

Rethinking Awareness-Based Interventions in the Circular Economy: Lessons from School-Based Waste Segregation

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Abstract

This perspective challenges the prevailing reliance on awareness-based interventions in circular economy (CE) initiatives by demonstrating limited effectiveness in producing sustained behavioral change. Empirical insights from a school-based waste segregation study in Thailand reveal a persistent knowledge–action gap and underscore the critical role of contextual and institutional factors in shaping behavioral outcomes. Awareness alone is insufficient and may misdirect intervention design. Building on the Theory of Planned Behavior (TPB), the proposed framework extends TPB by incorporating institutional and infrastructural conditions as active determinants of behavior and advances a system-oriented design that integrates infrastructure, social norms, and institutional reinforcement. This perspective contributes to CE implementation by shifting the focus from individual cognition to embedded behavioral systems.

Keywords Circular Economy · Waste Segregation · Environmental Awareness · School-based Interventions · Pro-environmental Behavior · Theory of Planned Behavior

1. Introduction

Despite the increasing prominence of circular economy (CE) principles in global sustainability agendas, many interventions continue to rely heavily on awareness-raising strategies to promote pro-environmental behavior. Educational campaigns (Abrahamse et al., 2005; McKenzie-Mohr, 2011), training workshops (Ardoin et al., 2020; Monroe et al., 2019), and communication materials (Schultz, 2014; Steg and Vlek, 2009) are widely implemented under the assumption that increased knowledge will translate directly into improved environmental practices. However, empirical evidence increasingly suggests that awareness alone is insufficient to produce sustained behavioral change, particularly in complex institutional settings (Kirchherr et al., 2017; Geissdoerfer et al., 2017; Ghisellini et al., 2016).

This limitation reflects the well-documented “knowledge–action gap” in environmental behavior research, where individuals with adequate environmental awareness do not consistently engage in corresponding pro-environmental actions (Kollmuss and Agyeman, 2002; Vicente-Molina et al., 2013). While awareness contributes to shaping attitudes, behavioral outcomes are also heavily contingent upon contextual and structural factors, including social norms, institutional support, and perceived behavioral control. These dynamics are central to the Theory of Planned Behavior (TPB), which emphasizes that behavior is determined not solely by knowledge, but also by a combination of cognitive, social, and environmental determinants (Ajzen, 1991; Steg and Vlek, 2009).

Drawing on insights from a school-based waste segregation study conducted among lower secondary school students in Thailand (Phothisawang et al., 2026), this perspective argues that circular economy interventions must move beyond awareness-based approaches toward system-oriented strategies that embed behavior within institutional contexts. The study examined awareness and waste segregation behavior across different

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intervention formats and school environments, providing empirical insights into the limitations of information-centered approaches in promoting sustained pro-environmental behavior. By rethinking the cognitive foundations of behavior change, this article contributes to ongoing discussions regarding the design of more effective and scalable interventions for advancing circular economy practices. Specifically, this perspective proposes a system-oriented framework that integrates the cognitive, social, and institutional dimensions of behavior within CE implementation. Unlike conventional applications of the Theory of Planned Behavior, this perspective conceptualizes institutional and infrastructural conditions not as passive contextual variables, but as active enabling mechanisms that directly shape behavioral performance within circular economy systems.

2. The Limits of Awareness-Based Interventions

Awareness-based interventions have long served as a cornerstone of environmental education and policy. These approaches implicitly assume a linear progression in which knowledge acquisition predictably translates into behavioral change. However, a substantial body of empirical research challenges this assumption, demonstrating that increased environmental awareness does not consistently translate into pro-environmental behavior. This limitation is further reflected in the observation that, despite the availability of numerous intervention tools, their effectiveness depends on how well they are aligned with behavioral mechanisms and contextual conditions (Schultz, 2014).

This discrepancy is widely conceptualized as the knowledge–action gap, whereby individuals with a clear understanding of environmental issues fail to act accordingly due to competing priorities, habitual patterns, or contextual constraints. Within the framework of the Theory of Planned Behavior (TPB), awareness contributes primarily to the formation of behavioral beliefs and attitudes. Yet, actual behavior is also shaped by subjective norms (e.g., social expectations) and perceived behavioral control (e.g., access to facilities and resources). In line with this, prior research highlights that pro-environmental behavior is strongly influenced by social norms, habits, and situational contexts rather than information alone (Schultz, 2014).

As a result, interventions that rely predominantly on awareness-raising may improve knowledge and attitudes but often yield only limited behavioral outcomes. This limitation is particularly evident in institutional environments, where behavior is structured by routines, physical infrastructure, and social interactions. Consequently, recognizing the limits of awareness-based approaches is essential for designing more effective circular economy interventions that account for the broader system conditions shaping behavior.

