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RESEARCH ARTICLE

Empowering tomorrow's governance leaders: Fostering self-motivation through education for sustainable development

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ABSTRACT - The successful implementation of Education for Sustainable Development (ESD) is paramount for addressing global challenges. Nevertheless, its effectiveness is contingent on student engagement, an area where the role of motivation remains under-researched. This study addressed this gap by examining the psychological drivers that foster a lasting commitment to sustainability principles among future leaders. The primary objective of this research was to empirically examine the relationship between self-motivation (SM), as conceptualised by Self-Determination Theory (SDT), and the engagement of pre-university students with ESD.A quantitative, cross-sectional survey design was employed, involving 127 pre-university students from a Kolej Pre-Universiti in Kuantan, Pahang, Malaysia. Participants were selected via convenience sampling and completed validated scales measuring SM and engagement with ESD. The collected data were analysed using descriptive statistics, Pearson correlation, and simple linear regression to test the study's hypothesis. The findings established SM as a substantial factor in fostering student engagement with sustainability education. These findings provided a clear empirical mandate for educational institutions to move beyond mere content delivery and actively create learning environments that support students' basic psychological needs for autonomy, competence, and relatedness. Cultivating these internal motivational resources is essential for developing the next generation of proactive and committed sustainability leaders who will act with integrity and will be prepared for roles in governance.

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1. INTRODUCTION

Amid unprecedented environmental, social, and economic challenges, the international community has converged on a shared blueprint for a more sustainable future: the 2030 Agenda for Sustainable Development. The 17 Sustainable Development Goals (SDGs) are central to this agenda, providing a comprehensive global progress framework (UNESCO, 2019). Within this framework, SDG 4 champions "inclusive and equitable quality education and promotes lifelong learning opportunities for all" (UNESCO, 2016, p. 8). This goal is not merely about access to education but its transformative power. Specifically, Target 4.7 calls upon nations to ensure that all learners acquire the knowledge and skills to promote sustainable development, including education on sustainable lifestyles, human rights, gender equality, and global citizenship (UNESCO, 2016). Education for Sustainable Development (ESD) is at the heart of the worldwide agenda, positioning it as a critical enabler for achieving all other SDGs. ESD seeks to empower learners to become visionary thinkers and pragmatic implementers, capable of anticipating future challenges and taking responsible actions to shape a more resilient and equitable world (UNESCO, 2017).

While the pedagogical importance of ESD is widely recognised, its successful implementation hinges on a factor often overlooked in curriculum design and policy mandates: student motivation. The mere transmission of knowledge about sustainability is insufficient to foster the deep, personal commitment required for sustained action. For ESD to be truly transformative, it must resonate with students personally, inspiring them to actively and willingly engage with its principles. Thus, a crucial "motivation gap" emerged, wherein understanding social and environmental issues did not necessarily result in pro-sustainability stances and actions (Arbuthnott, 2009).

Recent scholarship has increasingly highlighted this deficiency. Juma-Michilena et al. (2023), for instance, noted a significant gap in the literature concerning the role of both intrinsic (driven by personal interest) and extrinsic (driven by external rewards) motivation in shaping university students' engagement with sustainability initiatives. Much of the existing research has focused on measuring students' knowledge of and attitudes toward sustainability, while largely neglecting the underlying psychological processes that drive action. Therefore, understanding what motivates students to participate in sustainability efforts is not an ancillary concern but a central challenge for educators and institutions. Without a clear grasp of these motivational drivers, ESD programs risk becoming superficial, failing to cultivate the enduring commitment necessary to nurture the next generation of sustainability leaders (UNESCO, 2017).

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This motivational challenge is situated within the broader national context in Malaysia. Recent data from the Higher Education Report (Malaysia, 2022), in Table 1, reveal a concerning decline in student enrolment in private higher education institutions (HEIs) between 2018 and 2021. Although the reasons for this trend are multifaceted, it signals a potential systemic issue related to student motivation and the perceived value of pursuing higher education. Such a decline poses a significant risk to Malaysia's long-term development goals, which rely on a highly skilled and knowledgeable workforce to drive economic growth, civic engagement, and environmental stewardship (Psacharopoulos & Patrinos, 2018; Sterling, 2010). A decline in higher education participation can lead to limited career opportunities for individuals and, at a macro level, a diminished capacity for innovation and sustainable progress (Becker, 2009; Hanushek & Woessmann, 2020).

