

ANALYSIS OF STUDENTS' SUSTAINABILITY CONSCIOUSNESS BASED ON CONCEPTUAL DIMENSIONS, DETERMINANT FACTORS, AND THE KNOWLEDGE–ATTITUDE–BEHAVIOR GAP: A SYSTEMATIC LITERATURE REVIEW

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Abstract. This study aims to analyze students' sustainability consciousness based on its conceptual dimensions, determinant factors, and the relationships among knowledge, attitudes, and behavior. This study employed a systematic literature review (SLR) approach, guided by the PRISMA framework to ensure a structured and transparent process of literature identification, screening, and synthesis. The literature search was conducted using the Scopus database with keywords such as “sustainability consciousness in higher education,” “students' environmental awareness,” and “sustainability consciousness among university students.” The initial search yielded 249 records, of which 24 articles met the inclusion criteria and were included in the final analysis. The findings indicate that sustainability consciousness is a multidimensional construct consisting of knowledge, attitudes, and behavior that interact dynamically. The knowledge dimension is generally higher than the behavioral dimension, indicating a gap between students' understanding and their actual practices. In addition, sustainability consciousness is influenced by internal factors such as environmental literacy and individual values, as well as external factors including education, curriculum, campus environment, and pedagogical approaches. The relationships among these dimensions are complex and non-linear, mediated by variables such as social norms and learning experiences. A key finding is the presence of a knowledge–action gap, demonstrating that increased knowledge does not necessarily lead to sustainable behavior. This study contributes by integrating the dimensions, determinants, and relationships of sustainability consciousness into a comprehensive analytical framework.

Keywords: Sustainability Consciousness, Students, Chemistry Education

Abstrak. Penelitian ini bertujuan untuk menganalisis sustainability consciousness mahasiswa berdasarkan dimensi konseptual, faktor determinan, serta hubungan antara pengetahuan, sikap, dan perilaku. Penelitian ini menggunakan pendekatan systematic literature review (SLR) dengan panduan PRISMA untuk mengidentifikasi, menyeleksi, dan mensintesis literatur secara sistematis. Proses pencarian dilakukan melalui database Scopus menggunakan kata kunci seperti “sustainability consciousness in higher education,” “students' environmental awareness,” dan “sustainability consciousness among university students.” Dari hasil pencarian awal sebanyak 249 artikel, diperoleh 24 artikel yang memenuhi kriteria inklusi untuk dianalisis. Hasil penelitian menunjukkan bahwa sustainability consciousness merupakan konstruk multidimensional yang terdiri atas pengetahuan, sikap, dan perilaku yang saling berinteraksi secara dinamis. Dimensi pengetahuan ditemukan lebih dominan dibandingkan perilaku, yang mengindikasikan adanya kesenjangan antara pemahaman dan implementasi. Selain itu, sustainability consciousness dipengaruhi oleh faktor internal seperti literasi lingkungan dan nilai individu, serta faktor eksternal seperti pendidikan, kurikulum, lingkungan kampus, dan pendekatan pedagogi. Hubungan antar dimensi bersifat kompleks dan tidak linear, serta dimediasi oleh variabel seperti norma sosial dan pengalaman belajar. Temuan utama penelitian ini adalah adanya fenomena knowledge–action gap, yang menunjukkan bahwa peningkatan pengetahuan tidak secara otomatis menghasilkan perilaku berkelanjutan. Penelitian ini berkontribusi dalam mengintegrasikan dimensi, faktor determinan, dan hubungan sustainability consciousness ke dalam kerangka analisis yang komprehensif.

