



From Projects to Purpose: Project-Based Transformative Learning in Education for Sustainable Development toward Sustainable Lifestyles among Indonesian Transnational Students in Malaysia

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ABSTRACT

The problem and the aim of the study. Global initiatives such as UNESCO's Education for Sustainable Development and the UN's 2030 Agenda underscore the importance of education as a transformative force that shapes a sustainable lifestyle. When viewed from this perspective, the experience of Indonesian transnational students in Malaysia, who attempt to adjust to local environmental standards while remaining bound by Indonesian curricula, shows how sustainability practices can progress from compliance to values-based commitments with lessons that are relevant across borders. This study investigates the effectiveness of the Project-Based Transformative Learning with Education for Sustainable Development (PjBTL-ESD) model in enhancing cognitive, behavioral, and socio-emotional awareness of sustainable lifestyles.

Research methods. The study included middle school students, ages 12 to 14, and used a quasi-experimental design with pre-test and post-test control groups. A total of 157 students from three Indonesian schools in Malaysia (Kuala Lumpur, Johor Bahru, and Kota Kinabalu) participated, with roughly equal numbers in the experimental and control groups. Data were collected through surveys, observations, and reflective journals, and then analyzed using t-tests, effect size, and N-gain, employing a validated questionnaire ($\alpha = 0.913$).

Results. Findings revealed significant improvements in the experimental group compared to the control group. Students made large cognitive ($g = 0.77$) and behavioral ($g = 0.78$) gains and a moderate socio-emotional awareness ($g = 0.62$) gain. The strength of the PjBTL-ESD model lies in integrating project-based learning with transformative learning, integrating ESD projects in students' daily realities, and fostering critical reflection that shifts sustainable lifestyle from external compliance to internalized values. This mechanism explains the significant overall effect size, with Cohen's $d = 2.40$, where enhanced comprehension led to the adoption of sustainable lifestyle practices as pro-environmental actions. In contrast, the control group showed negligible changes across all domains.

Conclusion. The PjBTL-ESD model effectively combines knowledge, reflection, and practice, enabling Indonesian transnational students to incorporate sustainability into both identity and daily life. Theoretically, it substantiates the intersection between project-based and transformative learning in ESD. Practically, it presents a reproducible model available to multicultural schools interested in cultivating sustainable ways of life. With limitations in time and design, this research presents PjBTL-ESD as a promising approach in educating youth as global responsible citizens.

KEYWORDS

project-based learning, transformative learning, sustainable lifestyle, transnational students, environmental consciousness

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INTRODUCTION

Cross-border initiatives in schooling have emphatically underscored that sustainability is a universal imperative. UNESCO's Education for Sustainable Development (ESD) paradigm, the United Nations' Sustainable Development Goals (SDGs), as well as programs of the Council of Europe and the Union of International Associations, all underscore that schools ought to empower youth with both knowledge and values, competencies, and skills for sustainable living [1]. According to recent research, tackling the world's environmental problems is closely tied to education. Along with helping students develop essential ESD skills, schools can also involve students in project-based learning, problem-based learning, and service learning to help them develop a more in-depth and customized understanding of sustainability in their lives [2]. As more and more academics point out, the 2030 Agenda for Sustainable Development [3] emphasizes the importance of putting principles into practice in schools. They note that improved methods for utilizing and assessing sustainability capabilities are needed, as this field has emerged as a significant area of study.

Nevertheless, studies indicate that students often engage in environmentally friendly activities without a complete understanding of their significance [4]. This outcome is in line with previous research that indicates that while students may exhibit a high level of environmental awareness, they usually find it difficult to translate this awareness into a long-term commitment to sustainable practices [5]. This lack of thorough knowledge indicates a crucial gap, as externally directed sustainable actions cannot persist without internal belief [6]. Such behavior is frequently seen among students who may not fully grasp its importance [7], highlighting how essential personal commitment is for sustaining environmentally responsible actions that are initially guided externally. However, the results also suggest a more general trend toward holistic education, which integrates social, economic, ethical, and environmental aspects to help achieve the Sustainable Development Goals of the UN [1]. These programs highlight the idea that sustainability education is no local concern, but a global common agenda, making research on innovations in pedagogy in this sector worthwhile and engaging in various countries and circumstances.

Education that provides valuable, practice-based experiences to strengthen sustainable lifestyles in the face of climate change impacts is directly aligned with SDG 4 (Quality Education) and SDG 13 (Climate Action). More specifically, through education that encourages sustainable lifestyles, Goal 4.7 aims to ensure that all students receive the information and skills necessary to support sustainable development. Similarly, Goal 13 focuses on improving education, awareness, and human and institutional capacities for mitigation, adaptation, and early warning related to climate change. ESD is more than teaching facts. It helps students adopt beliefs and acquire skills that enable them to live sustainably and take significant action against climate change [1]. ESD is important because it influences people's knowledge and understanding of environmental issues as well as their attitudes, behaviors, and perceptions of the environment. Classroom instruction can become a setting where the curriculum is closely tied to real-world situations when paired with experiential learning strategies like project-based learning [8]. The growing climate crisis highlights the negative consequences of commonly ignored sustainability principles, further exacerbating the gap between awareness and actual action.

