Scientific Research Publishing

Advances in Applied Sociology, 2026, 16(9), 653-687
https://www.scirp.org/journal/aasoci
ISSN Online: 2165-4336
ISSN Print: 2165-4328

Translating Ecological Civilization Literacy into Behavior: A Developmental Alignment Framework across Educational Stages

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How to cite this paper: Liu, L. M. (2026). Translating Ecological Civilization Literacy into Behavior: A Developmental Alignment Framework across Educational Stages. *Advances in Applied Sociology, 16,* 653-687.
https://doi.org/10.4236/aasoci.2026.169039

Received: July 19, 2026
Accepted: September 13, 2026
Published: September 16, 2026

Abstract

A central challenge for ecological civilization education (ECE) is translating students' ecological knowledge, affective dispositions, and awareness into autonomous, sustained, and developmentally appropriate ecological civilization behavior. Existing surveys have reported generally favorable responses on several non-behavioral items, alongside distinct response patterns on selected behavior-related items and across educational stages. Taking these descriptive patterns as an empirical point of departure, this conceptual study examines the conditions that shape the translation of ecological civilization literacy into behavior. Drawing on the Model of Responsible Environmental Behavior, Self-Determination Theory, and the action competence approach, the study develops a framework linking literacy foundations, motivational conditions, action-related capabilities, contextual supports, ecological civilization behavior, and behavioral feedback. The framework proposes that behavioral translation may remain incomplete when ecological norms are not sufficiently internalized, ecological understanding is not developed into action-related capabilities, or educational and everyday contexts lack adequate support and feedback. Differences across educational stages may therefore reflect developmental misalignment among these conditions rather than declining ecological civilization literacy. Stage-differentiated ECE should accordingly coordinate motivation, action-related capabilities, contextual support, and feedback rather than merely increase the complexity of ecological knowledge. Because the available evidence is cross-sectional, primarily self-reported, and based on indicators that are not directly comparable across constructs and grades, these propositions require longitudinal, multi-source, and context-sensitive examination.

Keywords

Ecological Civilization Literacy, Ecological Civilization Behavior, Behavioral

Translation, Action Competence, Educational Stages

1. Introduction

Ecological civilization education (ECE) constitutes an important educational foundation for advancing China's ecological civilization strategy and the Beautiful China Initiative. In recent years, national policies have progressively extended the objectives of ECE from the cultivation of ecological awareness and green habits toward age-appropriate educational design, practical participation, and the formation of green and low-carbon behavior. The Opinions of the CPC Central Committee and the State Council on Comprehensively Promoting the Development of a Beautiful China called for incorporating ECE into national education and training systems and strengthening public participation in Beautiful China construction (Central Committee of the Communist Party of China & State Council, 2023). More recently, the Action Plan for Promoting Nationwide Participation in Building a Beautiful China (2026-2030) emphasized educational materials suited to different age groups, opportunities for practical participation, and the formation of green and low-carbon behavior (Ministry of Ecology and Environment et al., 2026). These policy developments indicate that the effectiveness of ECE should be assessed not only by what students know and endorse but also by whether ecological civilization literacy is enacted through autonomous and sustained behavior.

Existing survey findings provide a useful but limited empirical point of departure. Complementary analyses derived from the same dataset of 82,438 valid responses represent dual reports from a single survey rather than evidence from two independent studies (Ma, 2022, 2025). Focal literacy comparisons rely on secondary reporting of generally favorable responses across selected knowledge, affective, and awareness items, item-specific patterns on selected self-reported behavior items, and differences among Grades 4, 7, and 10 (Ma, 2025). Because these indicators represent distinct constructs, and because cross-grade measurement invariance and longitudinal change have not been established, the results cannot be used to rank literacy dimensions or infer individual decline with age. They nevertheless motivate a question posed by the present study: why do non-behavioral dimensions of ecological civilization literacy not necessarily translate into autonomous, sustained, and developmentally appropriate ecological civilization behavior?

Existing research has examined the conceptual development of ECE, its implementation in schools, and the assessment of students' ecological civilization literacy (Chen & Yuan, 2024; Shi et al., 2024; Wang & Jin, 2025). Comparatively little attention has been paid to the educational process through which ecological knowledge, affective dispositions, and awareness are translated into behavior, particularly whether motivational conditions, action-related capabilities, and contex-

tual supports develop in coordination across educational stages. To address this gap, the analysis integrates the Model of Responsible Environmental Behavior, Self-Determination Theory, and the action competence approach to explain the motivational, capability-related, and contextual conditions through which ecological civilization literacy may be enacted as behavior.

1.1. From Environmental Education to Ecological Civilization Education in China: Conceptual Evolution and Cultural Recontextualization

The emergence of ecological civilization education (ECE) has been influenced by the international development of environmental education while remaining rooted in the theory and practice of China's ecological civilization. Early environmental education primarily responded to practical problems such as pollution, resource depletion, and ecological degradation. It subsequently expanded from the dissemination of environmental knowledge to the formation of values, the development of capabilities, and participation in action. The 1977 Intergovernmental Conference on Environmental Education in Tbilisi identified awareness, knowledge, attitudes, skills, and participation as the five objectives of environmental education (UNESCO, 1978). Chapter 36 of Agenda 21, adopted in 1992, identified education, public awareness, and training as important means of promoting sustainable development and strengthening people's capacity to address environmental and developmental issues (United Nations, 1992).

Environmental education (EE) and education for sustainable development (ESD) have provided important intellectual resources for ECE, but neither can be equated directly with ECE as developed within China's particular historical and institutional context. Rather than departing from these traditions, ECE selectively integrates the participatory action orientation of EE and the systemic, intergenerational perspective of ESD. Its distinctive character lies not in narrowing the scope of environmental education, but in explicitly connecting environmental learning with the values, strategic objectives, institutional arrangements, and educational responsibilities of ecological civilization construction in China (Chen & Yuan, 2024).

Chinese scholarship and policy do not simply replicate international environmental education frameworks. Ecological civilization education in China has been described as a historically evolving educational practice shaped by the development of ecological civilization, national policy, and the value orientation of harmonious coexistence between humans and nature (Chen & Yuan, 2024). Assessment indicators have likewise been developed by combining national policy requirements, international frameworks, and traditional ecological ideas such as renmin aiwu, tianren heyi, and the frugal use of resources (Ma, 2025). These sources provide an important Chinese institutional and cultural point of departure, but they do not by themselves demonstrate that concepts developed in Western research have identical meanings or effects in Chinese schools.

Developing a Chinese-contextualized account of ecological civilization education

therefore requires conceptual recontextualization rather than the simple importation of models. In Self-Determination Theory, autonomy refers to volitional endorsement and a sense of ownership, not necessarily independence or resistance to authority (Ryan & Deci, 2020). In the action competence approach, action is conscious, considered, and goal-directed, and is connected to democratic education (Jensen & Schnack, 1997). These constructs remain analytically useful, but their educational expression may depend on interdependence, collective responsibility, institutional authority, and the opportunities available to students. In Chinese schools, autonomy may be expressed through bounded choice, reasoned endorsement, shared responsibility, and meaningful participation in collective and institutional processes rather than through rebellion or unrestricted individual independence. The framework proposed here therefore treats Western theories as sensitizing resources and reinterprets them in relation to Chinese educational conditions; it does not claim to have empirically established a uniquely Chinese model. Such recontextualization is consistent with the broader call to develop autonomous Chinese knowledge systems, but conceptual autonomy must be demonstrated through theoretical and empirical work rather than asserted by terminology alone (Li, 2026).

1.2. From Knowledge Dissemination to Behavioral Development: Policy and Educational Shift

The development of ECE in China is reflected not only in its value foundations but also in the progressive institutionalization of its educational objectives. The Guidelines on Moral Education in Primary and Secondary Schools, issued in 2017, identified ECE as an important component of moral education and called on schools to help students embrace the principles of respecting, adapting to, and protecting nature while cultivating habits of thrift, low-carbon living, and environmental protection (Ministry of Education, 2017). This policy established ecological values and everyday behavioral habits as important educational aims.

Subsequent policies further emphasized curricular integration, differentiated design, and the translation of learning into action. The 2019 Notice on Implementing Xi Jinping Thought on Ecological Civilization and Enhancing Ecological and Environmental Awareness in Primary and Secondary Schools required ecological and environmental education to be integrated into subject teaching, curricular and extracurricular activities, and school management. It also called for strengthening students' capacity for environmental protection and helping them translate what they had learned into voluntary action (General Office of the Ministry of Education et al., 2019). The 2022 Implementation Plan for Building an Education System for Green and Low-Carbon Development further required educational content and teaching methods to be organized in accordance with the psychological characteristics and receptivity of students at different ages, enabling green and low-carbon lifestyles and behavioral habits to develop progressively across educational stages (Ministry of Education, 2022).