3. Insights from School-Based Waste Segregation

This perspective draws on insights from a recent school-based waste segregation study conducted among lower secondary school students in Phitsanulok Province, Thailand (Phothisawang et al., 2026). The study employed a comparative intervention design involving multiple awareness-based activity formats, including workshops, printed media, video-based learning, and game-based activities. Awareness and behavioral outcomes related to waste segregation were assessed across intervention and control groups to examine the effectiveness of awareness-centered approaches in promoting pro-environmental behavior within school settings. The school setting was selected because it provides a structured institutional environment in which behavioral practices, social norms, and reinforcement mechanisms can be systematically observed.

The findings from these school-based waste segregation initiatives provide a robust empirical foundation for rethinking awareness-driven approaches in circular economy interventions. As synthesized in Table 1, the findings demonstrate that awareness alone has limited explanatory power, while behavioral outcomes are predominantly shaped by contextual and system-level determinants.

First, consistent with the “limited effect of awareness alone” and “weak awareness–behavior relationship” identified in Table 1, increases in awareness are not matched by proportional improvements in behavioral outcomes. Although educational interventions enhance knowledge and attitudes, their impact on actual waste segregation practices remains moderate and weakly correlated. This pattern reinforces the view that informational interventions alone are insufficient to sustain long-term behavioral change (Kollmuss and Agyeman, 2002; Vicente-Molina et al., 2013).

Second, as reflected in the “improvement in control group” insight, behavioral gains are observed even among students who do not directly participate in structured interventions. This suggests that pro-environmental practices emerge through broader social and institutional dynamics within the school environment, including peer interaction, informal learning, and information diffusion. Such system-wide effects align with prior research emphasizing the role of social influence and contextual factors in shaping pro-environmental behavior (Abrahamse and Steg, 2013; Steg and Vlek, 2009).

Third, the “similar outcomes across activity formats” further indicates that the mode of awareness delivery—whether through workshops, media, video, or games—is less influential than the surrounding implementation context. Instead, factors such as consistent supervision, student engagement, and integration into school routines exert a stronger influence on behavior, highlighting the importance of institutional embedding over intervention format.

Beyond these observations, Table 1 underscores the “strong role of school context” and the “importance of infrastructure and support” as key enabling conditions. Institutional factors—such as rules, supervision, and organizational culture—interact with physical infrastructure, including clearly labeled waste bins and accessible collection systems, to facilitate behavioral execution. These conditions enhance perceived behavioral control and enable the translation of intention into action (Ajzen, 1991; Steg and Vlek, 2009).

Table 1. Synthesized insights from school-based waste segregation interventions and their implications for circular economy implementation (Source: Synthesized from Phothisawang et al. (2026) and authors’ analysis.)

Key Insight	Empirical Observation	Interpretation	Implications for Circular Economy Interventions
Limited effect of awareness alone	Awareness scores increased significantly, while behavior improvements remained moderate and weakly correlated	Confirms the “knowledge–action gap”; awareness is a necessary but insufficient condition for sustaining pro-environmental practices	Interventions should extend beyond information provision to incorporate behavioral and structural support mechanisms
Improvement in control group	The control group showed significant gains in both awareness and behavioral outcomes	Indicates that behavioral outcomes are shaped by contextual dynamics, including peer interaction, informal learning, and information diffusion	CE strategies should account for system-wide effects and avoid attributing outcomes solely to discrete intervention programs
Similar outcomes across activity formats	No significant differences were observed across workshops, printed media, video-based learning, and game-based approaches	Suggests that the delivery format is less influential than the surrounding institutional context	Priority should shift from diversifying formats to strengthening implementation conditions (e.g., consistency, engagement, and supervision)
Strong role of school context	School-level variation significantly influenced behavioral outcomes	Demonstrates that institutional factors (e.g., rules, supervision, and organizational culture) are primary determinants of behavior	CE interventions should be embedded within institutional systems rather than implemented as standalone initiatives
Weak awareness–behavior relationship	The correlation between awareness and behavioral outcomes was weak (small effect size)	Indicates that behavior is mediated by social norms and perceived behavioral control (PBC)	Interventions should target social and structural drivers alongside cognitive factors
Importance of infrastructure and support	Waste segregation performance improved in settings with adequate bins, supervision, and established routines	Highlights the enabling role of physical and organizational conditions in facilitating the translation of environmental intention into practice	Investment in infrastructure and routine-based systems is critical for effective CE implementation
Evidence of behavioral spillover	Students influenced peers and potentially extended behaviors to households	Suggests that behavioral practices can diffuse through social networks beyond the initial intervention group	Schools can function as upstream nodes in circular economy systems, amplifying broader societal impact
Need for reinforcement mechanisms	Sustained behavioral outcomes were associated with monitoring, feedback, and routine integration	Indicates that behavioral consistency requires continuous reinforcement rather than one-time intervention	CE programs should incorporate feedback systems, monitoring mechanisms, and long-term engagement strategies

Behavioral outcomes are further mediated by social norms and perceived control, resulting in a weak direct relationship between awareness and behavior. This reinforces the view that pro-environmental behavior emerges from the interaction of cognitive, social, and structural factors rather than from awareness alone (Ajzen, 1991).

