Theory Into Practice*, 42(3), 195–202. [https://doi.org/10.1207/S15430421TIP4203\\_5](https://doi.org/10.1207/S15430421TIP4203_5)
- Howlett, C., Ferreira, J. A., & Blomfield, J. (2016). Teaching sustainable development in higher education Building critical, reflective thinkers through an interdisciplinary approach. *International Journal of Sustainability in Higher Education*, 17(3), 305–321. <https://doi.org/10.1108/IJSHE-07-2014-0102>
- Huang, P.-H., Chen, H., & Weng, L.-J. (2017). A Penalized Likelihood Method for Structural Equation Modeling. *Psychometrika*, 82(2), 329–354. <https://doi.org/10.1007/s11336-017-9566-9>
- Huckle, J., & Wals, A. E. J. (2015). The UN Decade of Education for Sustainable Development: business as usual in the end. *Environmental Education Research*, 21(3), 491–505. <https://doi.org/10.1080/13504622.2015.1011084>
- Ihemezie, E. J., Nawrath, M., Strauß, L., Stringer, L. C., & Dallimer, M. (2021). The influence of human values on attitudes and behaviours towards forest conservation. *Journal of Environmental Management*, 292, 112857. <https://doi.org/10.1016/J.JENVMAN.2021.112857>
- Kaloom, Q., & Khanam, A. (2017). Inquiry into sustainability issues by preservice teachers: A pedagogy to enhance sustainability consciousness. *Journal of Cleaner Production*, 164, 1301–1311. <https://doi.org/10.1016/j.jclepro.2017.07.047>

- Kapsalis, T. Ap., & Kapsalis, V. C. (2020). Sustainable Development and Its Dependence on Local Community Behavior. *Sustainability*, *12*(8), 3448. <https://doi.org/10.3390/su12083448>
- Katılmış, A. (2017). Values Education as Perceived by Social Studies Teachers in Objective and Practice Dimensions. *Kuram Ve Uygulamada Egitim Bilimleri*, *17*(4), 1231–1254. <https://doi.org/10.12738/ESTP.2017.4.0570>
- Kim, M. J., Hall, C. M., Kwon, O., & Sohn, K. (2024). Space tourism: Value-attitude-behavior theory, artificial intelligence, and sustainability. *Journal of Retailing and Consumer Services*, *77*, 103654. <https://doi.org/10.1016/J.JRETCONSER.2023.103654>
- Kolleck, N. (2013). Social network analysis in innovation research: using a mixed methods approach to analyze social innovations. *European Journal of Futures Research*, *1*(1), 1–9. <https://doi.org/10.1007/S40309-013-0025-2>
- Kopnina, H. (2020). Education for the future? Critical evaluation of education for sustainable development goals. *The Journal of Environmental Education*, *51*(4), 280–291. <https://doi.org/10.1080/00958964.2019.1710444>
- Kopnina, H., & Meijers, F. (2014). Education for sustainable development (ESD). *International Journal of Sustainability in Higher Education*, *15*(2), 188–207. <https://doi.org/10.1108/IJSHE-07-2012-0059>
- Krishnan, K., Joshith, V. P., Chittakath, S., & Ranjan, S. R. (2025). Trends and trajectories in MOOCs research terrain: a bibliometric mapping from 2008 to 2023. *Journal of Education and Learning*, *19*(4), 2266–2278. <https://doi.org/10.11591/edulearn.v19i4.23268>
- Lawrence, A. W., Ihebuzor, N., & Lawrence, D. O. (2020). Some Challenges Militating against Developing Countries Achieving SDG 4 on Targets: Nigeria as Case Study. *Modern Economy*, *11*(07), 1307–1328. <https://doi.org/10.4236/me.2020.117093>
- Leal Filho, W., Raath, S., Lazzarini, B., Vargas, V. R., de Souza, L., Anholon, R., Quelhas, O. L. G., Haddad, R., Klavins, M., & Orlovic, V. L. (2018). The role of transformation in learning and education for sustainability. *Journal of Cleaner Production*, *199*, 286–295. <https://doi.org/10.1016/J.JCLEPRO.2018.07.017>
- Lee, S., & Ha-Brookshire, J. (2017). Ethical Climate and Job Attitude in Fashion Retail Employees' Turnover Intention, and Perceived Organizational Sustainability Performance: A Cross-Sectional Study. *Sustainability*, *9*(3), 465. <https://doi.org/10.3390/su9030465>
- Lozano, R. (2008). Developing collaborative and sustainable organisations. *Journal of Cleaner Production*, *16*(4), 499–509. <https://doi.org/10.1016/j.jclepro.2007.01.002>
- Lozano-Díaz, A., & Fernández-Prados, J. S. (2020). Educating Digital Citizens: An Opportunity to Critical and Activist Perspective of Sustainable Development Goals. *Sustainability*, *12*(18), 1–14. <https://doi.org/10.3390/SU12187260>