The global climate crisis is no longer a projection; it is a reality that exists and has effects on ecosystems, communities, and economies globally. Rising sea levels, biodiversity loss, resource depletion, and environmental degradation are not isolated events but interrelated consequences of unsustainable human practices [9]. These problems have been exacerbated by rapid population growth and irresponsible uses of technology that place massive amounts of pressure upon the natural systems of the Earth [10]. With this situation, increasing awareness and responsibility towards the environment is not only desirable but imperative. The value lies in inspiring people, especially the younger generation, to make sustainable practices a way of life that avoids harming the environment and ensures long-term ecological harmony [11]. Sustainable lifestyle awareness means understanding how our everyday behaviors, from how we consume energy and waste disposal to how we move around and what we eat, either destroy or heal the environment. It is a life of responsibility and foresight that anticipates conscious choices informed by ethical and environmental considerations [12]. One example of this way of thinking is the design of sustainable buildings, like insulated homes, which significantly reduce energy consumption and carbon emissions while also

increasing comfort [13]. The global environmental crisis highlights the need for education to do more than impart knowledge. To close this gap, teachers must employ teaching strategies that foster self-reflection, identity formation, and long-term behavioral change, in addition to knowledge transfer. Empirical evidence shows that although students may have high sustainability awareness, their ability to translate it into consistent sustainable practices is still limited [14]. Additionally, developing self-awareness as a core sustainability competency can foster transformative learning experiences that strengthen personal growth, reflection, and long-term behavioral change [15]. In this context, this study investigates Indonesian transnational students in Malaysian schools to understand how sustainability education can be effectively implemented in diverse, transnational settings

This study investigates Indonesian transnational students in overseas schools in Malaysia, a group that remains understudied in sustainability education. These students are living in a liminal condition: they learn from Indonesia's national curriculum, but they live in a social and environmental setting in Malaysia that affects their daily lives. As a result, they often engage in environmentally friendly behaviors such as using recycled containers or reducing plastic, not necessarily driven by an intrinsic understanding of sustainability but frequently by administrative or practical needs rather than an innate understanding of sustainability [16]. Early interviews reveal that students often enact sustainable behaviors without fully understanding the underlying principles, whereas teachers recognize that laws and social norms strongly guide these actions [17]. Since research indicates that environmental knowledge, awareness, and risk perception have a major influence on future attitudes and behaviors, it is recommended that communities and educational institutions raise public awareness of environmental issues [18]. Aspects of social life that Indonesian transnational students in Malaysia must negotiate and adjust to include national policies such as the reduction of plastic, supporting the use of public transportation [19], and the adoption of clean energy [20].

To address this challenge, there has been increased interest in integrating Project-Based Learning (PjBL) with Transformative Learning, more effective models of sustainability education. Traditional PjBL engages learners in actual, often interdisciplinary projects that represent real conditions and challenges [21]. It has been criticized, meanwhile, for emphasizing immediate results at the expense of insufficiently promoting introspection or personal growth [22]. Conversely, Mezirow's concept of Transformative Learning emphasizes perspective transformation through critical reflection, emotional engagement, and the reevaluation of prior assumptions. Research shows that its core elements such as critical reflection, dialogue, and individual experience are interdependent and must be understood holistically, with particular attention to the sociocultural context in which learning takes place [23]. Additionally, Mezirow defines transformational learning as a process of bringing about a change in perspective, in which students examine their assumptions critically and gradually move toward more inclusive, integrative, and reflective points of view [24]. Building on this, subsequent studies highlight that transformative learning is not merely about knowledge acquisition but about fostering critical self-examination and enabling profound shifts in worldview, beliefs, and assumptions [25]. Together, these two models can potentially construct an enhanced learning context that maintains not only educational success but also identity formation and long-term behavior change. According to recent studies, the efficacy and usability of sustainability-oriented instructional approaches are increased when ESD components are incorporated. One narrative review on sustainable lifestyles identifies several key themes, including the relationship between agency and structure, the cognitive and behavioral dimensions of change, and the role of policymaking and future projections. It also emphasizes how effective instructional strategies are when they include chances for practice and behavior modification with sustainability theory and content [26]. A further research that focuses on teenagers shows how well project-based learning works to increase environmental consciousness. Using a pretest-posttest design, the research reported a statistically significant improvement in students' environmental awareness, reinforcing the potential of project-based approaches to foster pro-environmental attitudes despite limitations in sample size and context [27]. However, few empirical studies, particularly in Southeast Asian transnational school contexts, have examined the effectiveness of this combined model using robust pre-post designs. Furthermore, interventions aimed at evaluating not just behavioral results, but also cognitive and socio-emotional aspects of sustainable lives are limited.

This study addresses that gap by examining the efficacy of a Project-Based Transformative Learning with Education for Sustainable Development (PjBTL-ESD) model that promote living

sustainably awareness. Conducted among Indonesian middle school students in Malaysia, the study applies a quasi-experimental approach to measure students' awareness before and after the intervention. The aim is to understand whether this integrated learning model can improve students' understanding, attitudes, and actions related to sustainable living. It focuses on the cognitive, socio-emotional, and behavioral elements of lifestyle change, as well as students' self-awareness, while considering their environmental impact. This study contributes to the rising conversation on sustainability education by making evidence-based suggestions for improving ESD implementation in transnational and multicultural educational settings.

While various studies have separately explored project-based or transformative learning in sustainability education, there remains a clear research gap in integrating both approaches within a single instructional model in transnational school settings. This study provides a unique empirical framework by utilizing a combination of PjBTL-ESD model suited to the situation of Indonesian transnational students in Malaysia. Unlike prior works that emphasize either behavioral outcomes or knowledge acquisition alone, this study systematically measures changes across cognitive, behavioral, and socio-emotional domains. It also uniquely investigates how structured interventions can convert externally motivated environmental actions into internalized, values-driven practices. This represents one of the first attempts to validate an integrative learning model for sustainable lifestyles in multicultural, diasporic educational environments. As such, this study addresses a vital need by providing theoretical and practical insights into improving ESD in underrepresented yet internationally relevant school systems.