This broader concern about student motivation provided a compelling backdrop for the present study. Suppose a portion of the student population lacks the motivation to pursue higher education. In that case, a similar lack of drive can affect participation in voluntary, socially focused initiatives such as ESD. This study, therefore, used this national challenge as a narrative frame. While the national data suggested a potential problem, this research investigated a "motivated cohort" of pre-university students to understand the positive relationship between self-motivation (SM) and ESD engagement. By examining the characteristics of this engagement, this study aimed to provide valuable insights that could inform strategies to address the larger motivational challenges facing the Malaysian education system. It sought to understand what "works" in fostering engagement, offering a potential solution-oriented perspective.

Table 1. The number of enrolments in HEIs from 2010 to 2021

Year	Type of Institution				
	Public University	Private HEIs	Polytechnic	Community College	Total
2010	462,780	541,629	87,642	18,200	1,110,251
2011	508,256	428,973	89,229	6,319	1,032,840
2012	521,793	454,616	92,148	22,380	1,090,937
2013	560,359	484,963	89,503	21,468	1,156,293
2014	563,186	493,725	92,181	17,985	1,167,077
2015	540,638	580,928	96,069	18,529	1,236,164
2016	532,049	695,026	99,551	20,232	1,346,858
2017	538,555	666,617	99,606	20,921	1,325,699
2018	552,702	668,689	96,370	26,069	1,343,930
2019	567,625	633,344	96,362	26,118	1,323,449
2020	584,576	537,434	85,936	16,152	1,224,098
2021	590,254	517,580	84,556	14,741	1,207,131

Source: Higher Education Report: [MALAYSIA], 2022

This study aimed to move beyond descriptive accounts of sustainability education and provide empirical evidence on the psychological factors that underpin student engagement. The central objective was to investigate the relationship of SM, as conceptualised by Self Determination Theory (SDT), on pre-university students' engagement with ESD in the specific context of Kuantan, Pahang, Malaysia. Drawing upon the theoretical literature and the identified research gap, this study tested the following hypothesis:

- H1: SM is a significant positive predictor of engagement with ESD.

By empirically validating this relationship, the study sought to provide actionable evidence for educators and policymakers, demonstrating that fostering students' internal motivational resources is a key strategy for enhancing the effectiveness of ESD and cultivating future leaders committed to good governance and integrity.

2. LITERATURE REVIEW

Table 1 shows a noticeable decline in student enrolment, particularly in private HEIs in Malaysia. This trend may negatively impact efforts to promote ESD, potentially undermining progress made in recent years toward cultivating future governance leaders. Educational institutions must encourage students to engage in efforts that may not offer immediate personal benefits and can increase their workload. For sustained success, ESD needs to be more appealing in the immediate future. This decline in enrollment threatens the advancement of ESD. It raises broader concerns about the nation's ability to build a skilled and knowledgeable workforce, an essential component of sustainable national development. Compounding the issue, students often lack early exposure to sustainable development concepts, especially at the secondary education level. This gap in foundational knowledge may further hinder the achievement of national educational goals and long-term government strategies to improve student outcomes and institutional excellence (Choi, 2021). Considering these challenges, policymakers and educational leaders must adopt a more integrated and forward-thinking approach to education. Strengthening the pipeline from secondary to higher education will be vital while embedding sustainable development principles at every stage. Enhancing the accessibility, engagement, and relevance of

ESD in Malaysia can more effectively cultivate students' SM, thereby equipping future generations with the requisite knowledge, competencies, and values to advance sustainable development and bolster national resilience.

2.1 Self-Determination Theory (SDT): A Framework for High-Quality Motivation

To understand the complex nature of student motivation, this study was grounded in SDT, a comprehensive and empirically supported macro-theory of human motivation, personality development, and psychological well-being (Deci & Ryan, 1985; Ryan & Deci, 2020). Developed by Ryan and Deci, SDT asserts that all individuals possess three fundamental and innate psychological needs: autonomy, competence, and relatedness. These needs are universal and essential for fostering motivation and optimal functioning. Autonomy refers to the experience of acting with a sense of volition and psychological freedom. When individuals perceive their actions as self-endorsed and congruent with their values and interests, they experience a higher sense of autonomy (Ryan & Deci, 2020). Competence involves interacting effectively with the environment, mastering challenges, and developing skills. This need is fulfilled when individuals seek out and accomplish tasks that allow them to demonstrate and enhance their abilities. Relatedness is the need to feel connected, to care for and be cared for by others, and to experience a sense of belonging in one's social environment.

