

Mediating Role of Biospheric Values in the Relationship between Sustainability Consciousness and Construction Sustainable Behaviours among Building Technology Education Undergraduates

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Abstract

To assess sustainability consciousness (SC), its relationship with construction sustainable behaviours (CSB), and the mediating role of biospheric values, this study analyses survey data from 201 Building Technology Education (BTE) undergraduates across 13 public universities in the South-East and South-South regions of Nigeria. The data were examined using statistical tools such as mean, standard deviation, correlation, hierarchical multiple regression, and the PROCESS macro for SPSS (version 26) with 5000 bootstrap re-samples. Findings reveal a high level of sustainability consciousness among the respondents. Regression analysis shows that SC is a significant predictor of both CSB and biospheric values. Mediation analysis indicates that biospheric values partially mediate the SC-CSB relationship, with results suggesting a competitive mediation where the direct and indirect effects are significant but in opposite directions. This research adds to the body of knowledge on sustainability consciousness and sustainable behaviours, offering context-specific insights into the broader application of SC.

Keywords: building technology education, biospheric values, construction sustainable behaviours, sustainability consciousness, sustainability

Introduction

The acknowledgement that Technical Vocational Education and Training (TVET) provides nations with the skilled workforce needed to drive development across various sectors has maintained its significance for both individuals and countries. TVET is structured to meet labour market demands by supplying knowledgeable, skilled, and value-driven workers globally (Chukwu et al., 2020; Park, 2005). According to UNESCO (2014), "TVET is well-positioned to address challenges such as economic growth, low productivity, social inequality, instability, insecurity, environmental degradation, and limited understanding of sustainable practices." As such, TVET is considered one of the key tools for sustainable development (Bakar, 2011). Building Technology Education (BTE), a component of TVET in Nigerian tertiary institutions, is designed to produce professionals capable of handling essential tasks like production, management, cost estimation, maintenance, and delivery of building construction services (Federal

Republic of Nigeria [FRN], 2013). The BTE program serves a dual purpose, preparing students to become either building construction technologists or classroom teachers. As future educators, BTE students are expected to gain knowledge, experience, and behaviours related to sustainability, ensuring they can pass on these principles to their future students. Additionally, as trainees in building technology, they will work alongside graduates from fields such as engineering, environmental studies, and surveying, making it crucial for them to stay current on sustainability trends (Alsaati et al., 2020), particularly with the ongoing demand for housing development driven by rural-to-urban migration. Unfortunately, research indicates that preservice teachers often lack the necessary knowledge, awareness, experience, attitudes, and behaviours aligned with sustainability, resulting in low levels of sustainability consciousness (Kalsoom et al., 2017).

Sustainability consciousness (SC) refers to the presence of sufficient knowledge or experience that influences beliefs, emotions, and actions. It is built on three key elements: knowingness, attitude, and behaviour, which align with the three dimensions of sustainability – environmental, economic, and social (Gericke et al., 2017). Knowingness encompasses knowledge, awareness, and experiences shaped by an affinity for sustainability (Chen et al., 2022; Olsson, Gericke & Rundgren, 2016). A strong sense of sustainability knowingness leads to concern for sustainability, which is referred to as a sustainability attitude. This attitude is a psychological construct that reflects responses such as favourable or unfavourable, good or bad, harmful or beneficial, pleasant or unpleasant, and likeable or dislikable (Guan et al., 2019; Vaske & Donnelly, 1999). Furthermore, sustainable behaviours associated with SC involve pro-environmental actions essential for achieving sustainability in various domains of sustainable development. A study by Kalsoom et al. (2017) on the sustainability consciousness of preservice teachers in Pakistan provided valuable insights, although it focused only on SC values. The study did not explore SC in relation to the preservice teachers' areas of specialization, nor did it investigate potential links between SC components and other sustainable behaviours that benefit the environment. Therefore, this research explored the relationship between SC and construction-related sustainable behaviours.