MATERIALS AND METHODS

The study adopted a quasi-experimental approach in investigating the effectiveness of the PjBTL-ESD in raising awareness of sustainable lifestyles among Indonesian students in Malaysia. Two stages of research were involved: a small-scale pilot study and a large-scale implementation phase. The pilot study was conducted at Sekolah Indonesia Kuala Lumpur (SIKL) in February 2025, involving 40 students, 20 for the experimental group and 20 for the control group. The main trial was conducted in July 2025 and consisted of three Indonesian schools in Malaysia: SIKL, Sekolah Indonesia Johor Bahru (SIJB), and Sekolah Indonesia Kota Kinabalu (SIKK). Each school had 20 students in the control group and the experimental group, except for SIJB, which had 19 students in both groups.

This study used a systematic instrument to measure students' attitudes towards sustainable living on the cognitive, behavioral, and socio-emotional levels. A five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), was used to assess the survey's 30 items. These items were constructed based on representing students' understanding of concepts regarding sustainability, daily practices related to being ecologically conscious, and values or attitudes that express emotional attachments towards issues regarding sustainability.

To validate the content of the instrument, three experts in environmental education and educational measurement reviewed all the items to confirm the content validity of the instrument. They provided input that guided refinements related to language clarity, contextual applicability, and concordance with the PjBTL-ESD framework. A pilot test was conducted in November 2024 with 20 students outside the leading sample group before conducting the main study. Feedback from the pilot phase was used to enhance item clarity and response consistency further. With a Cronbach's alpha of 0.913, the final measure demonstrated great internal consistency and dependability.

Data collection was done in three phases, beginning with a pre-test administered to both the experimental and control groups. This was then followed by intervention for three weeks when the experimental group used the PjBTL-ESD model, whereas the control group engaged in traditional project-based learning. A post-test was finally administered to measure changes. All feedback was analyzed using SPSS statistical software. After confirming data normality through Shapiro-Wilk testing, inferential tests were performed. Paired sample t-tests were performed for group comparison within the same group, and independent t-tests were performed to compare between groups to assess the intervention effect. Practical significance was determined through Cohen's d effect size.

LITERATURE REVIEW

The concept of "lifestyle" refers to the ways of thinking, acting, and interacting with others that impact everyday life. It encompasses activities, values, attitudes, and social dynamics that define individual and group choices [28]. At the same time, lifestyles are understood as bundles of meaningful routines with both cultural and material dimensions, shaped by personal priorities and access to social, cultural, and economic resources [29]. It does not emerge in isolation but is shaped by cultural contexts that influence values, priorities, and social expectations, thereby directing consumer habits and lifestyle choices [30]. At the same time, individual attitudes, as cognitive, emotional, and behavioral predispositions, strongly affect decision-making and everyday practices, reinforcing how lifestyles are continuously constructed through personal and social dynamics [31]. As the cumulative outcome of daily practices, lifestyle is both personal and socially conditioned, dynamic, and context-dependent. Attitudes, actions, and larger material and social circumstances may either support or undermine sustainable transformation, according to research on low-carbon lifestyles [32]. According to health psychology, lifestyle is best understood as a complex idea that connects individual beliefs with broader social and life-cycle factors by combining internal, external, and temporal variables [33]. Within sustainability studies, lifestyle becomes essential because it determines long-term ecological balance and social justice. Because they improve the health of the earth and the community, practices such as trash reduction, energy conservation, and responsible consumption are often highlighted as core components of sustainable living [34]. At the same time, lifestyle is also closely tied to individual health outcomes. Research shows that unhealthy patterns of behavior place people in at-risk groups vulnerable to morbidity, disability, and premature mortality, whereas adopting healthier lifestyles significantly reduces such risks, even though its prevalence in the population remains low [35]. However, infrastructure, customs, and institutional frameworks that either encourage or restrict what people may do make sustainable lifestyles more than just personal preferences [6]. This emphasizes the need to address sustainability as both a systemic and individual issue.

Understanding sustainable living has an especially significant influence throughout adolescence, a crucial time when beliefs and behaviors solidify into an identity. At this point, promoting sustainability necessitates behavioral, emotional, and cognitive change [36]. Reusing containers and saving electricity are two examples of environmentally friendly behaviors that some teens participate in; however, they are usually unintentional rather than intentional. Therefore, by combining knowledge, empathy, and practice, education for sustainability should promote self-awareness, collaboration, and anticipatory thinking. In the school context, key competences include systems thinking, collaboration, action orientation, and values-based learning [37]. At a broader level, sustainability education is guided by a unified framework of eight core competencies that support transformative change [38]. Only when intrinsic motivation is present can observable indicators such as waste management, energy conservation, green transportation, or community involvement have real significance [7]. A similar effort to expand public awareness has been demonstrated through the use of Massive Open Online Courses (MOOCs) to promote science centers in Indonesia. This study emphasized that non-formal learning based on MOOCs can connect society with issues of science and sustainability through open participation, collaboration, and self-regulated learning [39]. A systematic review of education for sustainable development in primary schools shows that competences like systems thinking, collaboration, action orientation, and values-based learning are essential foundations for such practices, while futures thinking remains less explored [37]. Therefore, education must foster agency and ownership so that teenagers may relate their own ideals to sustainable conduct. Through reflective learning, students can understand why sustainability matters and envision themselves as active contributors to a more sustainable future [38]. A comprehensive framework of key competencies, including systems-thinking, anticipatory, normative, strategic, interpersonal, and emerging competences, guides how learners can be prepared as change agents to advance sustainability transformations [40].