Evidence of “behavioral spillover” suggests that pro-environmental practices can diffuse through social networks, with students influencing peers and potentially extending behaviors to households and communities. This positions schools as upstream nodes within broader circular economy systems, where localized behavioral change can generate wider societal impact (Thøgersen and Ölander, 2003; Abrahamse and Steg, 2013).

Finally, the “need for reinforcement mechanisms” highlights that sustained behavioral outcomes depend on continuous support, including monitoring, feedback, and the integration of practices into daily routines. Without such reinforcement, behavioral gains are unlikely to persist over time (Steg and Vlek, 2009).

Taken together, the insights summarized in Table 1 indicate that waste segregation behavior does not emerge directly from awareness alone but from the interaction of cognitive, social, and institutional factors. These findings reinforce the need for circular economy interventions to move beyond awareness-based approaches toward system-oriented strategies that integrate behavioral, social, and structural dimensions.

4. Rethinking Circular Economy Interventions: From Awareness to Systems

The findings discussed above call for a fundamental shift in how behavioral interventions are conceptualized within circular economy (CE) implementation. Rather than treating awareness as the primary driver of pro-environmental behavior, this perspective argues that behavior should be understood as an outcome of embedded system conditions. This shift reframes environmental cognition as one component within a broader socio-institutional system shaping pro-environmental practices.

Building on the Theory of Planned Behavior (TPB), this perspective extends the framework by explicitly incorporating institutional and infrastructural conditions as active determinants of behavior. While TPB conceptualizes behavior as a function of attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991), it largely treats contextual factors as background conditions influencing these mediators. In contrast, the framework proposed here conceptualizes institutional structures (e.g., rules, supervision, organizational routines) and physical infrastructure (e.g., waste segregation facilities) as integral components that directly shape behavioral performance and practice.

This perspective makes two key contributions. First, it provides an empirically grounded explanation of why awareness-based interventions often fail in real-world institutional settings. Evidence from school-based waste segregation demonstrates that awareness does not translate directly into action due to constraints related to infrastructure, social norms, and institutional practices. By situating behavior within these interacting conditions, this perspective advances the understanding of the knowledge–action gap beyond individual cognition.

Second, it advances a system-oriented conceptual framework for CE interventions that integrates cognitive, social, and structural dimensions of behavior. In this framework, awareness influences attitudes and intentions, but behavioral outcomes are mediated and enabled by social norms, perceived behavioral control, and, critically, institutional and infrastructural conditions. Reinforcement mechanisms—such as monitoring, feedback, and routine integration—are further incorporated as dynamic processes that sustain behavior over time.

Unlike conventional TPB applications, which often focus on predicting individual behavior, the proposed framework emphasizes the design of enabling systems that make pro-environmental behavior more likely to occur and persist. This shift from prediction to intervention design is particularly important in CE contexts, where sustained behavioral change depends on alignment between individual intentions and enabling institutional conditions.

Figure 1 illustrates this extended framework. Awareness is positioned as a cognitive input influencing attitudes and behavioral intentions, but its effect on behavior is indirect. Behavioral outcomes emerge from the interaction between mediating factors (subjective norms and perceived behavioral control) and system-level conditions (institutional context and infrastructure). Reinforcement mechanisms operate across these levels to stabilize behavior over time.