Based on Thomas and Muga's (2014) framework, sustainable behaviour encompasses actions guided by people's values, norms, beliefs, and sense of responsibility, all aimed at ensuring the well-being of current and future generations, along with all living beings. Steg and Vlek (2009) describe sustainability behaviour as any actions that prevent harm to or protect the environment. Although sustainable behaviours among students have been widely studied (Corral-Verdugo et al., 2021; Inkpen & Baily, 2020; Whitley et al., 2018; Xu et al., 2020; Yuriev & Sierra-Barón, 2020), these studies often focus on general eco-friendly behaviours, such as turning off lights when not in use, recycling, carpooling, and choosing eco-friendlier transportation options like cycling. According to Darko and Chan (2018), achieving a sustainable

agenda in building construction requires significant behavioural shifts. Yet, research has often overlooked specific behaviours and actions needed to meet this objective. For instance, while Xie et al. (2020) examined architectural students' awareness and motivation toward green building design, the study did not address the construction practices necessary to realize sustainable building goals. It is crucial to recognize that every stage in building – from design, siting, construction, and operation to maintenance, renovation, and deconstruction (EPA, n.d.; Kibert, 2013) - relates to sustainability and requires action, collectively termed construction sustainable behaviours.

Construction Sustainable Behaviour (CSB) encompasses actions aimed at developing buildings and environments aligned with sustainable construction principles, such as reducing resource use, reusing and recycling materials, protecting natural ecosystems, eliminating toxic substances, applying life-cycle costing, and prioritizing quality (Kibert, 2013). CSB involves moving away from outdated or conventional practices toward approaches that lessen construction's environmental impact. Examples include using integrated design processes, implementing green building technologies, and optimizing natural lighting. By adhering to sustainable construction principles, buildings can achieve high-performance standards, featuring green technologies, renewable energy sources like solar power, efficient resource usage, enhanced indoor environmental quality, pollution and waste reduction, and the use of recycled or recyclable materials (Monu & Neelam, 2015; Darko & Chan, 2018).

Without attention to CSB and sustainable principles, the construction industry may persist in traditional practices, which have detrimental environmental impacts, such as climate change, ozone depletion, soil erosion, desertification, deforestation, and pollution of land, water, and air (Kibert, 2013). Conventional building practices account for around 40% of global energy consumption, 35% of greenhouse gas emissions, 40% of global waste, and a significant portion of resource use (Chan et al., 2016). Conversely, CSB can drive sustainable methods in construction, potentially cutting building energy use by 30-80%, enhancing worker comfort, efficiency, and well-being (Chan et al., 2016), and transforming waste into valuable resources (Ma, 2011). Despite these benefits, sustainability-related behaviours and influences, such as values that may affect perceptions of sustainability's advantages, remain under-researched in the construction industry (Kuehne et al., 2017).

Values are internalized principles that guide decisions and behaviours by assessing their relative importance. Once abstract concepts, such as sustainability, become internalized, values motivate individuals to adopt behaviours that align with these principles (Whitley et al., 2018; Schwartz & Bilsky, 1987). In terms of sustainable behaviour, the literature highlights five types of values: self-interest (egoistic), traditionalism (conservation), openness to change, altruism, and biospheric values (Whitley et al., 2018; Stern & Dietz, 1994). Research by Whitley et al. (2018) has shown that biospheric values, which reflect the inherent interconnection between humans

and all species essential for life, are especially supportive of sustainable behaviours. These values are the most consistent in fostering pro-environmental actions and positively influence beliefs toward environmental care. López-Mosquera and Sánchez (2012) found that individuals with strong biospheric values tend to exhibit significant pro-environmental attitudes. Although previous studies have linked biospheric values to environmental beliefs (Liu et al., 2018) and indirectly to pro-environmental behaviours (Whitley et al., 2018), there is limited empirical research on the mediating role of biospheric values in the relationship between preservice teachers' sustainability consciousness (SC) and construction sustainable behaviour (CSB). This study therefore assessed preservice teachers' SC, examining the relationships among SC, CSB, biospheric values, and the mediating effect of biospheric values in these associations.