Building on the need for reflective and intentional sustainability learning during adolescence, the PjBTL-ESD, integrates the principles of Project-Based Learning (PjBL) with transformative learning approaches. Rooted in Dewey's idea of experiential "learning by doing" [41] and strengthened as a foundation for progressive education [42], PjBL was further advanced by Kilpatrick [14]. It emphasizes real-world projects that foster motivation, critical thinking, and problem-solving [43]. In sustainability contexts, such approaches also help students develop interdisciplinary competencies [44] and professional skills [45]. The PjBTL-ESD paradigm goes beyond skill improvement to include

Mezirow's transformational learning theory, which emphasizes the importance of critical reflection in transforming beliefs, values, and self-concept [46]. This method represents sustainability education as a process of developing new ideas, encouraging empathy, and strengthening a dedication to ecological values in addition to imparting knowledge and promoting a more profound comprehension. The paradigm views education for sustainability as a process of creating new perspectives on meaning, empathy, and commitment to environmental goals, rather than just imparting knowledge. The approach integrates transformative phases of learning, such as activating experiences, questioning presumptions, having critical conversations, and applying new perspectives, and builds on ideas by Nerstrom [47] and McGonigal [48]. During these phases, students tackle tangible sustainability issues (such as waste, energy use, or environmental deterioration), consider their solutions, and assimilate sustainable principles. Through the integration of sustainability into purposeful, inquiry-based initiatives, PjBTL-ESD facilitates both larger lifestyle change and the growth of knowledge acquisition. Figure 1 depicts a hypothetical model that guides the construction of practical PjBTL-ESD learning phases.

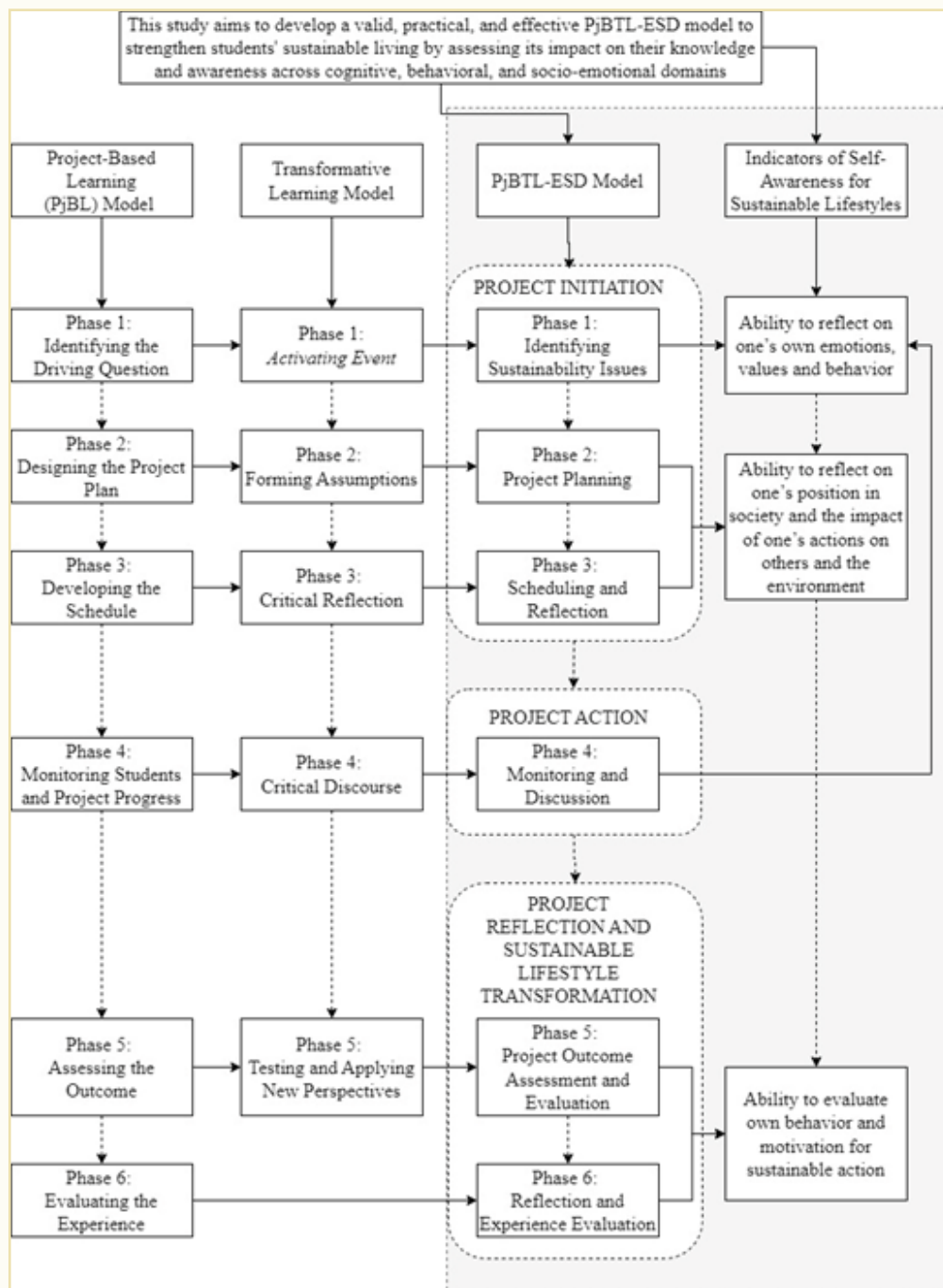


Figure 1 The hypothetical model of practical PjBTL-ESD learning phases

Reflective practices, integrative evaluation, teacher-student roles, and learning phases based on PjBL and transformational learning are the fundamental components of the PjBTL-ESD approach. Teachers facilitate students' active co-design and implementation of projects that address real-world environmental concerns by providing metacognitive and socially engaging experiences. Assessment is both formative through continuous feedback aligned with project phases and summative, as it evaluates sustainability competencies and behavioral outcomes. It gives a detailed account of how knowledge is learnt, applied, and remembered by use of proven learning theories, some of them being Bandura's social cognitive theory, Ausubel's theory of meaningful learning, and Vygotsky's theory of social constructivism. This method develops not just academic comprehension but also empathy and long-lasting habits by incorporating ESD concepts into students' everyday activities and encouraging continuous reflection. In this way, PjBTL-ESD transcends its role as a teaching tool and becomes a life-changing experience that helps students move beyond merely understanding sustainability to genuinely embracing and putting it into practice. It illustrates how reflective practice and experiential learning may foster sustainable lifestyles [49] and significant contributions to ESD objectives [1].