The 2023 Opinions of the CPC Central Committee and the State Council on Comprehensively Promoting the Development of a Beautiful China and the 2026 Action Plan for Promoting Nationwide Participation in Building a Beautiful China (2026-2030) further connected school education with nationwide participation in Beautiful China construction (Central Committee of the Communist Party of China & State Council, 2023; Ministry of Ecology and Environment et al., 2026). Together, these policies reveal a progression from value cultivation and behavioral habits toward curricular integration, age-specific design, practical participation, and behavioral development. This progression does not diminish the importance of knowledge education; rather, it redefines knowledge as a foundation for recognizing ecological problems, judging responsibility, selecting action strategies, and participating in practice. The effectiveness of ECE should therefore be examined not only in terms of what students know and endorse, but also in terms of whether they have reasons to act, understand how to act, and receive the support necessary for action to occur and persist. Age-specific design should not be understood as assigning fixed behavioral targets to different grades; rather, it concerns the progressive adjustment of the reasons, capabilities, task complexity, participatory authority, and forms of feedback through which students can take part in ecological action.

1.3. Empirical Point of Departure, Evidence Boundaries, and Research Question

Focal item-level comparisons among students in Grades 4, 7, and 10 provide key empirical insights into cross-stage variations (Ma, 2025). Specifically, the proportions reporting that they "love animals and plants very much" were 69.24%, 68.19%, and 61.55%, respectively; the proportions selecting "very willing" to participate in environmental volunteer activities were 73.80%, 70.02%, and 65.12%; and the proportions reporting that they "always" or "often" picked up litter at school were 86.80%, 82.86%, and 73.91% (Ma, 2025). Because the same questions and response categories were used across the three grades, these percentages can be compared descriptively at the item level. The three items nevertheless concern different constructs and should neither be combined into a common developmental score nor used to rank literacy dimensions. While willingness to volunteer was originally discussed under ecological affect (Ma, 2025), the present study interprets the item's content as a specific behavioral intention. This is a theory-guided analytical reclassification, not a claim about the validated factor structure of the source questionnaire. Without measurement invariance across grades or longitudinal data, these cross-sectional differences do not establish changes in latent constructs or individual developmental decline.

The two publications should be treated as separate reports derived from a single underlying survey dataset, as both identify identical total sample sizes (82,438 valid responses) and matching stage distributions: 33,353 primary, 29,715 lower-secondary, and 19,370 upper-secondary students (Ma, 2022, 2025). Methodologi-

cal descriptions nevertheless differ across reports: one account notes random sampling across all 31 provincial-level administrative regions and the Xinjiang Production and Construction Corps (Ma, 2022), whereas the other describes stratified sampling across Liaoning, Hebei, Guangdong, Inner Mongolia, Hubei, Jiangxi, Sichuan, Guizhou, Shaanxi, and other regions prior to online administration (Ma, 2025). Neither source clarifies how these sampling strategies align or whether random selection occurred within strata. Furthermore, while an urban-rural ratio of approximately 6:4 is noted in earlier documentation (Ma, 2022), neither report details the school-level sampling frame, recruitment procedures, nonresponse handling, or post-stratification weighting. Consequently, the dataset is best characterized as a large multi-region sample rather than a fully documented, nationally representative probability sample.

A more comprehensive description of the survey instrument is provided in subsequent documentation (Ma, 2025). The 58-item instrument comprised 42 literacy items (15 knowledge, 9 affect, 9 awareness, and 9 behavior items), 11 ECE items, and basic demographic questions. Although the report specifies that six knowledge items were multiple-choice while the remaining literacy items used five-point Likert scales, a complete item-by-item scoring scheme for all 58 questions is omitted (Ma, 2025). Psychometric reporting includes an overall Spearman-Brown split-half reliability coefficient of .887 and item factor loadings exceeding .50; however, subscale reliability, grade-specific reliability, and formal tests of measurement invariance across grades are not provided (Ma, 2025). Cross-construct contrasts should therefore not be interpreted as commensurable score differences, and cross-grade results must remain restricted to descriptive item-level comparisons.

Ecological knowledge and ecological awareness should also be distinguished. Ecological knowledge refers to accurate factual and conceptual understanding of ecological systems, environmental problems, and sustainability-related concepts. In the survey, examples included questions concerning biodiversity, green food, greenhouse gases, and renewable resources (Ma, 2025). Ecological awareness refers to recognition of the significance and implications of ecological protection, including the relationship between human actions and the ecological environment. An item asking whether protecting the ecological environment is important therefore functions as an indicator of ecological awareness rather than a factual knowledge item (Ma, 2025; Shi et al., 2024). A student may consequently express strong ecological awareness while still holding incomplete or imprecise ecological knowledge.

Existing Chinese scholarship has developed a substantial body of research on the historical evolution and theoretical construction of ECE, its implementation in schools, and the assessment of students' ecological civilization literacy (Chen & Yuan, 2024). Recent empirical and theoretical studies have extended these areas. A study that developed an assessment model using data from 4,504 students in more than 150 primary schools in Chongqing found that overall ecological civilization

literacy was above the scale midpoint, whereas scores for ecological knowledge and behavior were comparatively lower (Shi et al., 2024). A theoretical study grounded in child and adolescent psychological development proposed cognitive, affective, and behavioral pathways, together with a collaborative intervention framework involving families, schools, and communities (Wang & Jin, 2025). The former study was confined to primary schools and remained focused primarily on assessing levels across different dimensions of literacy, whereas the latter concentrated on the theoretical construction of intervention pathways.

Overall, existing research has clarified the basic content of ECE, described students' literacy profiles, and proposed possible directions for improvement. It has not, however, sufficiently explained how ecological civilization knowledge, affective dispositions, and awareness interact with motivational conditions, action-related capabilities, and external contexts to shape the emergence and persistence of ecological civilization behavior. Whether these conditions develop in coordination as students progress across educational stages has also received insufficient attention. Research must therefore move beyond static comparisons of literacy levels across educational stages to systematically examine the process through which ecological civilization literacy is translated into behavior, including whether the conditions supporting this process remain developmentally appropriate.

"Translation into behavior" does not refer to a mechanical or automatic conversion among the constituent dimensions. It refers to the process through which non-behavioral dimensions—such as ecological civilization knowledge, affective dispositions, and awareness—are enacted through the combined influence of motivational conditions, action-related capabilities, and external contexts. This definition does not presuppose a linear progression from knowledge through affect and awareness to behavior. Knowledge, affective dispositions, and awareness constitute foundations for behavior; whether they are translated into actual action also depends on whether students develop behavioral intentions, acquire appropriate action strategies and skills, and receive sufficient contextual support.

In this analysis, ecological civilization behavior is used as a working concept that overlaps with pro-environmental behavior and responsible environmental behavior in its general action orientation. Within the context of China's ecological civilization, however, it additionally emphasizes students' recognition and assumption of appropriate responsibility for ecological civilization construction, together with collaborative action and age-appropriate public participation within clearly defined institutional and safety boundaries.

For the purposes of this analysis, autonomous behavior means behavior undertaken with self-endorsed reasons and not primarily maintained by immediate prompting, surveillance, or contingent reward. Sustained behavior means repeated enactment across occasions and, where relevant, continuation over an extended period or transfer to related settings. Developmentally appropriate behavior means action that matches students' cognitive and practical capacities, available resources, safety requirements, and legitimate decision-making authority. Possible indica-

tors include initiating an action, explaining why it was selected, continuing it when direct supervision is absent, repeating it across relevant settings, and undertaking only those tasks that students can realistically perform or influence. The survey contains some self-reported behavioral indicators (Ma, 2025), but it does not directly measure prompting, persistence, transfer, or decision-making authority. These criteria therefore guide the conceptual analysis rather than constitute observed outcomes.

On the basis of these definitions, the source-reported item patterns and cross-sectional group differences are used to formulate, rather than predetermine, the analysis; they are not treated as direct evidence of a knowledge-action disjunction or developmental misalignment. The central research question is therefore as follows: Why do non-behavioral dimensions of ecological civilization literacy—including ecological knowledge, affective dispositions, and awareness—not necessarily translate into autonomous, sustained, and developmentally appropriate ecological civilization behavior across educational stages?