Given the limited focus on pro-environmental behaviours within the construction industry, this study contributed to the existing literature on sustainable behaviour and sustainability consciousness (SC) by exploring behaviours specifically relevant to construction. Thus, the proposed and examined a model (Figure 1) to test the mediating role of biospheric values in the relationship between SC and construction sustainable behaviours

Hypotheses

1. Sustainability consciousness will significantly predict construction sustainable behaviours.
2. Sustainability consciousness will significantly predict biospheric value.
3. Biospheric values will significantly predict construction sustainable behaviours.
4. Biospheric values will mediate the relationship between sustainability consciousness and sustainable construction behaviours.

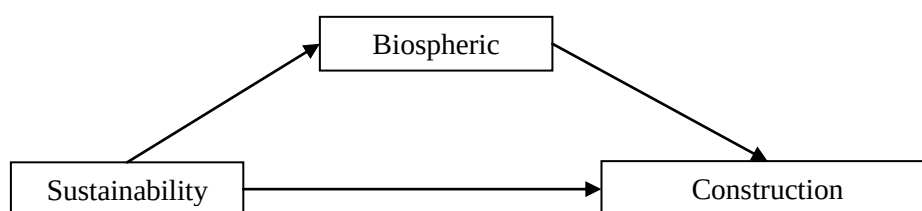


Figure 1: Proposed model illustrating the influence of biospheric values on the relationship between sustainability consciousness and construction sustainable behaviours

Method

Participants and procedure

Two hundred and twenty-nine (229) Building Technology Education (BTE) students in 13 government-owned universities across South-East and South-South, Nigeria participated in the study. The anonymity and confidentiality of the participants were

ensured, as we coded the instrument without any identifying information of the students. Two modes of data collection were used in this study – online mode using Google Forms, and pencil-and-paper using direct administration and retrieval. For the online mode, the link to the questionnaire was shared with the lecturers and class representatives who assisted in following up with members of the class to ensure compliance. On the other hand, “the participants were requested to complete the questionnaire and return same directly to their instructors”, who assisted in administering the instrument during their building construction practical classes in the second semester 2021/2022 session. After 10 weeks, two hundred and six (206) – 79 online and 127 hard copies of the instrument, representing 90%, were submitted/returned; 5 copies were rejected as they were incomplete; thus, 201 copies were used for the data analyses.

The demographic data show that 82.5% of participants are males, and 17.5% are females. All the participants are full-time regular students with 42.8% in the final year, while 57.2% are in 200 and 300 levels (First-year students were excluded as they have yet to choose an area of specialization). In terms of ages, 17.5% of participants are 16–18 years, while 41.3%, respectively represent both 19–21 years, and 22 years and above.

Measures

Section A comprised student’s level of study, age and gender. Except for biospheric values, section B has all constructs measured on a five-point Likert scale, ranging from 1 “strongly disagree” to 5 “strongly agree,”.

Sustainability Consciousness (SC) was measured using the *Sustainability Consciousness Questionnaire (Short version) (SCQ-S)*, which comprised a 27-item scale. SCQ-S was adopted from (Gericke et al., 2019) with little modifications, such as the replacement of “sustainable development with “sustainable construction,” to align the items with the focus of the study. SCQ is a multi-faceted instrument that measures SC in itself, using three subscales of sustainability knowingness, sustainability attitudes, and sustainability behaviour. Aggregated scores in different categories and subscales show sustainability knowingness, attitude and/or behaviours of the population of interest. The three subscales tested for reliability using Cronbach alpha showed a reliability coefficient (α) of 0.841.