Kata Kunci: Sustainability Consciousness, Mahasiswa, Pendidikan Kimia

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INTRODUCTION

Sustainability has emerged as a critical global concern within the context of higher education, particularly in response to escalating challenges such as climate change, environmental degradation, and resource scarcity. In this regard, university students are increasingly positioned as strategic agents of change, whose competencies and awareness are expected to contribute to the advancement of sustainable development. Consequently, the development of sustainability consciousness has gained considerable attention as a central objective of higher education systems. Sustainability consciousness is commonly conceptualized as a multidimensional construct encompassing cognitive, affective, and behavioral dimensions, which collectively shape individuals' awareness and engagement with sustainability-related issues (Uleanya et al., 2024). Despite the growing level of awareness among students, empirical evidence consistently indicates that the translation of such awareness into tangible pro-sustainability behavior remains limited, highlighting the inherent complexity in the interaction between knowledge, attitudes, and behavioral practices.

Sustainability consciousness is widely conceptualized as a multidimensional construct consisting of knowledge, attitudes, and behavior (Ariza et al., 2021; Torres et al., 2023). These dimensions represent the cognitive, affective, and behavioral components that shape students' awareness and engagement with sustainability issues (Uleanya et al., 2024). Although theoretical frameworks such as the Knowledge–Attitude–Behavior (KAB) model, Theory of Planned Behavior (TPB), and Education for Sustainable Development (ESD) have been used to explain these relationships (Agu et al., 2022; Malandrakis, 2022; Murzyn et al., 2025), empirical findings indicate that the interactions among these dimensions are often complex and non-linear (Torres et al., 2023). Previous studies indicate that sustainability consciousness is influenced by both internal and external factors. Internal factors include environmental literacy, individual values, and perceptions (Incesu & Yas, 2024; Urbańska et al., 2022), while external factors involve educational context, curriculum integration, and learning experiences (Aldawsari et al., 2025; Lin et al., 2022; Nguyen et al., 2025). These determinants interact dynamically, suggesting that sustainability consciousness is shaped by complex and context-dependent processes rather than isolated influences.

A persistent issue identified in the literature is the discrepancy between knowledge, attitudes, and behavior, commonly referred to as the knowledge–action gap or attitude–behavior gap. Numerous studies have reported that high levels of sustainability knowledge and positive attitudes do not consistently translate into corresponding behavioral practices (Luo & Wang, 2025; Murzyn et al., 2025). This inconsistency indicates that cognitive awareness alone

is insufficient to drive behavioral change. Several studies have further identified a range of mediating factors that influence this gap, including social norms, habitual practices, infrastructural constraints, and limited experiential learning opportunities (Nguyen et al., 2025; Yilmaz et al., 2022). These factors suggest that the translation of knowledge into behavior is shaped not only by internal cognitive processes but also by external contextual conditions. Moreover, the nature of knowledge itself plays a critical role in determining behavioral outcomes. Practical and action-oriented knowledge has been found to be more effective in promoting sustainable behavior compared to purely theoretical understanding (Wang et al., 2025). Therefore, the relationship among knowledge, attitudes, and behavior should not be viewed as linear, but rather as a complex and context-dependent interaction. These findings highlight the need for a more integrative perspective in understanding sustainability consciousness.

Despite the growing body of research on sustainability consciousness, several critical limitations remain. Existing studies tend to examine isolated dimensions—such as knowledge, attitudes, or behavior—without integrating these components into a unified analytical framework (Gök & Firat Kiliç, 2021; Moody-Marshall, 2023). In addition, most studies rely on cross-sectional designs and context-specific samples, limiting the understanding of dynamic relationships among these dimensions (Uleanya et al., 2024; Nguyen et al., 2025). The persistent knowledge–action gap also remains insufficiently explained, particularly in relation to the interaction between internal and external determinants (Luo & Wang, 2025; Murzyn et al., 2025). These limitations highlight the need for a more integrative and systematic synthesis of existing research. In response to these gaps, this study aims to analyze students' sustainability consciousness through the lenses of conceptual dimensions, determinant factors, and the relationships among knowledge, attitudes, and behavior using a systematic literature review approach. Specifically, this study seeks to (i) identify the conceptual characteristics and core dimensions of sustainability consciousness, (ii) examine the determinant factors influencing sustainability consciousness based on prior empirical findings, and (iii) analyze the interrelationships among its dimensions, including the patterns of discrepancy reported in the literature. By integrating diverse empirical findings within a comprehensive analytical framework, this study is expected to contribute both theoretically by refining the conceptualization of sustainability consciousness and practically by informing the design of more effective sustainability education strategies.