- Madar, M. J. (2021). Strategic Shift from Transmissive to Transformative Higher Education for Sustainable Development. In *Pages 315 - 324* (pp. 315–324). Springer Nature. [https://doi.org/10.1007/978-3-030-74349-9\\_25](https://doi.org/10.1007/978-3-030-74349-9_25)
- Mahmoudi, S., Jafari, E., Nasrabadi, H., & Liaghatdar, M. (2012). Holistic Education: An Approach for 21 Century. *International Education Studies*, 5(2), 178–186. <https://doi.org/10.5539/ies.v5n3p178>
- Manning, S. L. (2014). The role of universities in developing interdisciplinary action research collaborations to understand and manage resilient social-ecological systems. *Journal of Cleaner Production*, 64, 125–135. <https://doi.org/10.1016/j.jclepro.2013.07.010>
- Marouli, C. (2021). Sustainability education for the future? Challenges and implications for education and pedagogy in the 21st century. *Volume 13, Issue 5, Pages 1 - 15*, 13(5), 1–15. <https://doi.org/10.3390/su13052901>
- Memon, M. A., Thurasamy, R., Ting, H., & Cheah, J. H. (2025). PURPOSIVE SAMPLING: A REVIEW AND GUIDELINES FOR QUANTITATIVE RESEARCH. *Journal of Applied Structural Equation Modeling*, 9(1), 1–23. [https://doi.org/10.47263/JASEM.9\(1\)01](https://doi.org/10.47263/JASEM.9(1)01)
- Mezirow, J. (2018). Transformative learning theory. *Contemporary Theories of Learning*, 114–128. <https://doi.org/10.4324/9781315147277-8>
- Middleton, P. (2018). Sustainable living education: Techniques to help advance the renewable energy transformation. *Solar Energy*, 174, 1016–1018. <https://doi.org/10.1016/j.solener.2018.08.009>
- Mogren, A., Gericke, N., & Scherp, H. Å. (2019). Whole school approaches to education for sustainable development: a model that links to school improvement. *Environmental Education Research*, 25(4), 508–531. <https://doi.org/10.1080/13504622.2018.1455074>
- Molderez, I., & Fonseca, E. (2018). The efficacy of real-world experiences and service learning for fostering competences for sustainable development in higher education. *Journal of Cleaner Production*, 172, 4397–4410. <https://doi.org/10.1016/j.jclepro.2017.04.062>
- Moore, J. (2005). Is Higher Education Ready for Transformative Learning? *Journal of Transformative Education*, 3(1), 76–91. <https://doi.org/10.1177/1541344604270862>
- Nesbit, T. (1999). The Theory and Practice of Transformative Learning: A Critical Review. *Canadian Journal of University Continuing Education*, 25(1). <https://doi.org/10.21225/d59892>
- Nguyen, H. B. N., Hong, J. C., Chen, M. L., Ye, J. N., & Tsai, C. R. (2023). Relationship between students' hands-on making self-efficacy, perceived value, cooperative attitude and competition preparedness in joining an iSTEAM contest. *Research in Science and Technological Education*, 41(1), 251–270. <https://doi.org/10.1080/02635143.2021.1895100>