Building on this transformative potential, Indonesian transnational schools in Malaysia such as SIKL, SIJB, and SIKK are learning environments that preserve national identity but adapt to global contexts. Overseas schools cater to the learning needs of Indonesian children who live in transnational environments, including those of migrant workers, and depend on Indonesia's national curriculum. Located in urban multicultural settings like Malaysia, these schools must function both within Indonesian schooling values and the host nation's social-political context. Hence, they are more than just replicas of Indonesian education; they are adaptable, multicultural environments that are conditioned to the dynamics of diasporic existence.

Education plays a central role in shaping the behaviors and decision-making of students, especially in maintaining sustainable lifestyles. Education ought to be focused on raising awareness, critical reflection, and action, as noted in the ESD strategy. ESD equips learners with knowledge, skills, and values for sustainable living [1] through participatory, interdisciplinary, and action-learning [50]. In Indonesian secondary schools, both locally and internationally, ESD is integrated into the curriculum [51]. ESD-emphasized topics such as Sustainable Lifestyle are prioritized, and ESD-centered projects are increasingly being used to inculcate sustainable lifestyles and environmental awareness in students [52]. They integrate themes of sustainability in their instruction through environmental projects and climate change seminars [53], as well as community-based activities that foster awareness and responsibility among students [54].

In the Malaysian context, students must reconcile the Indonesian education standards with the country's environmental situation and its values. Sustainable behaviors such as decreasing plastic usage [17], promoting non-motorized and public transportation [19], and utilizing renewable energy sources [20] are progressively being encouraged in Malaysia's social and policy agendas. According to research performed in Malaysia, environmental awareness, risk perception, and personal efficacy all have a substantial influence on pro-sustainability behavior and attitudes. This is a twin challenge for Indonesian overseas schools: the need to uphold national education standards while simultaneously preparing their students to learn and make meaningful contributions to sustainable development in their immediate transnational environment. ESD-centered learning, as transformative project-based learning, is thus not merely relevant but key to preparing students for the skills to live responsibly within such environments.

RESEARCH PROGRAM

The study aims to explore the effectiveness of the PjBTL-ESD elements in raising Indonesian students' awareness of sustainable lifestyles in Malaysia. Derived from transformative learning theory and the principles of project-based learning, the model integrates experiential, reflective, and action-oriented components to mold learners' understanding and practice of sustainability. Because of the transnational and city-based learning situation that these students are living in, this study aims to understand how structured interventions would enhance the connection between knowledge and action towards real-life environmental challenges.

Research Objectives:

1. To assess Indonesian students' knowledge of sustainable living in Malaysia before and after implementing the PjBTL-ESD model.
2. To determine if the PjBTL-ESD model greatly enhances the awareness of students in three primary domains: cognitive (knowledge), behavioral (behaviors), and socio-emotional (values and attitudes).

Research Hypotheses:

H₀: There is no statistically significant difference between students' pretest and posttest scores of sustainable lifestyle awareness after the implementation of the PjBTL-ESD model.

H₁: There is a statistically significant improvement in students' sustainable lifestyle awareness following the implementation of the PjBTL-ESD model.

H₂: Each domain (cognitive, behavioral, and socio-emotional) shows a significant improvement after the intervention.

The conceptual framework of this study combines Project-Based Learning (PjBL) with Transformative Learning in ESD. The PjBTL model is the independent variable, while awareness of sustainable lifestyles as assessed by cognitive, behavioral, and socioemotional characteristics is the dependent variable. The model forecasts that students engaged in PjBTL-ESD will demonstrate substantive improvement across these components. A pre-test/post-test design captures this change, with the relationships schematically described in Figure 2.