Accordingly, this study aims to comprehensively analyze students' sustainability consciousness by examining its conceptual dimensions, identifying the determinant factors that influence it, and exploring the relationships among knowledge, attitudes, and behavior, including the patterns of discrepancy reported in the literature. Through this integrative analysis, this study seeks to provide a holistic understanding of sustainability consciousness in higher education and to contribute to the development of more effective educational strategies and policies for promoting sustainable development. This study aims to provide a comprehensive and integrative understanding of sustainability consciousness in higher education, thereby supporting the development of more effective policies and practices for advancing sustainable development.

METHOD

This study employed a systematic literature review (SLR) design guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure a transparent, structured, and reproducible process of literature identification, screening, and synthesis. The adoption of this approach enables the comprehensive integration of empirical findings related to students' sustainability consciousness across diverse research contexts, thereby facilitating a robust and systematic evaluation of the existing body of knowledge.

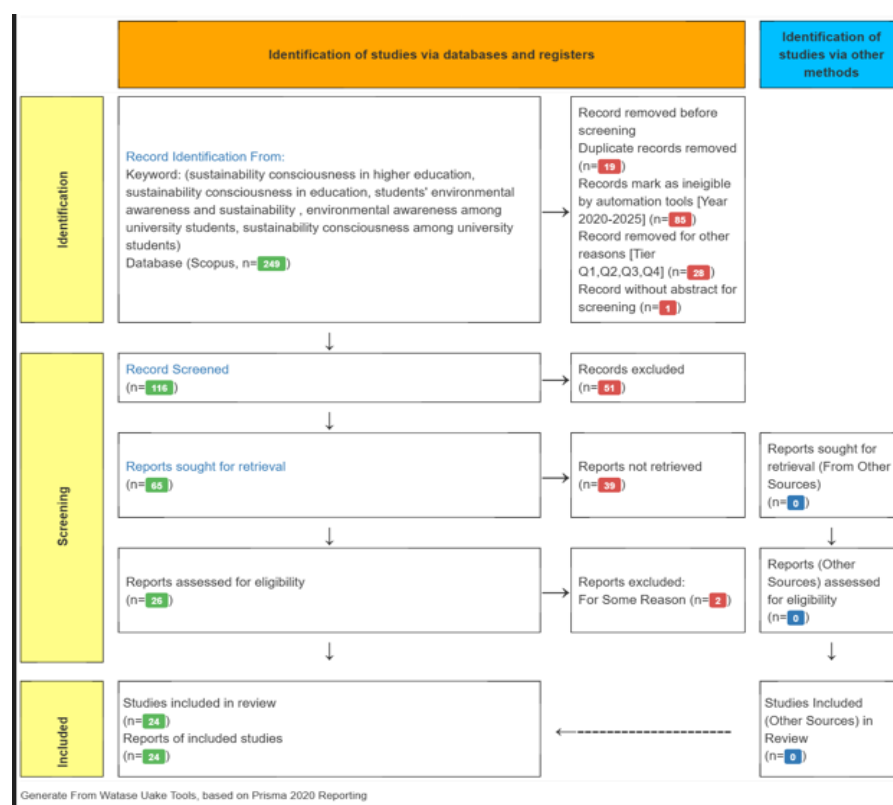


Figure 1. PRISMA flow diagram illustrating the identification, screening, eligibility, and inclusion of studies in the systematic literature review