Construction Sustainable Behaviour (CSB) comprised 15 items, developed by the researchers following the principles of sustainable construction (Kibert, 2013). The CSB tested were sieved to exclude the behaviours already suggested in the sustainability consciousness questionnaire. For instance, SCQ has items such as “I recycle as much as I can,” “I always sort waste before putting out the rubbish when I have the chance,” and “I have adjusted my personal lifestyle in order to reduce waste in and out of construction sites.” Thus, to avoid repetitions of similar behaviours in the

CSB, items in that order were deleted from the scale. The reliability coefficient of the scale was 0.891.

Biospheric values were measured using 6 items adopted without modifications from (Al Mamun et al., 2022), following the work of (Han et al., 2016). Respondents indicated the extent to which the value statements were a guiding principle in their lives using a 5-point Likert scale (*not important at all - 1, to extremely important - 5*). The mean score was computed, and higher scores indicated greater importance of a principle in favour of the environment. The six items combined formed a reliable scale ($\alpha = .76$)

Data Analyses

Data collected were analyzed using Statistical Package for Social Sciences (SPSS) version 26 and Process Macro version 4.1. Pearson product-moment correlation was used to estimate the bivariate correlations of study variables. Hierarchical Multiple Regression (HMR) was conducted to determine the predictive significance of the three dimensions of sustainability consciousness, controlling for the effects of gender, level and age, thereby testing hypotheses 1-3. Hypothesis 4 was tested using 5000 re-samples BC bootstrapping method of PROCESS macro program for SPSS to calculate the total effect, direct and indirect effects of biospheric values (Preacher & Hayes, 2008).

Results

Table 1 shows the correlations between the components of SC (sustainability knowingness, attitude and behaviours), construction sustainable behaviours (CSB), and biospheric values. Sustainability knowingness, attitude and behaviours significantly and positively correlated with SC ($r = .57, .65$ and $.68$ respectively). The strength of the relationship among the components of SC shows incremental interrelatedness, as each adds on the other. As assumed by the developers of SC (Gerickle et al. 2019), knowingness and attitude would stir pro-environmental behaviours, thus necessitating testing it with other similar behaviours in line with concerns for the environment. Notably, higher levels of sustainability behaviours were associated with higher levels of construction sustainable behaviours ($r = .82$). It is also observed that sustainability consciousness positively correlated with construction sustainable behaviours ($r = .50$). Furthermore, respondents' biospheric values showed strong relationship with the student's level of knowledge, experience and awareness ($r = .85$), thereby showing favourable attitude ($r = .44$), and which is generally related to improved sustainability consciousness ($r = .78$). But the respondents are not certain that biospheric values are related to pro-environmental behaviours. Table 1 also shows the mean and standard deviation of the components and overall SC of BTE students. The mean scores are high across the constructs, indicating high sustainability consciousness among the undergraduates.

Table 1: Correlations, means and standard deviations among the study variables.

Variables	Mean	SD	1	2	3	4	5	6	7	8	9
1 Gender	1.17	0.38	1								
2 Level	1.43	0.50	.024	1							
3 Age	2.24	0.73	-.093	-.107	1						
4 SKNOW	4.09	0.38	.123	.035	-.112	1					
5 SATTD	4.16	0.44	.090	.235	-.095	.038	1				
6 SBEHAV	3.88	0.43	-.071	.137	-.093	.132	.131	1			
7 SC	4.04	0.26	.070	.222	-.157	.571**	.647**	.677**	1		
8 CSB	3.89	0.49	-.110	.165	.050	.147	-.018	.821**	.504**	1	
9 BioValue	4.13	0.28	.003	.086	-.121	.845**	.444**	.244	.784**	.247	1

** . Correlation is significant at the 0.01 level (2-tailed).

Note: SKNOW = sustainability knowingness; SATTD = sustainability attitude; SBEHAV = sustainability behaviours; SC = sustainability consciousness, CSB = construction sustainable behaviours, BioValue = Biospheric values, N = 201