- O'Brien, K., King, H., Phillips, J., Dalton, Kath, & Phoenix. (2022). "Education as the practice of freedom?" – prison education and the pandemic. *Educational Review*, 74(3), 685–703. <https://doi.org/10.1080/00131911.2021.1996335>
- Odell, V., Molthan-Hill, P., Martin, S., & Sterling, S. (2020). *Transformative Education to Address All Sustainable Development Goals*. 905–916. [https://doi.org/10.1007/978-3-319-95870-5\\_106](https://doi.org/10.1007/978-3-319-95870-5_106)
- O'Flaherty, J., & Liddy, M. (2018). The impact of development education and education for sustainable development interventions: a synthesis of the research. *Environmental Education Research*, 24(7), 1031–1049. <https://doi.org/10.1080/13504622.2017.1392484;WGROU:STRING:PUBLICATION>
- O'Grady, M. (2023). Transformative education for sustainable development: A faculty perspective. *Environment, Development and Sustainability*, 1–17. <https://doi.org/10.1007/S10668-023-03609-Y/TABLES/2>
- Olson, J. M., & Zanna, M. P. (1993). Attitudes and Attitude Change. *Annual Review of Psychology*, 44(1), 117–154. <https://doi.org/10.1146/ANNUREV.PS.44.020193.001001>
- Ostroff, C. (1993). The Effects of Climate and Personal Influences on Individual Behavior and Attitudes in Organizations. *Organizational Behavior and Human Decision Processes*, 56(1), 56–90. <https://doi.org/10.1006/obhd.1993.1045>
- Paprock, K. E. (1992). Mezirow, Jack. (1991). *Transformative Dimensions of Adult Learning*. San Francisco: Jossey-Bass, 247 pages. \$29.95. *Adult Education Quarterly*, 42(3), 195–197. <https://doi.org/10.1177/074171369204200309>
- Paul, L. A., & Quiggin, J. (2020). Transformative Education. *Educational Theory*, 70(5), 561–579. <https://doi.org/10.1111/edth.12444>
- Pawłowski, A. (2008). How many dimensions does sustainable development have. *Sustainable Development*, 16(2), 81–90. <https://doi.org/10.1002/SD.339>
- Pienaar-Steyn, S. (2012). The millennium development goals as a conceptual framework for enabling and evaluating community engagement. *South African Review of Sociology*, 43(2), 40–57. <https://doi.org/10.1080/21528586.2012.694242>
- Postiglione, G. A., Johnstone, C. J., & Teter, W. R. (2023). Education for Sustainable Development (ESD) in the context of transformative education. In *Handbook of Education Policy* (pp. 1–375). Edward Elgar Publishing Ltd. <https://doi.org/10.4337/9781800375062>
- Ranjan, S., Joshith, V. P., Kavitha, K., & Chittakath, S. (2024). The AI-knowledge management nexus for sustainable learning: A PLS-SEM study. *Knowledge Management and E-Learning*, 16(4), 811–837. <https://doi.org/10.34105/j.kmel.2024.16.037>