The unit of analysis in this study comprised peer-reviewed scientific articles rather than individual human subjects. The initial dataset was retrieved from the Scopus database, yielding a total of 249 records. Inclusion criteria were defined to ensure both relevance and quality of the selected studies, including (i) publication within the period 2020–2025, (ii) indexing within Scopus quartiles Q1–Q4, and (iii) explicit focus on sustainability consciousness, environmental awareness, or sustainability-related behavior among university students. Exclusion criteria included duplicate records, articles lacking abstracts, studies with limited substantive relevance to the research objectives, and those not meeting minimum quality standards. The selection process followed the PRISMA stages of identification, screening, eligibility assessment, and final inclusion, resulting in 24 articles retained for in-depth analysis. This systematic procedure allows for a comprehensive mapping of research trends while identifying key patterns and gaps in the literature (Uleanya et al., 2024; Nguyen et al., 2025).

Data extraction was conducted using a structured data extraction form designed to capture the primary variables of interest, including the conceptual dimensions of sustainability consciousness (knowledge, attitudes, and behavior), determinant factors, and the interrelationships among these dimensions. The analytical framework was informed by established theoretical models, including the Knowledge–Attitude–Behavior (KAB) framework, the Theory of Planned Behavior (TPB), and the Education for Sustainable Development (ESD) paradigm, which were used to guide data categorization and interpretation (Agu et al., 2022; Malandrakis, 2022; Murzyn et al., 2025). Additionally, the Sustainability Consciousness Questionnaire (SCQ) was considered as a reference instrument, given its widespread application in prior studies for integrated measurement of sustainability consciousness (Ariza et al., 2021).

The data collection procedure involved a systematic keyword-based search strategy using terms such as “sustainability consciousness in higher education,” “environmental awareness among university students,” and related expressions within the Scopus database. Retrieved records were initially screened based on titles and abstracts, followed by a full-text eligibility assessment to determine their alignment with the predefined inclusion criteria. Each eligible article was subsequently subjected to detailed examination to extract relevant findings addressing the research questions. This process was conducted iteratively to ensure consistency, reliability, and accuracy in the extracted data.

Data analysis was performed using a combination of thematic analysis and narrative synthesis. Thematic analysis enabled the categorization of findings into key themes corresponding to the conceptual dimensions of sustainability consciousness, determinant factors, and the relationships among these dimensions. Narrative synthesis was subsequently employed to integrate and interpret these findings across studies, allowing for the identification of recurring patterns and divergences in the literature. In addition, a gap analysis was conducted to examine inconsistencies between knowledge, attitudes, and behavior, particularly in relation to the knowledge–action and attitude–behavior gaps reported in prior studies (Murzyn et al., 2025; Wang et al., 2025). Cross-study comparison further facilitated the identification of convergent and divergent evidence, thereby strengthening the interpretative depth of the analysis. The synthesized findings were then structured into a coherent narrative to address each research question. Through this approach, the study provides not only a descriptive overview but also an explanatory understanding of the relationships among the investigated variables. Accordingly, the methodological framework adopted in this study ensures validity, reliability, and reproducibility, supporting its applicability in future research contexts.

RESULTS

Conceptual Characteristics of Students' Sustainability Consciousness

The synthesis of the selected studies indicates that students' sustainability consciousness is consistently conceptualized as a multidimensional construct comprising three core dimensions: knowledge (knowingness), attitudes, and behavior (Ariza et al., 2021; Uleanya et al., 2024). The knowledge dimension encompasses students' understanding of sustainability-related issues, including climate change, environmental degradation, and socio-economic aspects of sustainable development. The attitudinal dimension reflects value orientations, environmental concern, and ethical responsibility toward sustainability issues, whereas the behavioral dimension represents the extent to which sustainability principles are translated into daily practices, such as waste management, sustainable consumption, and participation in environmental initiatives.

Across the reviewed studies, these dimensions are consistently described as interrelated and collectively forming an integrated system of sustainability awareness (Torres et al., 2023). Measurement approaches, particularly the use of instruments such as the Sustainability Consciousness Questionnaire (SCQ), further support the simultaneous operationalization of these dimensions within a unified analytical framework (Ariza et al., 2021). However, notable variation is observed in the level of attainment across dimensions, with knowledge generally

reported at higher levels compared to behavior. Attitudes tend to occupy an intermediate position, suggesting that the internalization of sustainability values remains incomplete. These findings highlight that, while the conceptual structure of sustainability consciousness is relatively stable across studies, its empirical manifestation exhibits dimension-specific disparities.