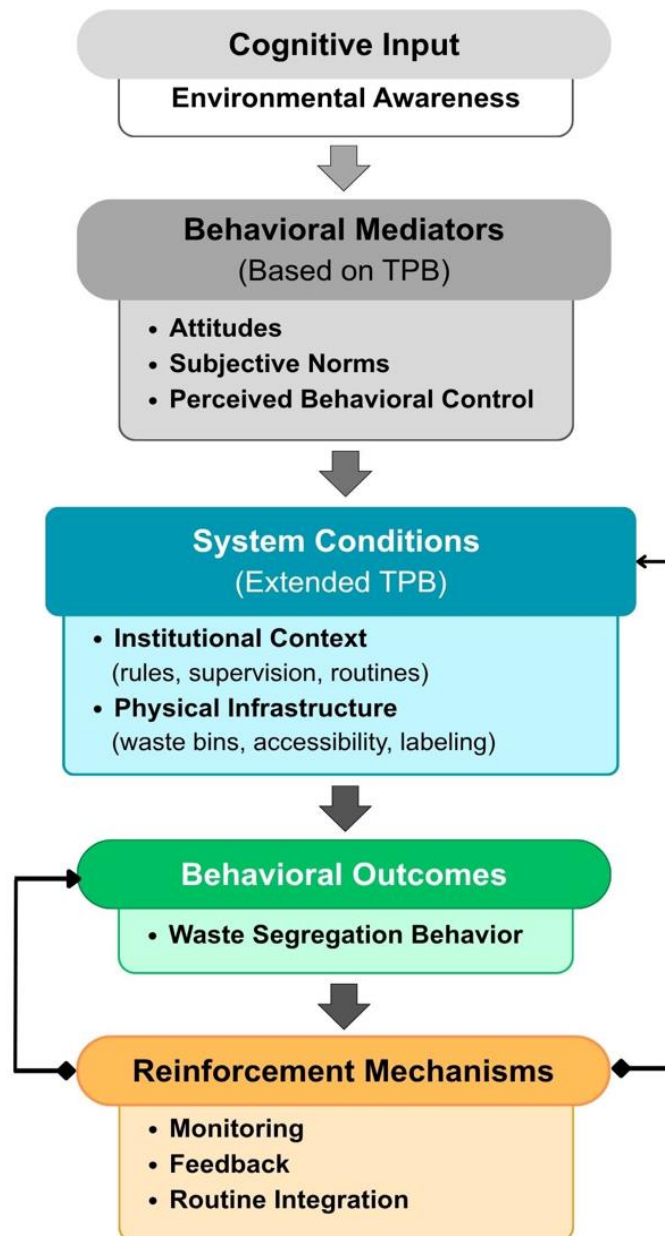


Figure 1. Extended TPB-based framework showing how system conditions and reinforcement mechanisms shape pro-environmental behavior in circular economy contexts.

From a circular economy perspective, this reconceptualization has important implications. CE implementation requires not only informed individuals but also environments that enable consistent action. By embedding behavior within institutional systems and material infrastructures, interventions can move beyond short-term awareness gains toward sustained and scalable behavioral change. This perspective therefore contributes to CE research by bridging behavioral theory and system design, offering a more robust foundation for real-world intervention strategies.

5. Policy Implications

The implications of this perspective extend across multiple stakeholders involved in circular economy (CE) implementation. For schools, the findings highlight the importance of embedding waste segregation practices into daily routines rather than relying on one-time awareness campaigns. Institutionalizing such practices

through consistent supervision, clear rules, and teacher engagement can enhance behavioral consistency and long-term adoption.

At the same time, effective routine integration should balance formal institutional mechanisms with opportunities for informal peer learning. While clear rules, supervision, and structured waste segregation practices help establish behavioral consistency, peer interaction and student-led participation can further strengthen social diffusion and behavioral spillover. Schools may therefore benefit from combining formal monitoring systems with collaborative activities, peer role models, and student-led environmental initiatives that normalize pro-environmental behavior through everyday social interaction.

For local governments, providing appropriate infrastructure—such as accessible and well-labeled waste segregation systems—and aligning school-based initiatives with municipal waste management policies are critical for improving intervention effectiveness. In this context, schools can function as upstream nodes within CE systems, influencing not only students but also households and surrounding communities.

At the policy level, these findings suggest that environmental education should be integrated with practice-based and behavior-oriented approaches within formal curricula. Policies that prioritize awareness alone may be insufficient if not supported by enabling system conditions. Therefore, effective CE policy design should combine educational efforts with institutional support, infrastructure provision, and mechanisms for ongoing reinforcement.

6. Future Research Directions

Future research should further examine the interaction between cognitive and contextual factors in shaping pro-environmental behavior within institutional settings. Advanced analytical approaches, such as multilevel modeling, are particularly relevant for capturing the influence of school-level and system-level conditions.

Longitudinal studies are needed to assess the durability of behavioral change and to understand how reinforcement mechanisms contribute to behavior maintenance over time. In addition, further investigation into social diffusion processes could provide valuable insights into how pro-environmental behaviors spread across peer networks, households, and communities.

Finally, future work could refine and empirically test the proposed system-oriented framework across different contexts, thereby strengthening its generalizability and contribution to circular economy research and behavioral theory.

7. Conclusion

While awareness remains an important component of environmental education, it is insufficient on its own to drive sustained behavioral change. Evidence from school-based waste segregation initiatives demonstrates that behavior is shaped by the interaction of cognitive, social, and institutional factors.

This perspective highlights the need to move beyond awareness-based interventions toward system-oriented approaches that embed behavior within enabling environments. By extending behavioral theory to explicitly incorporate institutional and infrastructural conditions, this study provides a more comprehensive framework for understanding and designing circular economy interventions.

Ultimately, the effectiveness of circular economy initiatives depends not on how much individuals know, but on how well systems enable and sustain their ability to act.

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Declarations

Competing Interests The authors declare no competing interests.

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