- Sakalasooriya, N. (2021). Conceptual Analysis of Sustainability and Sustainable Development. *Open Journal of Social Sciences*, 09(03), 396–414. <https://doi.org/10.4236/JSS.2021.93026>
- Salonen, A. O., & Siirilä, J. (2019). Transformative Pedagogies for Sustainable Development. In *Encyclopedia of Sustainability in Higher Education* (pp. 1966–1972). Springer International Publishing. [https://doi.org/10.1007/978-3-030-11352-0\\_369](https://doi.org/10.1007/978-3-030-11352-0_369)
- Sarstedt, M., Hair, J. F., Cheah, J. H., Becker, J. M., & Ringle, C. M. (2019). How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal (AMJ)*, 27(3), 197–211. <https://doi.org/10.1016/J.AUSMJ.2019.05.003>
- Scalabrino, C., Navarrete Salvador, A., & Oliva Martínez, J. M. (2022). A theoretical framework to address education for sustainability for an earlier transition to a just, low carbon and circular economy. *Environmental Education Research*, 28(5), 735–766. <https://doi.org/10.1080/13504622.2022.2031899>
- Scalco, A., Noventa, S., Sartori, R., & Ceschi, A. (2017). Predicting organic food consumption: A meta-analytic structural equation model based on the theory of planned behavior. *Appetite*, 112, 235–248. <https://doi.org/10.1016/J.APPET.2017.02.007>
- Schillewaert, N., Langerak, F., & Duharnel, T. (1998). Non-Probability Sampling for WWW Surveys: A Comparison of Methods. *Market Research Society. Journal*, 40(4), 1–13. <https://doi.org/10.1177/147078539804000403>
- Schröder, A., & Krüger, D. (2019). Social Innovation as a Driver for New Educational Practices: Modernising, Repairing and Transforming the Education System. *Sustainability 2019, Vol. 11, Page 1070*, 11(4), 1070. <https://doi.org/10.3390/SU11041070>
- Sharma, A. (2025). Transformative Teaching Methods in Higher Education. *International Journal For Multidisciplinary Research*, 7(1). <https://doi.org/10.36948/ijfmr.2025.v07i01.35395>
- Siddiqui, Dr. S., & Aqil, Dr. Z. (2014). Building Up an Ecologically Sustainable Society by Inculcating Environmental Ethics and Values in Children. *IOSR Journal of Humanities and Social Science*, 19(3), 05–09. <https://doi.org/10.9790/0837-19320509>
- Sterling, S. (2021). Concern, Conception, and Consequence: Re-thinking the Paradigm of Higher Education in Dangerous Times. *Frontiers in Sustainability*, 2, 743806. <https://doi.org/10.3389/FRSUS.2021.743806/BIBTEX>
- Sturges, M., Gray, T., Barnes, J., & Lloyd, A. (2023). Parents' and caregivers' perspectives on the benefits of a high-risk outdoor play space. *Journal of Outdoor and Environmental Education*, 26(3), 359–382. <https://doi.org/10.1007/S42322-023-00132-6/FIGURES/7>
- Subramaniam, K., Wider, W., Vasudevan, A., Khan, N., & Kohli, A. (2023). Transitions of value creation from traditional media to social media architecture. *Online Journal of*

- Communication and Media Technologies*, 13(4), e202356.  
<https://doi.org/10.30935/OJCMT/13775>
- Thomas, E. (1997). Developing a culture-sensitive pedagogy: Tackling a problem of melding 'global culture' within existing cultural contexts. *International Journal of Educational Development*, 17(1), 13–26. [https://doi.org/10.1016/S0738-0593\(96\)00066-1](https://doi.org/10.1016/S0738-0593(96)00066-1)
- Toka, K., & Gioti, L. (2023). BROOKFIELD AND MEZIROU ON CRITICAL REFLECTION: EMPOWERING ONESELF, TRANSFORMING SOCIETY. *European Journal of Education Studies*, 10(12).  
<https://doi.org/10.46827/ejes.v10i12.5120>
- Tomasella, B., Wylie, A., & Gill, D. (2023). The role of higher education institutions (HEIs) in educating future leaders with social impact contributing to the sustainable development goals. *Social Enterprise Journal*, 19(4), 329–346.  
<https://doi.org/10.1108/SEJ-03-2022-0027>
- Tongco, Ma. D. C. (2007). Purposive Sampling as a Tool for Informant Selection. *Ethnobotany Research & Applications*. <https://doi.org/10.5281/ZENODO.5825703>
- Trehan, K. (2007). Psychodynamic and Critical Perspectives on Leadership Development. *Advances in Developing Human Resources*, 9(1), 72–82.  
<https://doi.org/10.1177/1523422306294496>
- Trust, T., & Prestridge, S. (2021). The interplay of five elements of influence on educators' PLN actions. *Teaching and Teacher Education*, 97.  
<https://doi.org/10.1016/J.TATE.2020.103195>
- UNESCO. (2017). *Education for Sustainable Development Goals: learning objectives*. UNESCO.  
<https://doi.org/10.54675/CGBA9153>
- Vare, P., Arro, G., de Hamer, A., Gobbo, G. Del, de Vries, G., Farioli, F., Kadji-Beltran, C., Kangur, M., Mayer, M., Millican, R., Nijdam, C., Réti, M., & Zachariou, A. (2019). Devising a Competence-Based Training Program for Educators of Sustainable Development: Lessons Learned. *Sustainability 2019, Vol. 11, Page 1890*, 11(7), 1890. <https://doi.org/10.3390/SU11071890>
- Vargas, C. M. (2000). Sustainable development education: Averting or mitigating cultural collision. *International Journal of Educational Development*, 20(5), 377–396.  
[https://doi.org/10.1016/S0738-0593\(99\)00081-4](https://doi.org/10.1016/S0738-0593(99)00081-4)
- Vaughter, P., & Yume Yamaguchi, S. (2023). Education for Sustainable Development (ESD) in the context of transformative education. In *Handbook of Education Policy* (pp. 243–256). Edward Elgar Publishing.  
<https://doi.org/10.4337/9781800375062.00024>
- Wals, A. E. J., & Benavot, A. (2017a). Can we meet the sustainability challenges? The role of education and lifelong learning. *European Journal of Education*, 52(4), 404–413.  
<https://doi.org/10.1111/EJED.12250>