Table 1. Summary of conceptual dimensions, determinants, and relationships in students' sustainability consciousness

No	Main Aspect	Sub-aspect	Key Findings	Sources
1	Conceptual Dimensions	Knowledge	Students demonstrate an understanding of sustainability issues, including climate change and environmental challenges	Ariza et al., 2021; Uleanya et al., 2024
		Attitudes	Students exhibit concern and value orientations toward environmental issues	Torres et al., 2023
		Behavior	Actual sustainable behavior remains lower than knowledge levels	Ariza et al., 2021
		Dimension integration	The three dimensions are interconnected within an integrated awareness system	Torres et al., 2023
2	Internal Factors	Environmental literacy	Environmental literacy is positively associated with sustainability awareness	(Incesu & Yas, 2024)
		Knowledge	Knowledge influences attitudes and risk perception	Yilmaz et al., 2022
		Type of knowledge	Action-oriented knowledge has a stronger influence on behavior than system knowledge	Wang et al., 2025
		Values and attitudes	Pro-environmental values contribute to higher sustainability awareness	Yilmaz et al., 2022
3	External Factors	Education	Environmental education enhances awareness and responsibility	(Aldawsari et al., 2025)
		SDGs curriculum	Integration of SDGs promotes sustainable behavior	Al Husban, 2025
		Campus environment	University-related factors have a stronger influence than family factors	Nguyen et al., 2025
		Pedagogy	Active learning approaches increase student awareness	Lin et al., 2022
4	Dimensional Relationships	Technology	Educational technology enhances attitudes and awareness	Bhang & Huh, 2023
		Knowledge → Attitudes	Knowledge influences students' attitudes	Murzyn et al., 2025
		Attitudes → Behavior	Attitudes do not always translate into actual behavior	Moody-Marshall, 2022
		Awareness → Behavior	Awareness influences behavior through mediating variables	Yilmaz et al., 2022
5	Gaps	Dynamic relationships	Relationships among dimensions are non-linear	Torres et al., 2023
		Knowledge–action gap	High knowledge levels are not always followed by behavior	Murzyn et al., 2025
		Attitude–behavior gap	Attitudes are not always consistent with actions	(Bauerné Gáthy et al., 2022)

6	Role of Education	Low practice	Students' sustainable behavior remains relatively low	Moody-Marshall, 2022
		Contributing factors	Social norms, habits, and infrastructure influence the gap	Nguyen et al., 2025
		ESD	ESD-based education improves sustainability consciousness	Malandrakis, 2022
		Student engagement	Student engagement mediates sustainability awareness	Luo & Wang, 2025
		Experiential learning	Direct experience enhances awareness and behavior	Lin et al., 2022
		Reflective learning	Reflection strengthens environmental connection and behavior	(Porter & Couper, 2023)

Internal Determinants of Sustainability Consciousness

The analysis reveals that internal factors constitute key determinants shaping students' sustainability consciousness. These include environmental literacy, knowledge, values, attitudes, and individual perceptions of sustainability-related risks (Incesu & Yas, 2023; Yilmaz et al., 2022). Higher levels of environmental literacy are consistently associated with increased awareness of sustainability issues, particularly climate change. Knowledge plays a dual role by directly enhancing awareness and indirectly influencing behavior through the formation of attitudes and risk perceptions.

Importantly, the type of knowledge appears to be a critical factor. Practical or action-oriented knowledge has been shown to exert a stronger influence on behavior compared to abstract or theoretical knowledge (Wang et al., 2025). In addition, pro-environmental values and moral orientations significantly contribute to shaping positive attitudes toward sustainability. Mediating variables, such as perceived responsibility and risk awareness, further influence the translation of knowledge into behavior (Yilmaz et al., 2022). These findings suggest that internal determinants operate through complex, multi-layered mechanisms rather than direct linear pathways.