Using two publications based on a single large multi-region survey dataset as its empirical point of departure (Ma, 2022, 2025), this conceptual study adopts a problem-driven approach to theoretical integration. Theoretical resources were retained when they clarified one of three functions left underexplained by the survey reports: the internalization of reasons for action, the development of action-related capabilities, or the contextual enactment and feedback of behavior. Accordingly, the study draws on foundational models of responsible environmental behavior and action competence, self-determination research on motivational internalization, and recent meta-analytic, longitudinal, and context-specific studies of children's and adolescents' environmental behavior. These sources are used to identify plausible mechanisms, clarify construct boundaries, and delimit the scope of inference rather than to estimate effects or test a causal model. The analysis then examines whether motivational conditions, action-related capabilities, contextual supports, and behavioral feedback are adjusted in coordination across educational stages and derives corresponding educational implications. Because the raw survey data are not reanalyzed and the literature was not assembled as a systematic review, the proposed mechanisms remain theoretical propositions requiring further empirical examination.

2. Literature Review and Conceptual Framework

The translation of ecological civilization literacy into actual behavior depends both on the conditions required for behavior to occur and on how those conditions are developed through education. The model of responsible environmental behavior (REB model) provides a basic point of reference for identifying the conditions involved in this process. It offers less explanation, however, of how external norms become self-endorsed reasons for action, how ecological knowledge develops into the capabilities needed to address real-world problems, and how these processes change as students develop. Self-determination theory and the ac-

tion competence approach can supplement the REB model by explaining, respectively, the educational processes through which motivation is internalized and action-related capabilities are developed. This chapter first examines the contributions and limitations of the REB model, then considers motivational internalization and capability development, and finally integrates these theoretical resources into a framework for translating ecological civilization literacy into behavior.

These theoretical resources are selected not to maximize the predictive power of a general behavioral model, but because the REB model identifies conditions associated with behavioral enactment, Self-Determination Theory explains the internalization of reasons for action, and the action competence approach explains how capabilities required for action can be developed educationally. The concepts introduced below are therefore used as analytical resources. Although the Ma survey contains items whose labels overlap with responsibility, action methods, skills, educational provision, and family support, the two publications do not operationalize all of the framework's constructs as analytically distinct variables or test the proposed relationships among them (Ma, 2022, 2025).

2.1. The REB Model and Its Limitations

The constituent dimensions of ecological civilization literacy indicate what students possess, but they cannot directly explain how these dimensions are translated into actual behavior. To address why knowledge and attitudes do not necessarily produce behavioral change, Hines and colleagues conducted a meta-analysis and research synthesis covering 128 studies and proposed the model of responsible environmental behavior. The significance of the REB model lies in shifting attention away from the static juxtaposition of knowledge, attitudes, and behavior toward the processes through which an intention to act is formed and subsequently enacted. It therefore provides a theoretical point of departure for analyzing the translation of ecological civilization literacy into behavior (Hines et al., 1987).

The REB model does not treat environmental knowledge and attitudes as the starting points of a linear pathway that leads directly to behavior. Instead, it places them within the process through which an intention to act is formed. Knowledge of environmental issues enables individuals to recognize problems, while knowledge of action strategies and action skills provides a basis for selecting and implementing appropriate action. Attitudes, personal responsibility, and locus of control influence behavioral intentions through individuals' judgments about environmental values, the attribution of responsibility, and whether personal action can make a difference. Even after an intention to act has been formed, its enactment may still be facilitated or constrained by situational factors such as opportunities, resources, and social pressures. Recognizing a problem, being willing to act, and being able to act are therefore interrelated but non-interchangeable components of behavioral enactment rather than naturally connected stages in a continuous sequence.

Within this model, locus of control primarily concerns whether individuals believe that their behavior can affect environmental outcomes rather than attributing those outcomes to chance or powerful others. In synthesizing the relevant variables, the original study classified some measures of perceived efficacy under locus of control without drawing a strict distinction between the two constructs. For primary and secondary school students, however, believing that individual action can make a difference is not equivalent to believing that one is capable of performing a particular action. In the present analysis, efficacy beliefs therefore refer more specifically to students' judgments about whether they can perform an action and whether that action is likely to produce its intended effects. Although efficacy beliefs overlap with locus of control, they are not equivalent to the action skills students actually possess.

Subsequent research has further demonstrated the nonlinear relationships among knowledge, intentions, and behavior. Meta-analytic structural equation modeling supported the mediating role of behavioral intention between other psychosocial variables and pro-environmental behavior, and the resulting model explained 27% of the variance in self-reported pro-environmental behavior (Bamberg & Möser, 2007). A meta-analysis of 169 independent studies found that environmental education had substantially stronger effects on children' s and adolescents' environmental knowledge than on their pro-environmental behavior and behavioral intentions (van de Wetering et al., 2022). Two experiments involving children aged six to eight similarly found that narrative environmental education significantly increased environmental knowledge. The longer of the two experiments also improved environmental attitudes, but neither produced a significant improvement in behavioral intentions, and neither measured actual behavior (Yang et al., 2022). Taken together, these studies indicate that knowledge and positive attitudes provide important foundations for behavior but cannot by themselves ensure the formation of behavioral intentions or the occurrence of actual behavior.

The REB model is nevertheless a synthesis of existing correlational and experimental research rather than a fixed behavioral sequence that has been causally established. Its principal contribution is the identification of conditions associated with responsible environmental behavior. It offers less explanation of how these conditions are developed through education or how they change with the development of children's and adolescents' cognitive capacities, autonomy, and social relationships. Performing an environmentally responsible behavior under adult prompting or institutional constraint is not equivalent to acting autonomously in the absence of supervision; nor does understanding an environmental problem and its harmful consequences mean that a student possesses the capabilities needed to address it. The educational reinterpretation of the REB model should therefore focus not on adding further behavioral predictors but on explaining three interrelated developmental processes: how external ecological norms become sources of motivation for autonomous action, how curricular knowledge

develops into capabilities for addressing real-world problems, and how school, family, and wider social contexts support the occurrence and continuation of action.

2.2. Motivational Internalization and Action-Related Capabilities

Ecological civilization education generally begins with the communication of norms, behavioral modeling, and organized activities. For younger students, these external supports can facilitate rule compliance and behavioral imitation. As students' sense of autonomy develops, however, behaviors maintained primarily through supervision, rewards and sanctions, or adult evaluation may not persist. For ecological civilization behavior to become an autonomous choice, students need both an internal basis for understanding why they should act and the practical capabilities required to determine how they can act in response to a specific problem. Although the REB model identifies the principal conditions involved in behavioral translation, it does not fully explain how these conditions are generated through education. Self-determination theory and the action competence approach provide complementary accounts of motivational internalization and capability development. The former explains how external ecological norms can become self-endorsed reasons for action, while the latter explains how students develop the capacity to act through problem understanding, autonomous decision making, and practical participation.

Self-determination theory (SDT) conceptualizes motivational internalization as a continuum rather than a simple contrast between external control and autonomous choice. External and introjected regulation remain relatively controlled, whereas identified and integrated regulation reflect progressively greater endorsement of the value and meaning of an action (Ryan & Deci, 2020). Students may therefore express support for environmental protection because such support is expected by teachers, schools, and society without yet adopting ecological action as a self-endorsed commitment. Ecological norms are more likely to support sustained action when students understand the meaning of acting, distinguish the respective responsibilities of individuals, families, schools, and society, identify the responsibility they themselves can reasonably assume, and experience appropriate support for autonomy, competence, and relatedness. Internalization does not mean eliminating external guidance or assigning individuals sole responsibility for complex ecological problems. It means enabling students to move gradually from "I am required to do this" toward "I understand and endorse this action and am willing to participate."

A pre-registered randomized experiment involving 319 Dutch adolescents aged 12 - 17 found that framing pro-environmental behavior as an opportunity to rebel against unjust authority increased petition signing and pro-environmental behavioral intentions, whereas presenting it as mandatory reduced donation behavior (van de Wetering et al., 2025). These findings suggest that whether norms are communicated in ways that align with adolescents' need for autonomy directly

affects their actions, though the magnitude of these effects ranged from small to medium and varied across outcome measures. By integrating the personal responsibility and behavioral intention components of the Model of Responsible Environmental Behavior (REB) with the self-determination account of motivational internalization, motivational conditions can be analyzed at three interrelated levels: personal responsibility, autonomous motivation, and behavioral intention. Personal responsibility concerns who should act and what part of that responsibility the student should assume; autonomous motivation concerns whether the student genuinely endorses the value of the action; and behavioral intention reflects subjective readiness and willingness to invest effort in a particular action. These dimensions address the attribution of responsibility, the quality of motivation, and preparedness for action, respectively, and should not be collapsed into a general category of "attitude" or "awareness."