We ascertained if sustainability consciousness would significantly predict CSB and biospheric values. In Table 2, the demographic variables were introduced first in model 1 to control for the impact on the dependent variables. Table 2 shows that demographic variables accounted for a 4% variance in BTE students' CSB, $\Delta R^2 = .043$, $\Delta F(3,59) = .892$, $p = .451$. The inclusion of the components of SC in model 2 accounted for a significant 67.2 % variance in BTE students' biospheric values, $\Delta R^2 = .672$, $\Delta F(6,56) = 44.08$, $p = .000$, and significantly predicted biospheric values ($\beta = .94$, $p < .001$). As shown in model 3 in Table 2, biospheric values contributed an additional significant 4.4% variance in CSB, $\Delta R^2 = .044$, $\Delta F(7,55) = 10.13$, $p = .000$, and significantly predicted CSB ($\beta = 1.20$, $p < .001$). Thus, these results support hypotheses 1 – 3.

Table 2: Summary of HMR for construction sustainable behaviours (CSB)

	Model 1	Model 2	Model 3
	B	β	B
CVs			
Gender	-.138	.288	.070
Level of study	.169	-.047	.128
Age	.039	.093	.083
IVs			
SusKNOW		.074	-.679
SusATTD		-.149	-.478
SusBEHAV		.940	.880
Moderator			
BioValue			1.203
Adjusted R ²	-.005	.685	.729
R ² _{change}	.043	.672	.044
F-value	F(3,59)=0.892	F(6,56) = 23.462	F(7,55) = 24.834
F _{change}	.892	44.079	10.126
Sig.	.451	.000	.000

Note: SKNOW = sustainability knowingness; SATTD = sustainability attitude; SBEHAV = sustainability behaviours; SC = sustainability consciousness, CSB = construction sustainable behaviours, BioValue = Biospheric values, N = 201; CVs = control variables; IVs = independent variables.

We assessed if biospheric values will mediate the relationship between sustainability consciousness (SC) and construction sustainable behaviours (CSB). The unmediated result (total effect) obtained through PROCESS macro was significant ($\beta = .9290$, $SE = .2039$, $t = 4.556$, $p < .001$), as shown in Table 3. The results in Table 3 also reveal a significant indirect effect of SC on CSB ($\beta = -.3027$, $p < .001$), thus supporting hypothesis 4. Likewise, the direct effect of SC on CSB is equally significant ($\beta = 1.4872$; $p < 0.001$). Hence, Table 4 summarizes that biospheric values partially mediate the relationship between SC and CSB. Furthermore, the partial mediation of the relationship is competitive as the direct and indirect effects, though significant, point in opposite directions (bearing positive and negative signs respectively). This suggests that the relationship is more complex than a simple direct or mediated effect, warranting further investigation into underlying mechanisms, and strategies targeted at reducing the dual effects to enhance the positive pathway while mitigating the negative. This is, however, beyond the scope of this study.

Table 3: Total and Direct effects of SC on CSB

Effects	Estimate	SE	t	95% CI		Significance
				Lower	Upper	
Total	.9290	.2039	4.5561	.5213	1.3368	Significant
Direct	1.4872	.3184	4.6705	.8503	2.1242	Significant
Indirect	-.5582	.1318	-	-.5813	-.0609	Significant

Table 4: Mediation analysis test of biospheric values on SC and CSB

Hypothesis	Total effect	Direct effect	Indirect effect	95% CI (Indirect)		t-statistics	Conclusion
				Lower	Upper		
SC → BioValues → CSB	.9290	1.4872	-.3027	-.5813	-.0609	4.6705	Partial mediation (Competitive)

Note: SC = sustainability consciousness, CSB = construction sustainable behaviours, BioValue = Biospheric values