External Determinants of Sustainability Consciousness

In addition to internal factors, external determinants play a substantial role in shaping sustainability consciousness. These include educational systems, curriculum design, campus environment, and learning experiences (Aldawsari et al., 2025; Nguyen et al., 2025; Lin et al., 2022). The integration of sustainability concepts within curricula, particularly through Education for Sustainable Development (ESD) and the Sustainable Development Goals (SDGs), has been shown to significantly enhance both awareness and behavioral engagement (Al Husban, 2025).

Institutional context also emerges as a critical factor. University environments, including policies, infrastructure, and campus culture, have a stronger influence on students' sustainability behavior than familial or external social contexts (Nguyen et al., 2025). Furthermore, pedagogical approaches play a decisive role, with active and participatory learning methods demonstrating greater effectiveness in fostering sustainability consciousness compared to traditional instructional approaches (Luo & Wang, 2025). The incorporation of digital technologies, including immersive and interactive tools, further enhances student engagement and attitudinal development (Bhang & Huh, 2023). Overall, external determinants function as enabling or constraining conditions that shape the development and expression of sustainability consciousness.

Interrelationships Among Knowledge, Attitudes, and Behavior

The relationship among the three dimensions of sustainability consciousness is found to be complex, dynamic, and context-dependent. While the Knowledge–Attitude–Behavior (KAB) model posits a sequential relationship in which knowledge influences attitudes and subsequently behavior, empirical findings suggest that this pathway is not consistently linear (Murzyn et al., 2025). High levels of knowledge do not necessarily lead to corresponding behavioral outcomes, and positive attitudes do not always translate into action.

Several studies indicate that the relationship between awareness and behavior is mediated by additional variables, such as environmental connectedness, perceived responsibility, and risk perception (Yilmaz et al., 2022; Torres et al., 2023). These mediating mechanisms highlight the importance of considering sustainability consciousness as a dynamic system rather than a simple causal chain. Consequently, the interaction among dimensions is better understood as a network of reciprocal influences shaped by contextual and individual factors.

Knowledge–Attitude–Behavior Gap

A central finding across the reviewed literature is the persistent presence of a gap between knowledge, attitudes, and behavior, commonly referred to as the knowledge–action gap or attitude–behavior gap. Despite relatively high levels of awareness and positive attitudes, students' engagement in sustainable practices remains comparatively low (Murzyn et al., 2025; Moody-Marshall, 2022). This discrepancy is consistently reported across diverse research contexts, indicating its structural nature. Multiple factors contribute to this gap, including social norms, habitual behaviors, limited access to supportive infrastructure, and insufficient experiential learning opportunities (Nguyen et al., 2025). Furthermore, the nature of knowledge

plays a crucial role, as practical and experiential knowledge is more effective in promoting behavioral change than purely theoretical understanding (Wang et al., 2025). These findings underscore that behavioral transformation requires not only cognitive awareness but also supportive environments and experiential engagement. The persistence of this gap highlights a critical limitation in current sustainability education approaches.

Role of Education and Pedagogical Interventions

Education emerges as a pivotal factor in enhancing sustainability consciousness and bridging the knowledge–behavior gap. The integration of sustainability into curricula, particularly through ESD frameworks, has been shown to significantly improve both awareness and behavioral outcomes (Aldawsari et al., 2025; Malandrakis, 2022). Active learning strategies, including action-oriented and experiential learning, are particularly effective in fostering deeper engagement and facilitating the internalization of sustainability values (Lin et al., 2022). Student engagement plays a mediating role in this process, linking educational interventions to enhanced sustainability consciousness (Luo & Wang, 2025). Additionally, reflective learning approaches have been shown to strengthen the connection between knowledge and behavior by promoting critical thinking and personal relevance (Porter & Couper, 2021). The incorporation of technology further enhances learning effectiveness by providing interactive and immersive experiences (Bhang & Huh, 2023). The integration of SDGs into educational programs also contributes to the development of sustainable behaviors (Al Husban, 2025).