These empirical findings, however, should not be taken to mean that adolescent autonomy is inherently synonymous with rebellion or unrestricted independence. Autonomy may manifest differently across cultural settings and is less likely to take the form of anti-authoritarian rebellion in contexts characterized by higher loyalty to authority (van de Wetering et al., 2025). Indeed, while Self-Determination Theory posits that basic psychological needs are universally relevant, their fulfillment and behavioral expression remain deeply context-sensitive (Ryan & Deci, 2020). In a Chinese educational environment shaped by collective responsibilities, relational interdependence, and institutional authority, autonomy may be expressed through bounded choice, reasoned endorsement, shared responsibility, and meaningful participation within legitimate school processes. This conceptualization avoids a rigid binary between Western individualism and Chinese collectivism, framing autonomy instead as potentially relational and collectively oriented. The Dutch findings are therefore used to formulate a theoretical mechanism rather than as direct evidence for Chinese students. More generally, the framework retains the functional questions posed by these theories—whether action is self-endorsed, competent, and meaningfully participatory—while treating the institutional forms through which those conditions are realized as context-dependent. This recontextualization remains a hypothesis requiring empirical examination in Chinese schools.

Having reasons to act does not automatically eliminate the gap between intention and action. When confronting specific issues such as waste reduction, green consumption, or the governance of the school environment, students must identify the problem and its causes, understand available courses of action, compare the feasibility and likely consequences of alternative solutions, and, when necessary, deliberate, make decisions, and act with others. It is in this sense that the action competence approach rejects the reduction of environmental education to either knowledge transmission or the correction of overt behavior (Jensen & Schnack, 1997). Historically, the action competence approach emerged from a tradition of democratic and liberal education that distinguishes conscious, consid-

ered action from mere activity or behavior modification. This tradition emphasizes the educational value of participation rather than assigning schools the task of solving political problems through students' activities. This distinction is particularly important in the present context: participation should be treated as a pedagogical vehicle for fostering responsibility and capability development, not as proof that students possess unrestricted decision-making authority.

Recent measurement research operationalized action competence in sustainable development among early adolescents in terms of knowledge, willingness, and self-efficacy and validated the corresponding measurement structure (Sass et al., 2021). This structure represents one particular operationalization of action competence and cannot directly replace the conceptual distinctions adopted in the present study. Because willingness to act overlaps conceptually with behavioral intention, placing both in separate dimensions would duplicate the same form of preparedness for action. Behavioral intention is therefore included under motivational conditions, whereas action-related capabilities are analyzed primarily in terms of knowledge of action strategies, action skills, and efficacy beliefs. Knowledge of action strategies answers the question of what courses of action are available; action skills concern students' ability to investigate, deliberate, make decisions, and implement action; and efficacy beliefs concern students' judgments about whether they can act and whether their actions can make a difference. Efficacy beliefs influence whether students mobilize their existing capabilities but are not equivalent to the action skills they actually possess.

The development of ecological knowledge into action-related capabilities is therefore not a matter of simply accumulating more knowledge. It must occur through engagement with real-world problems. Students need to investigate environmental issues, evaluate alternative solutions, clarify the values involved, and then learn and apply action skills before general ecological knowledge can become a resource that is available for action (Hungerford & Volk, 1990). A three-wave longitudinal study of 760 Swedish upper-secondary students found that students' experiences of education for sustainable development at school were associated with the development of their self-perceived action competence for sustainability, although their confidence in their own influence did not increase significantly. This finding indicates that knowledge of action possibilities, willingness to act, and confidence in one's own influence do not necessarily develop in parallel and that cultivating action competence through school education requires a sustained process (Olsson et al., 2022). Because the study measured self-perceived action competence, its findings cannot be interpreted as direct evidence that students' actual action skills improved.

Experiences gained through participation may subsequently influence students' sense of responsibility, autonomous motivation, behavioral intentions, and efficacy beliefs. Conversely, established motivational conditions may encourage students to continue investigating problems, trying different actions, and adjusting their strategies. Motivational internalization and capability development thus re-

inforce one another. Both are also shaped by curricular tasks, teacher guidance, peer collaboration, and family conditions and should not be treated as separate sets of individual-level variables.

2.3. An Integrated Framework for Translating Ecological Civilization Literacy into Behavior

The REB model, self-determination theory, and the action competence approach perform different but complementary functions in the proposed framework. The REB model identifies the cognitive, skill-related, personality, intentional, and situational factors involved in responsible environmental behavior and thus provides a basic structure for differentiating the conditions of behavioral translation. Self-determination theory explains how external requirements can be internalized to varying degrees and become self-endorsed reasons for action. The action competence approach emphasizes that students should develop the willingness, experience, and capacity to act through problem understanding, autonomous decision making, and practical participation (Hines et al., 1987; Jensen & Schnack, 1997; Ryan & Deci, 2020). Integrating these perspectives does not mean simply combining behavioral predictors, motivational mechanisms, and educational principles. Instead, the framework reorganizes them around the development of ecological civilization behavior among primary and secondary school students into four interrelated components: literacy foundations, motivational conditions, action-related capabilities, and contextual supports. Ecological civilization behavior and behavioral feedback are then used to examine whether the translation is realized and sustained. The relationships among these components are presented in **Figure 1**.

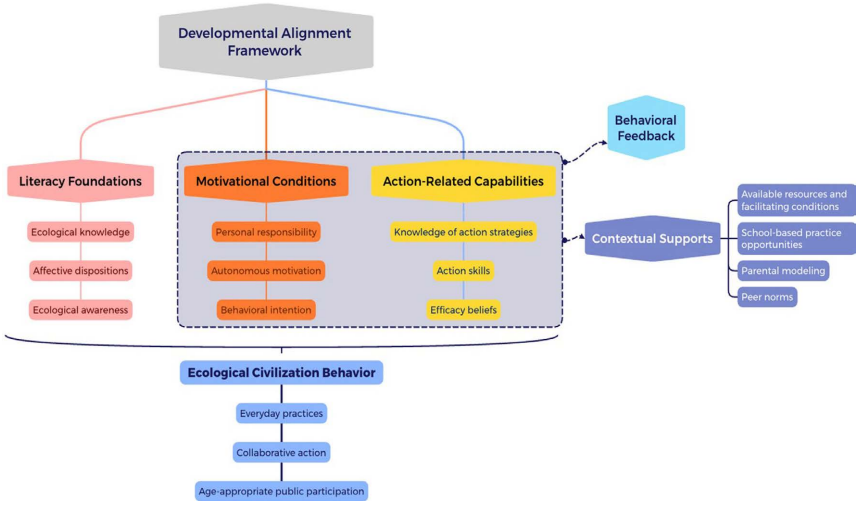

Figure 1. A developmental alignment framework for translating ecological civilization literacy into behavior.

Ecological knowledge, affective dispositions, and awareness constitute the literacy foundations of behavioral translation, enabling students to recognize ecolog-

ical problems and make basic value judgments. On this basis, motivational conditions comprise personal responsibility, autonomous motivation, and behavioral intention, corresponding respectively to the assumption of responsibility, the internalization of value, and preparedness for action. Action-related capabilities comprise knowledge of action strategies, action skills, and efficacy beliefs, corresponding to the identification of possible courses of action, the performance of action-related tasks, and subjective judgments about the feasibility and likely effects of action. Motivational conditions and action-related capabilities do not develop as two successive stages. Reasons for action may encourage students to acquire and apply action strategies, while practical experience may in turn modify their personal responsibility, autonomous motivation, behavioral intentions, and efficacy beliefs.

These constructs are related but analytically distinct. Ecological knowledge refers to accurate factual and conceptual understanding of ecological systems, environmental problems, and sustainability-related concepts, whereas ecological awareness refers to recognition of the significance of ecological problems, human-nature relations, and the responsibility associated with ecological protection. For example, identifying a renewable resource or explaining biodiversity represents a knowledge judgment, whereas judging that protecting the ecological environment is important represents an awareness judgment (Ma, 2025; Shi et al., 2024). Affective dispositions concern relatively general feelings of attachment, concern, or valuation toward nature. Personal responsibility concerns whether students judge that they themselves should assume a specific part of the response. Affective dispositions may provide an emotional basis for action, but autonomous motivation concerns whether students personally endorse the reasons for undertaking a particular action, while behavioral intention refers to their readiness to undertake that action and invest effort in it. Action skills concern the capacities required to investigate, deliberate, decide, cooperate, and implement. Within the present framework, efficacy beliefs comprise two related judgments: whether students can perform an action and whether that action is likely to make a meaningful difference. Efficacy beliefs may influence whether existing skills are mobilized, but they cannot substitute for the skills themselves.