According to SDT, the extent to which the social environment supports or undermines these three needs has profound implications for the quality of motivation and overall psychological health (Ryan & Deci, 2023). When these needs are satisfied, individuals are more likely to exhibit high-quality, autonomous motivation and engage with activities more persistently, creatively, and meaningfully. A key sub-theory within SDT, Organismic Integration Theory (OIT), elaborates on the different types of motivation by organising them along a continuum from controlled to autonomous forms (Ryan & Deci, 2000). This continuum is particularly relevant in educational settings, as it helps explain how students may internalise the value of learning activities, even those that are not inherently interesting. At the most controlled end of the continuum is external regulation, where behaviour is driven solely by external rewards or punishments. Introjected regulation represents a more internalised but still controlled form, where actions are motivated by internal pressures such as guilt, ego enhancement, or the desire for approval. Moving toward greater autonomy, identified regulation occurs when individuals accept the value of a behaviour as personally meaningful, even if the activity itself is not inherently enjoyable. Integrated regulation represents the most autonomous form of extrinsic motivation, in which the behaviour is fully assimilated into the individual's core values and identity. At the highest level of autonomy lies intrinsic motivation, where individuals engage in activities purely for the inherent satisfaction, interest, or enjoyment they provide (Ryan & Deci, 2020).

This framework is particularly applied to ESD, underscoring the importance of fostering internal motivational processes. Educators should not focus solely on controlling student behaviour through external incentives. Instead, they should create learning environments that support autonomy, competence, and relatedness, thereby facilitating the internalisation of sustainability values. By promoting more autonomous forms of motivation, especially identified, integrated, and intrinsic motivation, students are more likely to engage meaningfully with sustainability education and carry its principles into their future roles as responsible global citizens.

2.2 ESD as a Pedagogical Imperative

ESD is a holistic and transformative educational paradigm that aims to equip individuals with the knowledge, skills, values, and attitudes necessary to create a sustainable future. As defined by UNESCO (2017, p. 7). ESD is "a vision of education that seeks to empower people to assume responsibility for creating a sustainable future". This goes far beyond simply adding environmental topics to the curriculum. Instead, it involved reorienting the entire educational system to promote sustainability principles in all dimensions: ecological stewardship, social equity, and economic viability (Sterling, 2001). Scholars like Hopkins and McKeown (2001) emphasised that ESD requires reshaping education to foster critical thinking, systems thinking, collaborative decision-making, and a sense of responsibility for both local and global communities, while also promoting economic prosperity, social equity, environmental stewardship, good governance, and the rule of law (see also Wals & Jickling, 2002; Tilbury et al., 2002).

However, ESD presents a unique motivational challenge. Its core principles often revolve around long-term, collective benefits that can feel abstract and disconnected from the immediate concerns of students. Research in behavioural economics and psychology showed that individuals are often biased toward immediate gratification and struggle to stay motivated for actions whose rewards are delayed or diffused across a large group (McClure et al., 2004). This temporal discounting poses a significant hurdle for ESD, which asks students to invest effort in addressing complex problems like climate change, where the positive outcomes may not be realised for decades. Therefore, a central question for ESD practitioners is how to make sustainability both relevant and rewarding in the short term, sustaining student interest and commitment without over-relying on controlling, extrinsic incentives (Juma-Michilena et al., 2023). When students are inspired to address sustainability challenges, they are more likely to commit themselves to academic pursuits and, eventually, to become leaders who exemplify integrity and responsible governance.

In the Malaysian context, sustainability principles are not new; they have been embedded in the nation's development fabric since the New Economic Policy (NEP) of the 1970s, which focused on poverty eradication and social equity. Subsequent Five-Year Development Plans have continued this legacy, incorporating goals related to environmental conservation, equitable growth, and access to essential services. The global adoption of the SDGs has further reinforced this national commitment. Integrating ESD more formally into the pre-university curriculum will enable Malaysia to

strengthen its foundation, equipping a new generation to guide the next phase of the nation's sustainable development journey.