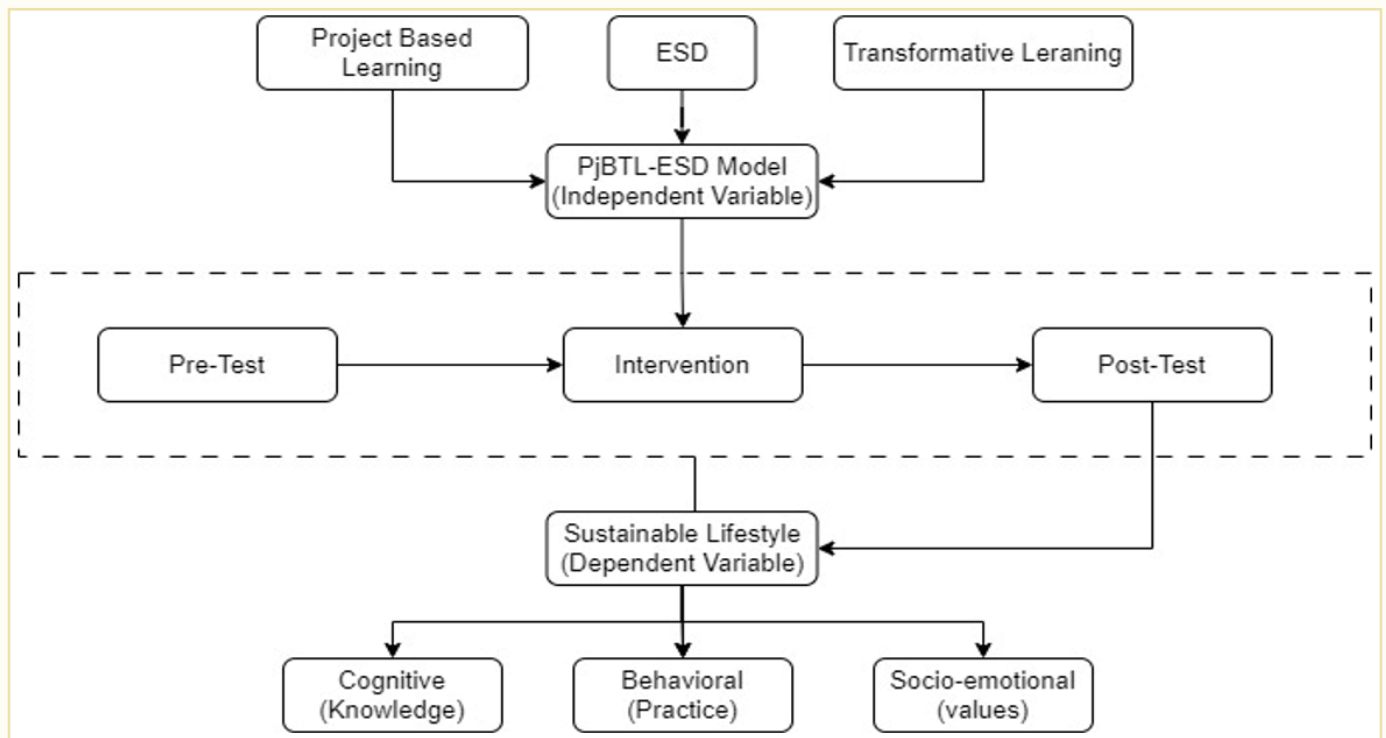


Figure 2 The conceptual framework of the study

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RESEARCH RESULTS

This section provides the statistical analysis of the data gathered both before and after the PjBTL-ESD was implemented. The study was conducted to evaluate the impact of the intervention on students' awareness of sustainable lifestyles in cognitive, behavioral, and socio-emotional aspects. Table 1 displays the demographic data of the 118 participants, with the groups evenly split between the control group (n=59) and the experimental group (n=59).

Table 1 Demographic characteristics of the research participants

Characteristic	E	C	Total
	n (%)	n (%)	N (%)
School Location			
SIKL	20 (33.9%)	20 (33.9%)	40 (33.9%)
SIJB	19 (32.2%)	19 (32.2%)	38 (32.2%)
SIKK	20 (33.9%)	20 (33.9%)	40 (33.9%)
Gender			
Male	26 (44.1%)	21 (35.6%)	47 (39.8%)
Female	33 (55.9%)	38 (64.4%)	71 (60.2%)
Total	59 (100%)	59 (100%)	118 (100%)
	M (SD)	M (SD)	
Mean Age (Years)	15.5 (0.5)	15.6 (0.5)	

Notes. E = Experimental group; C = Control group

A chi-square test of independence revealed that there was no statistical association between group allocation and school location, $\chi^2(2)=0.00$, $p=1.00$, or gender, $\chi^2(1)=1.37$, $p=.24$, and therefore at baseline the groups were comparable. An initial independent samples t-test of the pre-test scores provided this initial similarity, with no statistically significant difference between the control group

($M = 3.23$, $SD = 0.45$) and the experimental group ($M = 3.25$, $SD = 0.48$), $t(116) = 0.25$, $p = .80$. A Shapiro-Wilk test also confirmed that the data were normally distributed ($p > .05$), which made it suitable to use parametric tests.

1. Main hypothesis testing. Students' sustainable lifestyle awareness scores were compared pre- and post-intervention to test the primary hypothesis. As Table 2 shows, the experimental group had a statistically significant improvement following the PjBTL-ESD intervention. This suggests the intervention has a positive and measurable impact on students' awareness of sustainable living. A paired-samples t-test indicated that there was a significant difference between the pre-test ($M = 3.25$, $SD = 0.48$) and post-test ($M = 4.52$, $SD = 0.35$) scores, $t(58) = 18.42$, $p < .001$. The fact that the mean score was high following the intervention indicates that the students became more knowledgeable and aware of sustainable practices. A large effect size (Cohen's $d = 2.40$) spoke to the whopping practical significance of the intervention. Practically, this means the change was not only statistically significant but also significant in the real day-to-day classroom setting.

Table 2 Statistical Analysis and Intervention Effectiveness on

Variable-Group		Pre-Test M (SD)	Post-Test M (SD)	N-gain (g)	t-value	p-value	Effect Size (Cohen's d)
Cognitive	E	3.18 (0.55)	4.58 (0.40)	0.77 (High)	17.3	< .001	2.25 (Very Large)
	C	3.15 (0.52)	3.20 (0.53)	0.03 (Low)	0.85	0.399	0.11 (Negligible)
Behavioral	E	3.24 (0.50)	4.61 (0.38)	0.78 (High)	19.3	< .001	2.51 (Very Large)
	C	3.21 (0.48)	3.26 (0.50)	0.03 (Low)	0.92	0.361	0.12 (Negligible)
Socio-emotional	E	3.32 (0.58)	4.36 (0.44)	0.62 (Moderate)	13	< .001	1.69 (Large)
	C	3.33 (0.55)	3.40 (0.59)	0.04 (Low)	1.12	0.267	0.14 (Negligible)
Overall	E	3.25 (0.48)	4.52 (0.35)	0.73 (High)	18.4	< .001	2.40 (Very Large)
	C	3.23 (0.45)	3.29 (0.47)	0.03 (Low)	1.15	0.254	0.15 (Negligible)

Notes. E = Experimental group; C = Control group

To further support the analysis, learning effectiveness was also measured by quantifying based on Normalized Gain (N-gain). The results indicated that the experimental group had an N-gain score of 0.73, which fell under the "High" category. This measurement signified that the PjBTL-ESD model was not only effective at raising scores but also very practical, enabling students to reach 73% of their highest potential for improvement. In sharp contrast to this, the standard project-based learning control group showed no statistically significant difference ($p = .254$). The N-gain score for this group was only 0.03, classified as "Low," which suggests that the conventional teaching method made negligible learning gains.