The classification scheme of the proposed framework intentionally diverges from the original dimension labels employed in the source instrument. Specifically, earlier reporting categorizes ecological civilization responsibility under awareness, groups action methods alongside green-living and persuasive skills under behavior, and places willingness to participate in environmental volunteering under ecological affect (Ma, 2025). In contrast, the present framework conceptualizes personal responsibility and behavioral intention as motivational conditions, while framing knowledge of action strategies and action skills as action-related capabilities. These adjustments represent theory-guided analytical reclassifications; they neither alter the original questionnaire's scoring scheme nor imply that the source instrument empirically validated the proposed framework (Ma, 2025).

Literacy foundations, motivational conditions, and action-related capabilities are always embedded in specific educational and everyday contexts. Opportunities for school-based practice, parental modeling, peer norms, and available resources and other facilitating conditions together constitute contextual supports. Curricular tasks, teacher support, school rules and facilities, family lifestyles, peer evaluation, and the time and costs required for action may influence both motivational internalization and capability development and may facilitate or constrain the enactment of behavioral intentions (Kollmuss & Agyeman, 2002; Steg & Vlek, 2009). Contextual supports are therefore not distal variables that become relevant only after behavioral intentions have been formed. They operate throughout the internalization of motivation, the development of capabilities, and the enactment of behavior.

The framework examines ecological civilization behavior as the outcome toward which these conditions jointly contribute. To prevent a single composite score from obscuring differences among forms of behavior, ecological civilization behavior is differentiated analytically into everyday practices, collaborative action, and age-appropriate public participation according to the scope of action, mode of participation, and conditions of implementation. These categories differ in behavioral costs, decision-making requirements, dependence on context, and the authority required for action. They do not constitute a fixed hierarchy or a mandatory sequence through which every student must progress. Behavioral development should instead be examined in terms of an expanding repertoire of action and increasing autonomy, persistence, complexity, and transfer across contexts. Everyday practices remain important at later educational stages, while collaborative action and public participation should be introduced only when they are developmentally, institutionally, and ethically appropriate.

These criteria are carried into the framework through observable or reportable indicators. Autonomous behavior may be indicated by self-initiation, reason-giving, and continuation without direct supervision; sustained behavior by repeated enactment, maintenance over time, transfer across settings, and adjustment after feedback; and developmentally appropriate behavior by actions that students can realistically perform or influence within available resources, safety requirements, and legitimate decision-making authority. Because the survey does not directly measure these conditions, they remain analytical criteria rather than established properties of the surveyed students.

The actual consequences of action, responses from others, and experiences of success or failure constitute behavioral feedback. This feedback may modify students' judgments of responsibility, autonomous motivation, behavioral intentions, action strategies, and efficacy beliefs and may also inform adjustments to curricular tasks and contextual supports.

Alignment across educational stages is not treated as an independent variable alongside the framework's components; it functions as a developmental lens. The framework's distinctive contribution is to recast educational-stage differences as

a problem of coordination among motivational conditions, action-related capabilities, and contextual supports rather than as simple differences in literacy levels. Developmental alignment does not prescribe uniform growth in every component. It asks whether changes in task demands and behavioral expectations are accompanied by corresponding changes in self-endorsed responsibility, action-related capabilities, participatory authority, contextual supports, and feedback. The analytical focus is therefore not whether students at later educational stages perform the same low-cost behaviors more frequently, but whether they develop more self-endorsed reasons for action, more complex and transferable capabilities, and correspondingly greater opportunities for choice, deliberation, participation, and feedback.

The framework therefore generates three analytical propositions rather than empirically tested hypotheses. First, literacy foundations are more likely to support behavior when ecological norms are internalized as personal responsibility, autonomous motivation, and specific behavioral intentions. Second, ecological understanding is more likely to become actionable when students develop knowledge of action strategies, action skills, and efficacy beliefs. Third, motivational conditions and action-related capabilities are more likely to support enacted and sustained behavior when educational and everyday contexts provide appropriate opportunities, resources, authority, and feedback. Section 3 uses these propositions as an interpretive lens for the reported survey patterns; it does not claim their empirical validation.

3. Discussion: Potential Developmental Misalignment in Behavioral Translation

The following discussion employs the proposed framework as an interpretive lens; it neither formally tests the hypothesized relationships nor purports to establish a definitive developmental trajectory. Cross-stage item differences spanning ecological affect, volunteering willingness, and self-reported litter picking serve strictly as descriptive indicators (Ma, 2025). Longitudinal evidence similarly cautions against assuming a uniform developmental trajectory: environmental attitudes and behaviors often diverge along distinct age-related paths (Otto et al., 2019), with recent empirical work finding no evidence of a generalized adolescent decline in pro-environmental behavior (Krettenauer et al., 2024). Developmental trajectories must therefore be understood as highly heterogeneous, varying across specific constructs, behavioral domains, cohorts, and contextual settings.

According to the preceding framework, progression in ecological civilization behavior should not be assessed only by whether the same basic behaviors become more frequent with age. It should also be examined in terms of whether responsibility becomes more self-endorsed, whether students acquire increasingly complex and transferable action-related capabilities, and whether educational and everyday contexts provide correspondingly greater opportunities for choice, deliberation, participation, and feedback. The following analysis therefore develops three

interrelated explanations for the central research question: external norms may not be sufficiently internalized as reasons for autonomous action; ecological understanding may not develop into the capabilities required for action; and students' increasing need for autonomous participation may not receive adequate contextual support.

3.1. From External Norms to Self-Endorsed Responsibility

Whether external norms are internalized as personal responsibility is fundamentally a question of how motivational conditions are developed. Teacher modeling, classroom requirements, and parental supervision can help students at earlier educational stages understand which behaviors are encouraged and develop basic behavioral routines through repeated practice. These external norms primarily clarify what students are expected to do. Whether a behavior persists when reminders and supervision are absent also depends on whether students recognize their own responsibility, endorse the meaning of the action, and form a corresponding behavioral intention. The central question is therefore not whether external norms are effective, but whether normative support develops into motivational conditions as students mature.

As their cognitive capacities and social understanding develop, students at later educational stages may become increasingly aware that climate change, biodiversity conservation, and resource use cannot be addressed through individual self-discipline alone but involve multiple actors, including governments, businesses, and civil society organizations. This understanding helps avoid assigning individuals sole responsibility for complex ecological problems, but it also makes the attribution of responsibility more difficult. When the respective responsibilities of individuals, families, schools, and society remain unclear, students may view ecological protection primarily as a public matter for which other actors are responsible. Even when they continue to endorse ecological civilization values, they may not be able to identify the responsibility they themselves can assume or develop stable autonomous motivation and specific behavioral intentions.

If ecological civilization education at later educational stages continues to rely primarily on uniform requirements, moral exhortation, and outcome-based praise, students may have few opportunities to deliberate over responsibility, choose among possible actions, and confirm the meaning of their participation. Ecological civilization may consequently remain a value requirement that students regard as correct but experience as external. Episodic participation is also unlikely to develop into a stable sense of responsibility in the absence of feedback about its results. The comparatively lower willingness of students at later educational stages to participate in environmental volunteering therefore does not necessarily indicate that their ecological awareness has weakened. It may instead suggest that external requirements have not been fully translated into personal responsibility, autonomous motivation, and behavioral intention. This provides one possible explanation of differences across educational stages from the perspective of motivational

conditions. Whether established reasons for action are enacted, however, also depends on whether students possess the necessary action-related capabilities.

3.2. Coordinating Ecological Understanding and Action-Related Capabilities

Whether ecological understanding can be translated into implementable action depends on the development of action-related capabilities. Knowledge of the causes of pollution, resource constraints, and climate change can help students understand ecological problems and the need to address them, but it does not directly provide the means of solving those problems. Effective engagement with real-world issues also requires students to understand available action strategies, acquire skills in investigating problems and collecting evidence, evaluating evidence, comparing alternatives, deliberating over disagreements, and implementing action, and develop efficacy beliefs consistent with their capabilities and practical experience. Efficacy beliefs refer to students' subjective judgments about whether they can perform an action and whether that action can make a difference. They are not equivalent to the action skills students actually possess, but they influence whether students are willing to mobilize and use those skills.