2.3 ESD as a Pedagogical Imperative

Integrating ESD into secondary education is crucial for preparing the future. The intersection of SDT and ESD provides a powerful theoretical lens for addressing the motivational challenges inherent in sustainability education. SDT offers a precise psychological mechanism to explain *how* to foster the high-quality, autonomous motivation needed to drive sustained engagement in ESD. The core argument is that when educational environments are designed to support students' innate needs for autonomy, competence, and relatedness, students are more likely to internalise the values of sustainability. They will progress along the OIT continuum from a sense of control to self-direction, changing their engagement from a task into a personally significant endeavour.

A growing body of empirical research supported this theoretical link. For instance, studies showed that students with higher levels of SM are more likely to engage in pro-environmental behaviours and champion sustainability practices (Thomas & Nicita, 2002). Kinoshita et al. (2019) successfully developed a university curriculum to foster sustainability-related motivation, demonstrating that such interventions are feasible and practical. Similarly, Svicher et al. (2022) found that Italian university students' motivation was strongly linked to their self-efficacy regarding the SDGs. These studies collectively suggested that motivation is not just a desirable personality trait but a malleable competency that can be cultivated through well-designed educational experiences. As Arbuthnott (2009) argued, the goal of sustainability education must extend beyond mere attitude change to inspire genuine behavioural change, which commences with personal motivation. This study was built on this foundation by directly testing the link between SM and ESD engagement in the context of Malaysian pre-university. Confirming this relationship, this study aimed to provide strong evidence that investing in the psychological well-being and motivational quality of students is a direct and effective strategy for advancing SDGs.

3. METHODOLOGY

3.1 Research Design

This study employed a quantitative, cross-sectional survey design to examine the relationship between student SM and engagement with ESD. The cross-sectional approach allowed for efficient data collection on key variables from a defined population at a single point in time, providing a snapshot of the existing relationship between the constructs. The target population for this study consisted of pre-university students (Form 6) in Kuantan, Pahang, Malaysia. A total of 127 students from Kolej Pre-Universiti, Kuantan, participated in the research. Participants were selected using a non-probability convenience sampling method, chosen for its practicality and the accessibility of the student population to the researchers. While this method limited the generalizability of the findings, it provided a valuable exploration of the relationships within this specific and vital demographic.

The demographic characteristics of the sample are detailed in Table 2. The sample was nearly balanced in gender, with 65 females (51.2%) and 62 males (48.8%). The racial composition was predominantly Malay (91.3%), with smaller representations of Chinese (4.7%), Indian (2.4%), and other ethnic groups (1.6%). Regarding parental occupation, a majority of fathers were employed (55.1%) and self-employed (28.3%), while mothers were split between being employed (43.3%) and other roles, including homemaker (46.5%). This demographic profile was crucial for contextualising the study's findings and understanding the specific population from which the results were derived.

Table 2. Participant demographic characteristics (N = 127)

Category	Group	Frequency (n)	Percentage (%)
Gender	Male	62	48.8
	Female	65	51.2
Race	Malay	116	91.3
	Chinese	6	4.7
	Indian	3	2.4
	Other	2	1.6
Father's Occupation	Employed	70	55.1
	Self-employed	36	28.3
	Unemployed	3	2.4
	Other	18	14.2
Mother's Occupation	Employed	55	43.3
	Self-employed	13	10.2
	Other	59	46.5

Source: Developed for the research

Data were collected using physically printed questionnaires distributed to the students. Ethical protocols were strictly followed throughout the research process. Researchers obtained informed consent from all participants before their involvement, ensuring they understood the purpose of the study and their voluntary role. To protect participant privacy, anonymity and confidentiality were guaranteed; no personally identifiable information was collected, and all data were aggregated for analysis. The study was designed to minimise potential risks to participants and maintain transparency in its procedures.

3.2 Measures

A structured, closed-ended questionnaire was used for data collection. The instrument was divided into sections covering demographics, SM, and engagement with ESD. All substantive items were measured on a 5-point Likert scale, ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). The scales were adapted from established instruments and prior research to ensure their relevance and validity for the study's objectives (Ryan & Deci, 2023; Tilbury, 2021; UNESCO, 2017, 2023).cSM served as the independent variable. This construct was measured using a 12-item scale designed to capture the essence of autonomous motivation as described by SDT. The items were adapted from instruments informed by the work of Ryan and Deci (2023) and were tailored to the educational context of the participants. The scale demonstrated excellent internal consistency, with a Cronbach's alpha coefficient of 0.905, indicating high reliability.