A comparison of post-test scores across the two groups further confirms these findings, with the experimental group score ($M = 4.52$) considerably greater than that of the control group ($M = 3.29$), $t(116) = 14.88$, $p < .001$. Based on evidence from statistical significance (p-value), practical significance (Cohen's d), and learning effectiveness (N-gain), the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted.

2. Analysis by awareness domains. To test hypothesis H_2 , a more detailed analysis was conducted on each awareness domain: cognitive, behavioral, and socio-emotional. These findings, enriched by N-gain analysis, are summarized in Table 2.

Students' understanding of sustainability improved statistically significantly ($p < .001$) when the PjBTL-ESD model was used in the cognitive domain; their N-gain score of 0.77 was categorized as "High." This implies that the curriculum was effective in helping students develop a more systematic way of thinking and in understanding environmental concerns. The most substantial gain, however, was found in the behavioral domain, which recorded the highest effect size (Cohen's $d = 2.51$) and an N-gain of 0.78. This suggests that the model translated knowledge into sustainable daily actions through hands-on projects and contextual engagement. In the socio-emotional domain, which measures empathy, attitudes, and values, the N-gain reached 0.62 (Moderate) yet still indicated a

meaningful improvement in students' affective awareness and responsibility toward the environment. Notably, the control group across all domains yielded very low N-gain scores (0.03–0.04), reaffirming the limited effect of conventional instruction. These findings fully support hypothesis H₂ and affirm the holistic effectiveness of the PjBTL-ESD model across all three dimensions of awareness.

Across all measured domains, the control group demonstrated minimal progress, with N-gain scores ranging only from 0.03 to 0.04, indicating the limited impact of traditional instruction. The experimental group, on the other hand, continuously produced significant gains, demonstrating the PjBTL-ESD model's efficacy. These results validate the hypothesis H₂ and show that in a variety of educational contexts, integrative, reflective, and project-based learning approaches are better equipped to create enduring and significant knowledge of sustainable lifestyles.

DISCUSSION

Findings in this study support that the PjBTL-ESD model is a practical approach to enhancing Indonesian students' sustainable lifestyle awareness in Malaysia. Improvements in cognition, behavior, and socio-emotion were observed consistently throughout. Students not only showed improved understanding of the concepts of sustainability but also altered daily habits and values, reflecting authentic internalization of learning outcomes. These changes, while statistically significant, also reflect an educational experience of depth over content. This suggests that education centered on real problems can bring about lasting attitudinal and behavioral change.

The foundation of this impact lies in the proximity of the learning process. Projects gain relevance when aligned with students' daily life in Malaysia, for instance waste reduction plans, the design of green public areas, and affordable public transport systems. Evidence from Malaysia shows that environmental commitment, consciousness, green lifestyle, and self-efficacy shape pro-environmental behaviour among students [17]. Research on non-motorized transport highlights walking and cycling as low-carbon practices that also foster healthier lifestyles [19]. Studies on renewable energy stress the urgency of reducing fossil fuel dependence through alternatives such as agricultural waste [20]. Scaffolding with structure enabled students to recognize the interdependencies between environmental, economic, and social systems [1]. A study upper secondary students highlights how diverse arguments on the interconnectedness of sustainability dimensions, particularly the economic aspect, can enrich holistic and pluralistic approaches to education for sustainable development [55]. Peer dialogue also facilitated co-construction of meaning, resonating with research on transformative learning that emphasizes the role of social interaction, experience, and the development of sustainability competencies in fostering deeper learning processes [56]. These environments encouraged mutual respect, peer influence, and critique. Therefore, the most concrete gains were registered in behavior, wherein students began to apply what they had learned to routine practices. Improving student competencies to address sustainability challenges has been widely debated in higher education. Problem- and project-based learning models have been shown to strengthen sustainability competencies, integrate interdisciplinary perspectives, and provide practical outcomes through collaboration with community partners [44]. Evidence also shows that project-based approaches can foster pro-environmental behaviors such as sustainable food choices, reduced car use, and resource conservation [57]. In addition, the transformative role of education for sustainable development highlights its capacity to link knowledge with moral values, behavioral change, and social engagement in diverse learning contexts [58]. Qualitative reflections reinforced this; one student, for example, noted feeling "more aware that throwing garbage is a personal responsibility, not just a school rule," underscoring how internalization moved beyond compliance.

Theoretically, these results align with transformative learning theory, where perspective shifts arise through critical reflection, dialogue, and the re-examination of prior assumptions. Research on Mezirow's framework confirms that such transformation requires not only reflection and experience but also an awareness of personal and sociocultural context, which allows learners to broaden their meaning perspectives and reconstruct their frames of reference [23]. Further studies underline that transformative learning is one of the most influential theories in adult education, highlighting how individuals change their worldview by questioning assumptions and integrating new experiences [24]. Moreover, the transformative potential of education emphasizes that learning is not only about acquiring knowledge but also about reshaping beliefs and values through critical examination [25].