Progression in action-related capabilities does not mean that basic behaviors developed at earlier educational stages lose their value. Rather, students should gradually develop the capacity to address more complex problems after mastering basic rules and procedures. Tasks such as conserving water, sorting waste, and maintaining a clean school environment have relatively clear behavioral requirements and outcomes. They are therefore suitable for helping younger students understand basic norms and practice fundamental procedures. As students' ways of thinking, life worlds, and capacities for participation develop, ecological practice at later educational stages should extend appropriately to problems that are more systemic, open-ended, and shaped by competing interests. Students can thus progress from following established rules toward identifying problems, analyzing causes, comparing alternatives, deliberating over decisions, and implementing action collaboratively. Behavioral development consequently involves more than increasing the frequency of similar basic behaviors. It also involves making reasoned choices when addressing real-world problems for which no single correct answer exists.

According to the preceding analysis of action competence, if curricular content continues to repeat general environmental knowledge and practical activities remain limited to publicity campaigns, visits, and short-term experiences, students may acquire primarily declarative knowledge rather than resources for addressing real-world problems. Without opportunities to investigate issues, evaluate alternatives, clarify values, and learn and apply action skills, students may have difficulty determining the conditions under which different strategies are appropriate or using experiences of success and failure to develop new skills and efficacy beliefs. Students at later educational stages may therefore gain a deeper understand-

ing of ecological problems while still perceiving that viable courses of action are unavailable or beyond their personal capabilities. Insufficient knowledge of action strategies and limited opportunities to practice relevant skills may constrain the development of efficacy beliefs, while weak efficacy beliefs may in turn reduce students' willingness to mobilize the capabilities they already possess.

Whether ecological understanding and action-related capabilities develop in coordination therefore depends not only on whether relevant knowledge is taught but also on whether the external context provides sustained opportunities to apply, test, and revise that knowledge and those skills.

3.3. Aligning the Need for Autonomous Participation with Contexts for Practice

The formation of reasons for action and the possession of some action-related capabilities do not ensure that ecological civilization behavior will occur. Whether behavioral intentions are enacted also depends on whether the external context provides appropriate opportunities and conditions for implementation. As students progress through educational stages, they may seek broader autonomy and participation; participation, however, should not be equated with independent or oppositional action, but may involve bounded choice, collaborative problem solving, collective consultation, or shared decision making within legitimate school authority. Whether the external context accommodates this development can be examined in terms of opportunities for school-based practice, parental modeling, peer norms, and available resources and other facilitating conditions. These conditions influence not only whether a plan can be implemented but also whether students can revise their judgments of responsibility, action strategies, and efficacy beliefs through practice. Insufficient family or school support, restrictive group norms, a limited scope for exerting influence, and a lack of concrete opportunities for action have been identified as key contextual barriers to adolescents' pro-environmental behavior (Huoponen, 2024). The external context therefore does more than accommodate motivational conditions and action-related capabilities that have already been developed. It actively contributes to their formation through structured opportunities for choice, collaboration, and feedback.

Student-reported data provide an indicator of stand-alone course provision rather than a direct measure of curricular continuity, instructional quality, or authentic practice opportunities (Ma, 2022). Across the full sample, 42,063 of 82,438 respondents (51.02%) indicated that their schools offered a dedicated ecological civilization education course. Among the three focal grades, the corresponding "yes" proportions were 54.74% in Grade 4, 52.39% in Grade 7, and 44.21% in Grade 10. The Grade 4 proportion exceeded those for Grades 7 and 10 by 2.35 and 10.53 percentage points, respectively (Ma, 2022). The reported test statistic (χ^2 = 933.436, $p < 0.001$) reflects an omnibus comparison across all seven sampled grades and three response options, rather than an isolated test recalculated for Grades 4, 7, and 10 (Ma, 2022). Given the large sample size (N = 82,438) and the

absence of reported effect sizes, statistical significance alone must not be interpreted as evidence of an educationally meaningful disparity. Furthermore, because grade-specific sample counts, standard errors, confidence intervals, design effects, and weighting protocols are omitted (Ma, 2022), these descriptive patterns raise—but cannot empirically resolve—the question of whether curricular and practical supports are sustained across educational stages.

The extent to which school-promoted ecological principles transition into students' everyday lives may depend on parental modeling, students' decision-making authority, and the material conditions of family life. The source survey, however, does not directly measure parental modeling (Ma, 2022). It indicates that 94.1% of students perceived their parents as "very" or "relatively" supportive of their participation in ecological civilization activities, while 41.2% reported that their schools "always" or "often" invited parents to participate (Ma, 2022). Crucially, the latter indicator captures school-level outreach rather than parents' actual attendance, joint practice, or home behavior. Consequently, these two metrics cannot be juxtaposed to infer a behavioral gap between supportive parental attitudes and modeling; rather, they differentiate perceived parental approval from school-provided opportunities for parental involvement (Ma, 2022). Independent empirical evidence regarding parental modeling is provided by an analysis of 518 parent-child dyads across five Chinese cities, which found that children's perceptions of parental action fully mediated the relationship between parent and child pro-environmental behavior, whereas parent-child communication and joint participation exerted marginal indirect effects (Jia & Yu, 2021). Although cross-sectional constraints preclude causal inference, these findings highlight visible parental modeling, communication, and shared activities as plausible conduits for child behavior (Jia & Yu, 2021). Furthermore, because children rarely hold ultimate decision-making authority over household consumption, transportation, or energy management, ingrained family routines, structural constraints, and material conditions may impede green action even when autonomous intentions are present.

Peer norms may likewise influence adolescents' willingness to participate publicly in ecological action. A systematic review of 23 studies found that both parents and peers contribute to adolescents' environmental socialization. Because most of the included studies were conducted in Western contexts, however, the specific forms and strength of these influences require further examination in different cultural settings (Papa et al., 2025). Participating in environmental activities, proposing greener ways of living, or challenging environmentally harmful behavior may expose students to evaluation by their peer group. When positive ecological action does not receive peer approval or is perceived as inconsistent with group practices, the social cost of translating behavioral intentions into public action may increase. Conversely, teacher support, family participation, and positive peer responses can reduce the social costs of action and enable students to reconsider their responsibilities, revise their strategies, and adjust their efficacy beliefs in light

of practical outcomes.

The developmental appropriateness of contexts for practice therefore cannot be judged solely by the number of activities offered or whether a stand-alone course exists. It requires examining whether students actually receive opportunities for choice, deliberation, implementation, and feedback and whether they possess the resources and authority needed to use those opportunities. Developmentally appropriate contexts should enable behavioral intentions to be enacted while also allowing practical experience to feed back into responsibility judgments and capability development. If activities at later educational stages continue to rely primarily on uniform requirements, behavioral modeling, and external supervision, students' developing need for autonomous participation may not be adequately addressed, and their motivational conditions and action-related capabilities may have little opportunity to develop further through authentic action.

3.4. An Integrated Explanation of Behavioral Translation and the Boundaries of the Evidence

The central research question can therefore be addressed analytically in terms of the coordination of three sets of conditions. Non-behavioral dimensions of ecological civilization literacy do not necessarily translate into autonomous, sustained, and developmentally appropriate behavior because knowledge, affective dispositions, and awareness constitute foundations for action rather than sufficient causes of action. Translation may remain incomplete when external norms are not sufficiently internalized as personal responsibility, autonomous motivation, and specific behavioral intentions; when ecological understanding is not developed into knowledge of action strategies, action skills, and efficacy beliefs; and when school, family, peer, and wider social contexts do not provide adequate opportunities for practice, resources, participatory authority, and outcome feedback. These conditions interact rather than operate as successive stages. Motivation without capability may not produce implementable action; capability without opportunities for application may not develop or persist; and participation without meaningful choice and feedback may be insufficient to support motivational internalization and efficacy.

From an educational-stage perspective, the issue is therefore not whether students at later stages have simply "lost" ecological literacy. The more relevant question is whether responsibility, capability, and participation are adjusted in coordination with students' developing cognition, autonomy, and scope of social participation. This explanation remains a theoretical proposition rather than a mechanism demonstrated by the available survey evidence. The cross-sectional data show only that response distributions on selected items concerning ecological affect, volunteering intention, and self-reported litter picking differ among the Grade 4, 7, and 10 groups; they cannot identify individual developmental change or causal relationships among motivational conditions, action-related capabilities, and contextual supports.

4. Educational Implications for Behavioral Translation

The preceding section offered an interpretive explanation of possible barriers to behavioral translation, from which the present section derives educational implications framed as design propositions rather than empirically confirmed intervention effects. The preceding analysis identifies three conditions through which the translation of ecological civilization literacy into behavior may be constrained: insufficient motivational internalization, limited development of action-related capabilities, and inadequate contextual support for autonomous participation. Because these conditions remain theoretical propositions rather than an empirically confirmed diagnosis of educational misalignment, improvement should not begin from an attempt to "correct an apparent decline among students at later educational stages." Nor should it be reduced to adding curricular content, increasing the number of activities, or repeating publicity campaigns more frequently. Instead, ecological civilization education should connect responsibility development, capability development, practical participation, and outcome feedback, while adjusting the forms of support provided at different educational stages.