ESD Engagement served as the dependent variable. This construct was measured using a 16-item scale. The items were developed to assess students' cognitive, affective, and behavioural engagement with sustainability principles, values, and practices, drawing on frameworks from UNESCO (2017) and Tilbury (2021). This scale also showed strong internal consistency, with a Cronbach's alpha coefficient of 0.895. The Cronbach's alpha for SM and ESD is detailed in Table 3. Moreover, the specific conceptual framework is referred to in Figure 1.

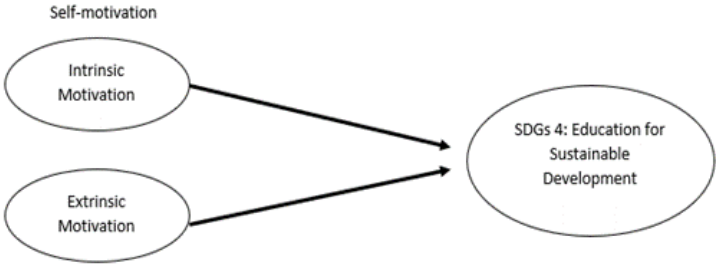

Figure 1. The conceptual framework for this study

To further ensure the measures' psychometric integrity, the data's suitability for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. This test provides an index of the proportion of variance among the variables that might be common variance. High KMO values (closer to 1.0) suggest that the items are sufficiently correlated to coalesce into fewer underlying factors. The KMO value for the SM scale was 0.895, and for the ESD Engagement scale, it was 0.851. These data details are referred to in Table 3. According to established guidelines, both values were considered 'meritorious' to 'Marvellous', providing strong evidence of sampling adequacy. This bolstered confidence in the scales' reliability (internal consistency) and their construct validity, suggesting that the items in each scale were indeed measuring a coherent, unified latent construct.

Table 3. Cronbach's alpha and KMO test

Constructs	Cronbach's Alpha	Kaiser-Meyer-Olkin (KMO) Test	No. of Items
Self-Motivation (SM)	0.905	0.895	12
Education for Sustainable Development (ESD)	0.895	0.851	16

3.3 Data Analysis Plan

All data collected from the questionnaires were coded and analysed using the Statistical Package for the Social Sciences (SPSS) software. The analysis was conducted in three main stages. First, descriptive statistics were calculated, including means, standard deviations, frequencies, and percentages. This was done to summarise the demographic profile of the participants as shown in Table 1 and to describe the central tendency and variability of the primary study variables (SM and ESD engagement). The normality of the data distribution was also assessed by examining skewness and kurtosis values for each item. The statistics for all items dropped within acceptable ranges for assuming a normal distribution, justifying the use of parametric tests.

Second, a Pearson product-moment correlation analysis was performed. This inferential statistic was used to assess the strength and direction of the bivariate linear relationship between the composite score for SM and the composite score for ESD engagement. Third, a simple linear regression analysis was conducted to test the primary research hypothesis. In this model, ESD engagement was the dependent (outcome) variable, and SM was the independent (predictor) variable. This analysis determined whether SM could significantly predict the variance in students' engagement with ESD and

quantified the magnitude of this predictive relationship. A significance level (alpha) of 05 was used for all inferential tests.

4. RESULTS AND DISCUSSION

This section presents the statistical findings of the study objectively. The results were organised into two parts: preliminary analyses, which included descriptive and correlational findings, and the primary hypothesis testing conducted via regression analysis.

4.1 Preliminary Analyses

Overall, students demonstrated strong internal motivation to engage with sustainability. The mean scores for the 12 SM items ranged from 3.50 to 3.66, suggesting general agreement and positive attitudes. The highest-rated item was SM5, *"I find joy and fulfilment in participating in sustainability-related activities,"* which recorded a mean of 3.66 and a standard deviation (SD) of 0.620. This suggests that students were emotionally connected with sustainability and found personal satisfaction in related efforts. Two other highly rated items, SM4 (*"Engaging in sustainable practices makes me feel like I am contributing to a meaningful cause,"* M = 3.65, SD = 0.585) and SM6 (*"I am curious to explore and learn more about sustainability beyond what is taught in the curriculum,"* M = 3.65, SD = 0.611) also reflect a deep personal interest and sense of purpose among students. These items had skewness values ranging from -0.952 to -1.107, indicating a strong tendency toward higher agreement. Even the lowest-scoring SM items remained favourable. SM2 ("I feel a sense of autonomy in choosing topics or projects related to sustainability,") had the lowest mean at 3.50 (SD = 0.589). At the same time, SM3 ("I am genuinely interested in learning about sustainable development,") followed closely with a mean of 3.51 (SD = 0.677). These findings indicated that although motivation was generally high, there might be less perceived freedom in how students engage with sustainability topics.