Collectively, these findings demonstrate that educational strategies must move beyond knowledge transmission toward experiential, participatory, and context-sensitive approaches to effectively promote sustainability consciousness. Such strategies are essential for addressing the persistent gap between awareness and action and for fostering long-term behavioral change.

DISCUSSION

Conceptual Characteristics and Dimensions of Sustainability Consciousness

The findings of this study confirm that students' sustainability consciousness is consistently conceptualized as a multidimensional construct comprising knowledge, attitudes, and behavior. These dimensions represent the cognitive, affective, and behavioral components of sustainability awareness and collectively form an integrated system (Ariza et al., 2021; Uleanya et al., 2024). The knowledge dimension extends beyond environmental understanding to include broader sustainability literacy encompassing social and economic aspects, while

attitudes reflect value orientation and ethical responsibility. Behavior, in turn, represents the practical manifestation of these dimensions, although it is consistently reported at a lower level.

The observed imbalance among dimensions reinforces previous findings that knowledge does not automatically translate into behavior (Ariza et al., 2021). Attitudes appear to function as an intermediary construct; however, their mediating role remains inconsistent. Furthermore, the integration of theoretical frameworks such as the Knowledge–Attitude–Behavior (KAB) model, Theory of Planned Behavior (TPB), and Education for Sustainable Development (ESD) highlights the non-linear and dynamic nature of sustainability consciousness (Agu et al., 2022; Malandrakis, 2022; Murzyn et al., 2025). These findings emphasize that sustainability consciousness should be understood as a complex and integrative construct requiring holistic analytical approaches. From a disciplinary perspective, particularly in chemistry education, these findings highlight the need to extend learning beyond cognitive understanding toward affective and behavioral dimensions. Sustainability-related topics such as climate change, pollution, and waste management provide relevant contexts for embedding sustainability consciousness within chemistry curricula.

Determinant Factors Influencing Sustainability Consciousness

The results indicate that sustainability consciousness is shaped by the interaction of internal and external factors. Internal determinants including environmental literacy, knowledge, values, and individual perceptions play a foundational role in shaping awareness (Incesu & Yas, 2023; Feijoo & Moreira, 2020). However, their influence on behavior is indirect and often mediated by risk perception and personal responsibility. Notably, the distinction between types of knowledge is critical, as action-oriented knowledge has a stronger impact on behavior than theoretical knowledge (Aikowe & Mazancova, 2023).

External determinants, particularly educational factors, emerge as dominant influences. The role of higher education institutions is especially significant, as university environments exert a stronger influence on students' behavior than family contexts (Nguyen et al., 2025). Curriculum integration, particularly through ESD and SDGs frameworks, significantly enhances sustainability awareness and behavioral engagement (Aldawsari et al., 2025; Al Husban, 2025). Additionally, pedagogical approaches such as action-oriented and experiential learning, as well as student engagement, play a mediating role in strengthening sustainability consciousness (Lin et al., 2022; Luo & Wang, 2025). The use of technology further supports attitudinal development and awareness (Bhang & Huh, 2023).

These findings suggest that sustainability consciousness is not solely an individual attribute but is strongly influenced by institutional and contextual factors. In chemistry education, this implies the need for contextualized, problem-based learning approaches that connect chemical concepts with real-world sustainability issues.

Interrelationships and Gap Patterns

The relationship among knowledge, attitudes, and behavior is found to be complex and non-linear. While theoretical models suggest a sequential relationship, empirical findings reveal persistent gaps, particularly the knowledge–action gap and attitude–behavior gap (Murzyn et al., 2025; Moody-Marshall, 2022). High levels of awareness do not consistently translate into sustainable behavior, indicating limitations in knowledge-based educational approaches. The study further identifies that attitudes do not always function as effective mediators, as positive attitudes may coexist with unsustainable practices (Gáthy et al., 2022). The relationship among dimensions is influenced by mediating factors such as social norms, habits, and experiential learning (Lin et al., 2022). Additionally, environmental connectedness and emotional engagement play important roles in strengthening behavioral outcomes (Yilmaz et al., 2023; Torres et al., 2023; Porter & Couper, 2021).