Discussion

Beyond confirming the hypotheses stated for this study, the components of SC have been tested to predict CSB, targeted at ensuring that the construction industry aligns with the sustainability agenda. Again, SC has been applied to numerous populations and contexts in different countries, but with little or no attention to specific contexts of study like TVET preservice teachers, nor has it been applied to Nigerian undergraduates. Thus, our interesting findings indicate:

First, the study ascertained the sustainability consciousness of BTE undergraduates, to explain the extent of their experience, awareness and knowledge of sustainability, their attitude and behaviours likewise. Our finding shows that the undergraduates have high sustainability consciousness, and there were no significant differences in the mean and standard deviations across the various constructs. This finding contradicts Kalsoom et al., (2017), who found that preservice teachers in Pakistan possess low SC across the board. Berglund et al., (2020) also found differences in the SC constructs when tested in different cultural settings (samples from Taiwan and Sweden). The differences between the two samples were largest in terms of behaviours and smallest in terms of knowingness. Perhaps the contradiction could be explained by nature of this study – as it is tailored to a specific area (construction), instead of having a general outlook. More so, it may be attributed to transformative learning techniques such as inquiry-based learning, problem-based learning, which were found to enhance SC of preservice teachers (Kalsoom & Khanam, 2017), and is one way of learning adopted in most TVET programmes (Orji & Ogbuanya, 2020).

Second, we extended the use of SC and found that SC was associated positively with CSB. The result indicates that the SC plays a significant role in activating a set of pro-environmental behaviours. This result authenticates the view that SC constructs are not factual, but a merge of cognitive and affective competencies necessary to spur dispositions in favour of the environment. These findings are in line with (Gericke et al., 2019) who stated that sustainability knowingness and attitude constructs of SC were developed and confirmed, to have the ability to test sustainability behaviours. Our extension of these sustainability behaviours to include construction sustainable behaviours (CSB) further validates the potency of SC. Thus, Ariza et al., (2021) corroborate the importance of the constructs of SC (sustainability knowingness, sustainability attitude, and sustainability behaviours), adding that they are essential components of becoming agents of change and sustainability advocates.

Third, biospheric values significantly mediate the relationship between SC and CSB. The study showed that biospheric values are the partial and competitive mediator of the association between SC constructs and CSB. The result thus implies that the relationship between the variables, SC and CSB, was partially through the mechanism of mediation. Previous findings on values emphasize the connections between values and beliefs (Al Mamun et al., 2022; Whitley et al., 2018), and their indirect effect on behaviour as supported by the Value-belief-norm theory (McFarlane & Boxall, 2003; Stern et al., 1999). However, biospheric values in particular have been found to strongly support pro-environmental behaviours (De Groot and Steg 2007; Dietz, Fitzgerald, and Shwom 2005). The findings of this present study corroborate the fact that biospheric values are positioned to have more indirect effects on sustainable behaviours. More so, in judging what an institution should pursue towards maintaining pro-environmental behaviours, Whitley et al., (2018) supported the pursuit of biospheric values, stating that it can sustain beliefs, outlive norms, and ensure that graduates uphold sustainable behaviours after the university days.

Limitations of the study

The first observable limitation in this study was the self-report measures which likely resulted in common method variance (CMV). If CMV is overcome, associations of the variables may differ in positive or negative directions. Secondly, the research method made it difficult for causal inferences to be established, suggesting quasi-experimental, and intervention studies involving observations or triangulation of data for future research.

Conclusion

This study showed that SC is a significant positive predictor of CSB. It revealed that the association between SC and CSB may be a result of the link that SC had with biospheric values, which further connects to CSB. These findings have advanced our understanding of SC and the constructs, as well as the presence of underlying principles inherent in undergraduates (values) which may promote or limit actions in

favour or against the environment. This study thus contributes to sustainability consciousness and sustainable behaviour literature, by not only investigating to establish the SC of TVET-BTE undergraduates but extending SC to test association with CSB through biospheric values. It is however necessary to widen the population and test other constructs of value, and other variables such as beliefs and norms, to substantiate the findings of this study.

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