- Wals, A. E. J., & Benavot, A. (2017b). Can we meet the sustainability challenges? The role of education and lifelong learning. *European Journal of Education, 52*(4), 404–413. <https://doi.org/10.1111/ejed.12250>
- Walsh, K. D., Crisp, J., & Moss, C. (2011). Psychodynamic perspectives on organizational change and their relevance to Transformational Practice Development. *International Journal of Nursing Practice, 17*(2), 205–212. <https://doi.org/10.1111/j.1440-172X.2011.01926.x>
- Wang, G., Yao, Y., Ren, L., Zhang, S., & Zhu, M. (2023). Examining the role of generativity on tourists' environmentally responsible behavior: An inter-generational comparison. *Journal of Hospitality and Tourism Management, 57*, 303–314. <https://doi.org/10.1016/j.jhtm.2023.10.008>
- Wang, X., Van der Werff, E., Bouman, T., Harder, M. K., & Steg, L. (2021). I Am vs. We Are: How Biospheric Values and Environmental Identity of Individuals and Groups Can Influence Pro-environmental Behaviour. *Frontiers in Psychology, 12*, 618956. <https://doi.org/10.3389/FPSYG.2021.618956/BIBTEX>
- Wang, Y., Chung, T., & Lai, P. C. (2023). Go Sustainability—Willingness to Pay for Eco-Agricultural Innovation: Understanding Chinese Traditional Cultural Values and Label Trust Using a VAB Hierarchy Model. *Sustainability (Switzerland), 15*(1), 751. <https://doi.org/10.3390/su15010751>
- Wei, Y., Zhong, F., Song, X., & Huang, C. (2023). Exploring the impact of poverty on the sustainable development goals: Inhibiting synergies and magnifying trade-offs. *Sustainable Cities and Society, 89*, 104367. <https://doi.org/10.1016/J.SCS.2022.104367>
- Whiting, K., Konstantakos, L., Misiaszek, G., Simpson, E., & Carmona, L. G. (2018). Education for the Sustainable Global Citizen: What Can We Learn from Stoic Philosophy and Freirean Environmental Pedagogies? *Education Sciences, 8*(4), 204. <https://doi.org/10.3390/educsci8040204>
- Zheng, Q., Wen, X., Xiu, X., & Chen, Q. (2023). Income Quality and Organic Food Purchase Intention: The Chain Mediating Role of Environmental Value, Perceived Consumer Effectiveness. *SAGE Open, 13*(4). [https://doi.org/10.1177/21582440231218974/ASSET/IMAGES/LARGE/10.1177\\_21582440231218974-FIG2.JPEG](https://doi.org/10.1177/21582440231218974/ASSET/IMAGES/LARGE/10.1177_21582440231218974-FIG2.JPEG)
- Zsóka, Á., Szerényi, Z. M., Széchy, A., & Kocsis, T. (2013). Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. *Journal of Cleaner Production, 48*, 126–138. <https://doi.org/10.1016/J.JCLEPRO.2012.11.030>

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## Funds

The present study has not received any funds from any organisations or supporting institutions or was not performed as part of employment. This is independent research done by the authors for their academic purposes.

## Competing Interests

The authors declare that there is no conflict of interest regarding the publication of this article.

## Ethics and Consent

The study received ethical approval, and informed consent was obtained from all participants for participation and for publication. Their confidentiality and anonymity were ensured.

## Citation

Shana, C., Joshith, V.P., & Ranjan, S. (2026). Sustainable development through Transformative Education Framework. A structural equation modelling. *Visions for Sustainability*, 25, 13008, 1-43. <http://dx.doi.org/10.13135/2384-8677/13008>



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