These findings highlight that sustainability consciousness operates as a dynamic system influenced by contextual and experiential factors. In the context of chemistry education, this underscores the importance of integrating experiential and reflective learning approaches to bridge the gap between knowledge and behavior.

Significance and Contributions

This study contributes to the advancement of sustainability consciousness research by integrating conceptual dimensions, determinant factors, and interrelationships within a unified analytical framework. It extends existing theoretical models by emphasizing the non-linear and dynamic nature of sustainability consciousness and provides empirical support for the persistence of the knowledge–behavior gap. Practically, the study offers insights for designing more effective educational strategies, particularly in integrating sustainability into disciplinary contexts such as chemistry education. The findings suggest that contextual, experiential, and participatory learning approaches are essential for fostering meaningful behavioral change.

Implications

The implications of this study are both theoretical and practical. Theoretically, it reinforces the importance of a multidimensional approach in understanding sustainability consciousness. Practically, it highlights the need for holistic, context-based, and experience-driven educational strategies. Institutions are encouraged to create learning environments that actively support sustainable practices. In chemistry education, this implies integrating sustainability concepts into curricula and adopting active learning approaches that connect theory with real-world applications.

CONCLUSION

This study confirms that students' sustainability consciousness is a multidimensional construct comprising knowledge, attitudes, and behavior that interact in a dynamic and non-linear manner. The findings reveal a persistent imbalance in which knowledge levels are relatively high, while behavioral implementation remains limited, indicating a significant knowledge–action gap. Furthermore, sustainability consciousness is shaped by the interaction of internal factors (e.g., environmental literacy and individual values) and external factors (e.g., educational context, curriculum integration, and pedagogical approaches). These results highlight that enhancing sustainability consciousness requires holistic and context-sensitive educational strategies that go beyond knowledge acquisition to promote meaningful behavioral change.

Several limitations should be acknowledged. First, the reliance on a systematic literature review means that findings depend on the scope and quality of selected studies. Second, the dominance of cross-sectional research limits insights into longitudinal changes (Luo & Wang, 2025; Wang et al., 2025). Third, contextual variability may affect generalizability. Finally, mediating and moderating variables remain insufficiently explored. Despite these limitations, this study provides a comprehensive synthesis and establishes a foundation for future research exploring sustainability consciousness in more diverse and dynamic contexts.

RECOMMENDATIONS

It is therefore recommended that the development of students' sustainability consciousness be more strongly emphasized within the context of chemistry education, given its direct relevance to key sustainability issues such as climate change, environmental pollution, energy, and waste management. Chemistry educators are encouraged to systematically integrate the principles of Education for Sustainable Development (ESD) and the Sustainable Development

Goals (SDGs) into curricula and instructional practices, as these approaches have been shown to enhance both awareness and sustainable behavior. Furthermore, chemistry learning should be designed using active, contextual, and experiential approaches such as action-oriented learning that enable students to engage directly with real-world environmental problems, thereby reducing the knowledge–action gap. The incorporation of educational technologies can also support the development of conceptual understanding while fostering students' attitudes and awareness toward sustainability issues. In addition, future research is recommended to adopt more diverse methodological approaches, including mixed methods and longitudinal designs, in order to capture the dynamic nature of sustainability consciousness. Greater attention should also be given to mediating variables such as learning experiences, campus culture, and student engagement. Accordingly, chemistry education should not be limited to the transmission of scientific knowledge but should be positioned as a strategic platform for fostering sustainable attitudes and behaviors through holistic, applied, and context-relevant learning experiences.

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