Table 4. Descriptive statistics, mean, SD, normality test

Variable	Item	Mean	Standard Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
Self-Motivation (SM)	SM1	3.53	0.602	-0.440	0.215	-0.280	0.427
	SM2	3.50	0.589	-0.221	0.215	-0.460	0.427
	SM3	3.51	0.677	-0.433	0.215	-0.152	0.427
	SM4	3.65	0.585	-0.952	0.215	0.573	0.427
	SM5	3.66	0.62	-1.247	0.215	1.099	0.427
	SM6	3.65	0.611	-1.107	0.215	0.815	0.427
	SM7	3.62	0.603	-0.703	0.215	0.268	0.427
	SM8	3.57	0.636	-0.849	0.215	0.191	0.427
	SM9	3.56	0.586	-0.713	0.215	-0.167	0.427
	SM10	3.54	0.699	-0.795	0.215	0.003	0.427
	SM11	3.61	0.592	-0.805	0.215	0.251	0.427
	SM12	3.58	0.635	-0.882	0.215	0.251	0.427
Educational Sustainable Development (ESD)	ESD1	3.74	0.538	-1.057	0.215	1.358	0.427
	ESD2	3.25	0.723	-0.040	0.215	-0.451	0.427
	ESD3	3.47	0.653	-0.506	0.215	-0.283	0.427
	ESD4	3.55	0.639	-0.937	0.215	0.093	0.427
	ESD5	3.35	0.717	-0.363	0.215	-0.598	0.427
	ESD6	3.61	0.593	-0.770	0.215	0.183	0.427
	ESD7	3.73	0.511	-1.036	0.215	0.938	0.427
	ESD8	3.52	0.615	-0.907	0.215	-0.175	0.427
	ESD9	3.57	0.572	-0.914	0.215	-0.151	0.427
	ESD10	3.58	0.541	-0.794	0.215	-0.491	0.427
	ESD11	3.44	0.600	-0.330	0.215	-0.504	0.427
	ESD12	3.37	0.640	-0.330	0.215	-0.488	0.427
	ESD13	3.46	0.639	-0.761	0.215	-0.429	0.427
	ESD14	3.57	0.624	-0.787	0.215	0.135	0.427
	ESD15	3.64	0.514	-0.932	0.215	-0.366	0.427
	ESD16	3.69	0.542	-1.276	0.215	1.164	0.427

Importantly, all SM items had skewness and kurtosis values within an acceptable range of ±2 (Hair et al., 2010) (skewness range: -0.221 to -1.247; kurtosis range: -0.460 to 1.099), confirming that the data were approximately normally distributed and suitable for further analysis. Students also expressed positive views about the value and importance of

ESD, though their responses were slightly more varied compared to the SM items. The mean values for the 16 ESD items ranged from 3.25 to 3.74. The highest-rated item, ESD1 (*"Sustainable development is an important concept for our future"*), received a mean score of 3.74 (SD = 0.538), indicating widespread agreement. Similarly, ESD7 (*"Individuals have a responsibility to address environmental and social issues,"* M = 3.73, SD = 0.511) and ESD16 (*"I believe my generation has a role in creating a more sustainable future,"* M = 3.69, SD = 0.542) also ranked highly, with very low standard deviations, reflecting strong consensus.

Despite these affirmations, several items revealed areas of uncertainty or limitation. The lowest-scoring item was ESD2 (*"I can explain what sustainable development means"*), with a mean of 3.25 and the highest SD of 0.723. This suggested that many students were uncertain or lacked confidence in their conceptual understanding of sustainability. ESD5 (*"I have participated in hands-on activities related to environmental sustainability at school,"* M = 3.35, SD = 0.717) and ESD12 (*"I actively seek information about global sustainability issues,"* M = 3.37, SD = 0.640) also had relatively low scores, indicating limited real-world engagement and varied information-seeking behaviour. All ESD items also met normality criteria, with skewness ranging from -1.276 to -0.040 and kurtosis from -0.598 to 1.358, further validating the data's suitability for inferential analysis. All the descriptive statistics, mean, SD and normality test results are detailed in Table 4.