A stage-differentiated approach cannot be reduced to making knowledge progressively more difficult. It must also ensure the vertical articulation of motivational conditions, action-related capabilities, contextual supports, and behavioral feedback. At the primary level, clear norms and concrete tasks can be used to develop basic behaviors and initial experiences of responsibility. At the lower-secondary level, curricular tasks can provide increasing opportunities for students to investigate problems, deliberate over responsibility, compare alternatives, and engage in collaborative action. At the upper-secondary level, curricular design can place greater emphasis on evaluating evidence, justifying proposed solutions, negotiating competing interests, and participating appropriately in public affairs. These stages should not be assigned isolated sets of educational content. They should form a continuous process in which responsibility develops from compliance with external requirements toward self-endorsed commitment, action develops from rule following toward problem solving, and participation develops from task completion toward deliberative decision making. These stage descriptions should be understood as developmental design hypotheses rather than fixed prescriptions based solely on grade level. In practice, task complexity and participatory authority should also be adjusted to students' prior experience, demonstrated capabilities, school conditions, and the institutional and safety requirements of particular activities.

4.1. Promoting the Internalization of Responsibility and Fostering Motivation for Autonomous Action

Personal responsibility cannot be developed primarily by repeatedly emphasizing the importance of ecological civilization. Students need to understand the meaning of action, distinguish the boundaries of responsibility, and identify what they themselves can reasonably undertake in relation to specific problems. External norms are likely to become self-endorsed reasons for action only when students

have opportunities to understand, choose, and participate. Responsibility education should therefore not require students to assume an undifferentiated responsibility for ecological problems. It should help them distinguish the responsibilities of individuals, families, schools, businesses, governments, and other actors and understand the relationships among individual action, collective cooperation, and institutional governance. Here, autonomy-supportive practice does not require the removal of adult guidance or the adoption of adversarial relations with authority. It means providing meaningful reasons, bounded choices, and opportunities for students to exercise judgment within shared rules, collective responsibilities, and clearly defined safety boundaries (Ryan & Deci, 2020).

Deliberation over responsibility needs to be incorporated into everyday issues that students can encounter and influence. When examining campus resource use, food waste, waste management, or community environmental problems, curricula can guide students in analyzing the multiple factors contributing to the problem, the authority available to different actors, which actions can be completed independently, which require deliberation and cooperation, and which can be addressed only by making proposals or seeking institutional change. Such analysis avoids converting complex ecological problems entirely into a personal moral burden for students. It also prevents students from denying their own participatory responsibilities simply because other actors are involved.

The internalization of responsibility also requires authentic but bounded opportunities for choice. Activities in which teachers determine the issue, proposed solution, division of labor, and expected outcome in advance may train students to follow rules, but they are unlikely to foster stable responsibility for decisions and their consequences. Within clearly defined safety boundaries and basic requirements, curricular tasks can allow students to participate in selecting issues, comparing alternatives, allocating responsibilities, and evaluating outcomes. Students need not assume responsibility for the entire problem, but they should be able to explain which action they selected, why they made that choice, with whom they need to cooperate, and which specific tasks they are prepared to undertake. Personal responsibility thus becomes a commitment grounded in understanding and choice rather than mere compliance with external requirements.

The relationship between choice and responsibility should be adjusted progressively across educational stages. At the primary level, teachers can provide a small number of clear and feasible options, help students understand basic rules and their underlying reasons, and enable them to complete tasks they can undertake independently in classroom, family, and school settings. At the lower-secondary level, students can map the actors involved in specific school or community problems and the relationships among them, compare the actions available to different actors, and determine responsibilities through group deliberation. At the upper-secondary level, students can examine ecological issues that involve structural mechanisms and competing interests, analyze the respective boundaries of individual action, collective cooperation, and institutional governance, and autono-

mously determine how to participate within the limits of their authority. Progression across educational stages is reflected in increasingly specific judgments of responsibility and increasingly autonomous choices of action, not in transferring an ever-greater burden of environmental governance to students.

The assumption of responsibility should also be connected to feedback from action. Behavioral commitments should not remain at the level of slogans, signatures, or one-off expressions of attitude. They should include a basic process of choice, implementation, documentation, and reflection. Whether an action was completed, what effects it produced, which conditions constrained it, and whether it needs to be adjusted should all become subjects of subsequent discussion. Teacher assessment should not focus solely on whether students appear "enthusiastic." It should examine whether they can explain their reasons for acting, fulfill the tasks they have undertaken, and revise their judgments of responsibility in response to outcomes. Experiences of responsibility that are tested through actual action are therefore more likely to support autonomous motivation and relatively stable behavioral intentions.

4.2. Reorganizing Curricular Tasks to Develop Action-Related Capabilities

Action-related capabilities cannot be developed by appending an isolated practical activity after knowledge instruction has been completed. Ecological knowledge should instead be embedded in a complete problem-solving process. Curricula can organize tasks around a sequence of "problem identification—evidence collection—causal explanation—strategy comparison—plan implementation—outcome evaluation," thereby making knowledge a tool for analyzing problems, evaluating alternatives, and supporting action. Learning to apply action strategies through investigation, decision making, and practical participation can enable students to translate general ecological knowledge into transferable resources for action (Hungerford & Volk, 1990; Jensen & Schnack, 1997).

This organization of tasks requires different subjects to perform complementary functions rather than assigning ecological civilization education entirely to a single subject. In relation to food waste at school, for example, science, biology, and geography can help students understand the relationships among food production, resource consumption, and waste treatment. Morality and the Rule of Law can address personal responsibility and public rules; mathematics and information technology can support data collection and analysis; and comprehensive practical activities can provide opportunities for investigation, deliberation, and implementation. The purpose of interdisciplinary integration is not for every subject to add more ecological knowledge simultaneously. It is to connect conceptual understanding, evidence-based judgment, and action around a shared problem.

Developing age-specific teaching materials and popular science readers likewise requires more than adjusting the difficulty of the language. At the primary level, curricular resources can use observations of nature, everyday situations, and prac-

tical tasks to help students understand basic relationships between behavior and environmental consequences and provide actions they can attempt directly. At the lower-secondary level, resources should incorporate more data, causal relationships, and alternative solutions, guiding students to explain problems on the basis of evidence and compare the applicability of different action strategies. At the upper-secondary level, resources can further introduce systemic mechanisms, competing interests, uncertainty, and modes of governance involved in ecological problems, requiring students to evaluate the multiple consequences that different solutions may produce. Differences in curricular resources across educational stages should therefore involve not only increasing depth of knowledge but also changes in the purposes for which knowledge is used and in the complexity of action-related tasks.

Action skills should be explicitly included in curricular objectives and developed through sustained practice. At the primary level, students can practice observation, classification, documentation, communication, and the performance of rule-governed procedures. At the lower-secondary level, they can progressively develop skills in information retrieval, questionnaire and interview methods, data interpretation, group deliberation, and task management. At the upper-secondary level, greater emphasis can be placed on evidence evaluation, justification of proposed solutions, communication among stakeholders, project implementation, and public presentation. These skills need to be applied repeatedly in continuous tasks, receive feedback, and undergo revision. They should not be assumed to develop naturally merely because students have participated in an activity. Correspondingly, curricular assessment should distinguish between whether students are willing to act and whether they are able to complete an action, rather than using enthusiasm for participation as a substitute for evaluating knowledge of action strategies and action skills.

Developing efficacy beliefs requires enabling students to recognize both the effects and the limits of action. Education should neither exaggerate individual influence to create an unrealistic sense of success nor lead students to conclude that personal action is meaningless in the face of large-scale ecological problems. Curricular tasks can distinguish among goals that students can achieve independently, goals that require collaboration, and issues for which students can only make recommendations. Students can then determine an appropriate scope of participation in accordance with their capabilities, available resources, and decision-making authority. When a plan succeeds, students should examine which strategies and supporting conditions contributed to that success. When it does not succeed, they should determine whether the constraints arose from insufficient skills, inadequate resources, limited authority, or the decisions of other actors. Efficacy beliefs developed in this way are more likely to correspond to students' actual capabilities and the conditions in which action occurs.