The PjBTL-ESD model extends transformative learning by embedding the transnational dimension of hybrid identity formation, helping students reconcile dual cultural expectations. It also bridges the gap between project-based learning (practical, short-term) and transformative learning (reflective, identity-shaping), creating a more integrated ESD pedagogy. In ESD, learning fosters not only intellectual but also ethical and moral growth, where affective elements such as empathy, skepticism, and curiosity drive reflective thinking, enabling pupils to view sustainability as a framework for decisions and relationships. These outcomes legitimize experiential learning as a foundation for motivating climate-related student action [42], strengthen the use of project-based approaches in sustainable education inspired by Dewey's legacy [43], and align with transformative learning perspectives that emphasize shifts in meaning-making as illustrated in the Nerstrom Transformative Learning Model [47]. Students are more likely to guide sustained action in loops of experience, reflection, and application. Experiential learning renders abstract ideas concrete, which strengthens motivation and retention. As an instrument for civic engagement, it enables students to act, reflect, and improve. Thus, experiential learning anchors sustainability in lived practice, making abstract values actionable.

In practice, this study shows that ESD models like PjBTL-ESD are flexible and responsive to the requirements of transnational education [59]. Such flexibility also resonates with findings from international programs that highlight the need to move beyond mere project execution toward deeper interdisciplinary and evaluative engagement [60]. This is further supported by research on study-abroad initiatives that demonstrate how competence-based sustainability learning requires strong contextualization to maximize its transformative potential. Transnational education refers to mobility between different norms, expectations, and identity pressures of education. Indonesian students in Malaysia reside in a double space where they should maintain Indonesian values, together with conforming to Malaysian surroundings. The double influences shape personal development. The PjBTL-ESD model is used to synthesise these dimensions so that students can navigate their learning experience through patterned yet adaptive learning. The model supports multiple identities and shared purpose in sustainability. Curriculum-wise, the study suggests the limitations of content-based instruction and the strengths of more integrated, dynamic models. Instead of grappling with curriculum as discrete subjects, PjBTL-ESD positions learning in core human challenges and student agency [61]. It equips students with interdisciplinary knowledge and encourages holistic, ethical behavior. It integrates problem-solving with critical thinking, and knowledge with reflection. Within Malaysian Indonesian schools where environmental stimuli are accessible, this model equips students to problem-solve, question, and act.

It is what renders PjBTL-ESD emotionally compelling. Not only are the students enlightened, but intellectually, ethically, and emotionally engaged. They link real-world challenges like biodiversity or climate change to everyday practices and personal habits. This leads students to take ownership of sustainability issues. Through internalized education, students are motivated by faith, not obedience. When education is rooted in their lives, transformation is attainable. This emotional investment facilitates long-term impact through the integration of environmental ethics in day-to-day decisions.

Additionally, students in this research inhabit cultural hybridity. Living half-way between Indonesian roots and Malaysian dominance, they create hybrid identities involving intercultural flexibility. A curriculum that ignores this risks isolation. One that addresses it, like PjBTL-ESD, allows reconciling competing narratives and ethical reasoning. Navigating this complexity is key to global citizenship. The model enables learners to make sense of cultural systems, identity formation, empathy, and resilience. It empowers global citizenship by encouraging comparison of environmental norms and values. By engaging with diverse practices and reflecting on their social drivers, students develop systemic thinking, empathy, and intercultural sensitivity.

Ultimately, this research contributes to global dialogue about curriculum change. It means that education for sustainability must be mainstreamed in school culture, for example, shaping the way students think, feel, and act through the curriculum. This whole-school commitment creates accountability and extended timelines, making schools a community of practice. The message is urgent for Indonesian education. The Ministry of Education and Culture and global school leaders have to integrate ESD in curriculum planning, pedagogy, and evaluation. With thoughtful, action-oriented reforms, Indonesia can take the lead in world education innovation that equips young people to navigate and direct a sustainable future. Nevertheless, some limitations remain. The short three-week intervention restricted the depth of value internalization, and reliance on self-reported data may have introduced social desirability bias. A longer intervention and triangulated data could yield deeper insights into identity transformation.

CONCLUSION

The findings of this study provide firm evidence that the integration of Education for Sustainable Development (ESD), Project-Based Learning (PjBL), and transformative learning within the PjBTL-ESD model is a capable approach to improving sustainable lifestyles among Indonesian transnational students in Malaysia. The model successfully facilitated not only cognitive learning but also fostered affective identification and behavioral involvement towards sustainability. Participants in the intervention demonstrated higher understanding, stronger values, and increased willingness to engage in pro-environmental actions. By blending knowledge, emotional connection, and practical application, the PjBTL-ESD model enabled young learners to advance from a superficial understanding to authentic, values-based practices in sustainability, which is a critical building block for a lifetime of environmental responsibility.

Despite these positive findings, this research is subject to some considerable limitations, which must be noted. The quasi-experimental methodology, while involving experimental and control groups, did not include complete randomization of participants and hence is still susceptible to selection bias. In addition, the three-week intervention duration was too brief to allow for in-depth learning, internalization of values, or long-term behavior change. Moreover, the utilization of self-report questionnaires has introduced social desirability bias, particularly in the assessment of socio-emotional learning, in which students have overestimated dedication or empathy. Most critically, the long-term effect of the intervention is unknown; no follow-up was done to assess whether changes in attitude or behavior were maintained over time.

Future research should employ a full Randomized Controlled Trial (RCT) design to improve the internal validity of findings. Long-term studies, including post-intervention follow-ups, show whether or not change is transformative and long-lasting. Incorporating reflective diaries, teacher diaries, classroom observations, or interviews into mixed-method designs offers a more thorough picture of students' developmental paths. Finally, replication of this research in different cultural, institutional, and geographic settings would test the scalability and applicability of the PjBTL-ESD model, further refining it and applying it to more transnational education systems.

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