A Pearson correlation analysis was conducted to explore the relationship between SM and student engagement in ESD. Table 5 presents a moderate, statistically significant positive correlation between the two variables, r (125) = .458, p < .001. This finding indicated that students with higher levels of SM tend to exhibit greater engagement in ESD-related activities and learning. The strength and direction of this correlation supported the study's theoretical framework, particularly SDT, which asserted that intrinsic motivation contributed meaningfully to sustained educational involvement. The significance at the 0.01 level (2-tailed) further underscored the robustness of this relationship.

Table 5. Pearson correlation analysis

Correlations			
		SM	ESD
SM	Pearson Correlation	1	.458**
	Sig. (2-tailed)		0.000
ESD	Pearson Correlation	.458**	1
	Sig. (2-tailed)	0.000	

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

4.2 Hypothesis Testing: Regression Analysis

A simple linear regression analysis was performed to test the primary hypothesis that SM predicted engagement with ESD. The overall regression model was statistically significant, F(1, 125) = 33.226, p <.001. This result indicated that the model provided a significantly better prediction of ESD engagement than the mean value alone. The model's coefficient of determination (R2) was 0.210, with an adjusted R2 of 0.204. SM accounted for 21.0% of the variance observed in students' ESD engagement scores. This is considered a large effect size within social science research, highlighting the substantial predictive power of SM. The specific results of the regression analysis are detailed in Table 5. SM emerged as a significant positive predictor of ESD engagement. The standardised regression coefficient (β) was 0.458, t(125) = 5.764, p <.001. The positive beta value confirmed that as SM increased, engagement with ESD also tended to increase, controlling for other factors. The unstandardised coefficient (B = 0.533, 95% CI [0.350, 0.715]) provided a clear interpretation: for each one-unit increase on the 5-point SM scale, a 0.533-unit increase in the ESD engagement score is predicted. The collinearity statistics (Tolerance = 1.000, VIF = 1.000) indicated no multicollinearity issues in the model.

Table 6. Simple linear regression analysis predicting ESD Engagement from SM

Predictor	B	SE	β	t	p
(Constant)	1.623	0.331		4.903	<.001
Self-Motivation	0.533	0.092	.458	5.764	<.001

Note. N = 127. Dependent Variable: ESD Engagement. B = Unstandardised coefficient; SE = Standard Error; β = Standardised coefficient. R2 =.210; Adjusted R2 =.204

Based on these results, the research hypothesis (*H1: SM is a significant positive predictor of engagement with ESD*) was strongly supported.

5. CONCLUSIONS

The results of this study clearly showed that SM plays a central role in shaping student engagement with ESD. The descriptive analysis revealed that students reported consistently high levels of intrinsic motivation, with mean scores for all 12 SM items ranging between 3.50 and 3.66 on a 5-point Likert scale. The highest-rated item, "I find joy and fulfilment in participating in sustainability-related activities", recorded a mean of 3.66, followed closely by items reflecting students'

sense of purpose (M = 3.65) and curiosity (M = 3.65). These findings highlighted that student were emotionally and intellectually engaged with sustainability, and their motivation was grounded in personal values rather than external rewards. This aligned firmly with SDT, which emphasises the importance of autonomy, competence, and relatedness in driving motivation. The lower mean score for the item on autonomy (M = 3.50) suggested that while students were interested in sustainability, some felt limited in their ability to make personal choices about how they would engage with it in their studies. This reflected the SDT view that internal motivation can be strengthened or weakened depending on the learning environment and opportunities for self-directed learning.

In contrast, students' responses regarding their educational experiences with sustainability were more mixed. The 16 ESD-related items showed a wider range of mean scores from 3.25 to 3.74, with strong agreement on the importance of sustainable development (M = 3.74) and individual responsibility to act on environmental issues (M = 3.73). Students also recognised their generational role in creating a sustainable future (M = 3.69). However, their responses indicated uncertainty about more practical and cognitive dimensions. The item "I can explain what sustainable development means" received the lowest mean score of 3.25, with the highest standard deviation (SD = 0.723), suggesting variation in students' confidence and understanding of core sustainability concepts. Similarly, experiences with hands-on sustainability activities (M = 3.35) and actively seeking information (M = 3.37) were also rated lower, pointing to limited experiential exposure. These findings have several practical implications. While students demonstrated strong internal motivation, the data indicated a disconnect between their drive and the educational opportunities provided. This gap underscored the importance of creating learning environments that informed and empowered students to take ownership of their learning. Teachers should design tasks that allow student autonomy, such as project-based learning and choice-driven assignments. Breaking down sustainability topics into manageable, action-oriented components can enhance students' sense of competence, while encouraging collaboration through group projects and community engagement can fulfil the need for relatedness.

From a policymaker's point of view, this research suggested that teacher training should incorporate strategies to promote intrinsic motivation and psychological need satisfaction, as emphasised by SDT. Schools and institutions should also be supported to implement flexible curricula that connect classroom learning with real-world sustainability challenges. Such strategies boost student engagement and foster deeper understanding and commitment to sustainability goals. Despite its strengths, this study had limitations. The sample was drawn from a single pre-university institution in Kuantan, with limited demographic variation, which restricted the generalizability of the results. The study's cross-sectional design also prevented causal conclusions, as it captured responses at only one point in time. Additionally, using self-reported surveys introduced potential biases, such as social desirability or self-perception error. These limitations provided valuable guidance for future research. Longitudinal studies could explore how student motivation and engagement evolve. Expanding the sample to include diverse institutions and demographic backgrounds would also enhance the generalizability of findings. Furthermore, qualitative methods such as interviews or focus groups could provide deeper insights into how students perceive sustainability education and what specific classroom strategies enhance their motivation and involvement.

This study explored the relationship between students' SM and engagement with ESD. The findings demonstrated that students possess a high intrinsic motivation toward sustainability, driven by personal values such as joy, curiosity, and purpose. They also strongly believe in the importance of sustainable development and acknowledge their generational responsibility in shaping a more sustainable world. However, the lower ratings on students' ability to explain sustainability concepts and limited participation in hands-on activities revealed a disconnect between motivation and educational practice.

These results emphasised that for sustainability education to be truly transformative, it must do more than transfer knowledge; it must also empower learners to act with integrity and assume governance responsibilities. Internal motivation alone is insufficient if students lack the space, support, and skills to make ethical decisions and take responsible actions within their communities and beyond. Therefore, educational institutions must focus on cultivating knowledge and developing character, critical thinking, and accountability. By aligning teaching approaches with the principles of SDT, fostering autonomy, competence, and relatedness, educators can create environments that reinforce both the psychological foundations of motivation and the ethical expectations of leadership. Future-ready learners must understand and embody sustainability through values-based action, guided by personal integrity and a deep commitment to responsible governance.

In sum, this research called for a paradigm shift in sustainability education that empowers students to become competent, motivated, and ethically grounded leaders who are equipped to navigate and govern the challenges of our time with conviction, compassion, and accountability.

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AUTHORS CONTRIBUTION

Tun Norasida bt Aziz was responsible for the overall conceptualisation, methodology design, data collection, data analysis, interpretation of findings, and writing of the original draft. She also contributed to the review and editing of the manuscript, project administration, supervision, and secured funding for the study.

Po Hui Yee contributed to the conceptual development of Education for Sustainable Development (ESD), participated in data collection, and was involved in the development, adoption, and adaptation of the research questionnaires.

Siti Fatiha Ismail contributed to the conceptual development of the motivation framework, assisted in data collection, and helped in the development, adoption, and adaptation of the research questionnaires.

Aznira Zakaria was responsible for the conceptualisation related to Self-Determination Theory (SDT), participated in data collection, and contributed to the development, adoption, and adaptation of the questionnaires.

Irma Tyasari provided overall review and editing support throughout the manuscript preparation process.

AVAILABILITY OF DATA AND MATERIALS

The data supporting this study's findings are available on request from the corresponding author.

ETHICAL STATEMENT

Not applicable.

CONFLICT OF INTEREST

The author(s), as noted, certify that they have NO affiliations with or involvement in any organisation or agency with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, jobs, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, expertise or beliefs) in the subject matter or materials addressed in this manuscript.

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