Curricular tasks extending across educational stages should also avoid low-level repetition. Basic behaviors such as conserving water and electricity and sorting

waste still require continued reinforcement, but education at later stages should not remain confined to publicity, check-ins, and compliance monitoring involving the same content. The same topic can be addressed at progressively different levels. At the primary level, students can learn the basic rules of waste sorting. At the lower-secondary level, they can investigate the sources of school waste and the processes through which it is handled. At the upper-secondary level, they can analyze waste-reduction plans, facility provision, and management rules. Such vertical articulation preserves basic behaviors while creating space for continued development in knowledge of action strategies, action skills, and efficacy beliefs.

4.3. Strengthening Practical Support and Outcome Feedback to Enable Behavioral Enactment

Whether motivational conditions and action-related capabilities are translated into actual behavior depends on whether students receive practical opportunities, resources, and authority appropriate to their development. Schools can turn everyday matters such as cafeteria management, energy use, maintenance of green spaces, and waste treatment into relatively stable issues for practical participation. They can also establish basic pathways connecting curricular learning with problem investigation, deliberation over proposed solutions, trial implementation, and outcome feedback. Student participation does not mean allowing students to replace school administrators as final decision makers. It means enabling students, within clearly defined institutional boundaries, to identify problems, provide reasons, express views, and receive formal responses.

In addition, the effectiveness of participatory mechanisms cannot be judged merely by whether a student organization exists or whether practical activities have been conducted. In a study of 902 students from three Norwegian upper-secondary schools, participation in ESD teaching and learning was positively associated with knowledge of action possibilities and confidence in one's own influence, while participation through the student council was positively associated with all three components of self-perceived action competence: knowledge of action possibilities, confidence in one' s own influence, and willingness to act. By contrast, participation through the "School and Leadership" and "Community Connections" pathways was not significantly related to any of the three components (Torsdottir et al., 2024). This study provides a context-specific illustration rather than a transferable template: it was cross-sectional, involved only three Norwegian schools, and examined participation within a Norwegian whole-school arrangement. It does not establish that student councils, democratic deliberation, or the same forms of participation will have equivalent meanings or effects in Chinese schools. In the present framework, meaningful participation may include student council activity, class- or school-based problem solving, collective consultation, and shared responsibility, provided that students have legitimate influence, institutional support, and visible responses. Autonomy is therefore not equated

with adversarial independence from authority. Across contexts, the educational value of participation may depend on whether students can influence learning or decision-making processes and observe responses to their participation, rather than merely holding the nominal status of participants.

Practical participation should also maintain a degree of continuity. Visits, thematic publicity campaigns, and concentrated volunteering activities can provide short-term experiences, but they rarely allow students to monitor outcomes or revise their plans over time. Schools can establish tasks extending across several months or semesters around relatively stable issues, enabling students to experience the complete process of investigation, decision making, implementation, documentation, and improvement. Necessary records of outcomes and continuity of tasks should also be maintained when students move between educational stages, preventing lower- or upper-secondary education from restarting with general environmental knowledge and elementary publicity activities. Even when later educational stages face pressures from subject specialization and academic schedules, space should be retained for the sustained application of action strategies and action skills.

Out-of-school educational sites can provide real-world problems, specialized information, and participatory contexts that are difficult to create within schools, but their function should extend beyond visits and experiential exposure. Protected natural areas, environmental monitoring organizations, science centers, and community public spaces can support nature observation, data collection, technological understanding, and social deliberation, respectively. Before an activity, schools should identify the questions to be investigated and the methods to be used. During the activity, students should collect evidence, interview relevant personnel, or test their existing judgments. Afterward, the resulting material should be brought back into the classroom and used to compare alternatives, reflect on action, and formulate subsequent tasks. Resources inside and outside school can become cumulative and transferable action experiences only when they are incorporated into the same problem-solving process.

Family and peer support should likewise move from external supervision toward joint participation. Environmental check-in tasks completed at home can turn questions of household resource use into evidence that students have fulfilled an individual assignment without necessarily changing the family's actual choices. Schools can instead design investigative tasks that require discussion among family members. Students might document household transportation, energy use, or food waste, propose alternative plans, invite family members to explain practical constraints, and jointly decide which changes can be attempted. Such tasks recognize students' limited authority in family affairs while providing opportunities to express views, participate in deliberation, and observe outcomes.

Peer norms should be developed through shared tasks. Schools should not rely primarily on selecting a small number of "environmental role models" to establish behavioral norms, because this approach can turn ecological action into a moral

comparison among individuals. Allowing classes or project groups to set shared goals, deliberate over responsibilities, and publicly report their outcomes is more conducive to making ecological action a matter of collective responsibility. Teachers should also attend to unequal opportunities for participation within groups, the concentration of tasks among a small number of students, and the exclusion of dissenting views, thereby preventing nominal cooperation from concealing inadequate participation.

Practical support must ultimately be embodied in appropriate institutional arrangements and resource provision. Curricular design should specify the basic objectives, student authority, and safety boundaries of practical activities at different educational stages, allocate the time required for interdisciplinary tasks, and coordinate the respective responsibilities of schools, families, communities, and external organizations. Developing age-specific teaching materials, establishing educational sites inside and outside school, or increasing the number of practical projects can become conditions that genuinely support behavior only when these measures are coordinated with teacher guidance, curricular tasks, students' participatory authority, and outcome feedback.

Behavioral outcomes are both manifestations of educational effectiveness and sources of feedback for adjusting motivational conditions, action-related capabilities, and contextual supports. Evaluation should neither count only the number of activities in which students participate nor use a small number of low-cost everyday behaviors to represent ecological civilization behavior as a whole. Everyday practices, collaborative action, and appropriate forms of public participation differ in implementation costs, decision-making requirements, and dependence on context and therefore need to be examined separately. In addition to whether a behavior occurs, evaluation should consider the extent to which it depends on external supervision, whether it persists over time, and whether it can be transferred to new problem contexts.

A one-off self-report provides insufficient evidence for determining whether behavior is autonomous, sustained, and transferable. A systematic review of 76 studies involving children aged 6 - 12 found a shortage of longitudinal research and widespread reliance on self-report scales rather than observational measures of behavior (Liu & Green, 2024). Because the review was restricted to children aged 6 - 12, its conclusions cannot be directly extended to the entirety of primary and secondary education. Nevertheless, the methodological and measurement limitations it identified suggest that the evaluation of ecological civilization behavior should incorporate process-based and context-sensitive evidence. Schools can combine situational tasks, process observation, project portfolios, action plans, school operational records, and periodic reflection to determine what actions students undertook, the conditions under which those actions were completed, how long they were sustained, and whether students revised their original plans in response to outcomes.

The purpose of evaluating ecological civilization behavior is not to rank stu-

dents according to ecological morality but to diagnose where the process of behavioral translation is constrained. A student may fail to act because a specific behavioral intention has not been formed, because the available course of action is unclear, because the necessary skills are lacking, or because adequate time, resources, or authority have not been provided. Only by examining behavioral outcomes together with judgments of responsibility, task processes, and contextual conditions can educators determine whether improvement should focus on motivational support, curricular tasks, skills training, or the external environment. Behavioral outcomes can thereby re-enter the educational process and inform continuing adjustments to motivational conditions, action-related capabilities, and practical support.

Ultimately, advancing ecological civilization education across educational stages does not mean adding separate sets of knowledge or activities to primary, lower-secondary, and upper-secondary education. It means establishing an educational pathway that begins with basic norms and behavioral practice and gradually progresses toward self-endorsed responsibility, real-world problem solving, and collaborative participation. Within this pathway, curricula provide the knowledge needed to understand problems and formulate action strategies; practical participation supports the development of responsibility, skills, and efficacy beliefs; schools, families, peers, and external organizations provide the conditions for action; and behavioral outcomes inform subsequent adjustments to the educational process. Such a continuous and developmentally aligned pathway is more likely to enable ecological knowledge, affective dispositions, and awareness to be enacted as autonomous, sustained, and developmentally appropriate ecological civilization behavior.

5. Conclusion and Future Research

The two publications derived from the identical 82,438-response dataset represent a single descriptive baseline rather than independent corroborating sources (Ma, 2022, 2025). Focal literacy comparisons examined in the present study rely on secondary reporting of selected items across Grades 4, 7, and 10—specifically spanning ecological affect, volunteering willingness, and self-reported behavior—alongside generally positive trends on non-behavioral indicators (Ma, 2025). While uniform item phrasing permits descriptive cross-grade comparisons, indicators representing conceptually distinct constructs must not be aggregated onto a unified scale or used to rank literacy dimensions. Furthermore, cross-sectional differences cannot be interpreted as evidence of latent construct shifts or individual developmental decline. Ultimately, these descriptive patterns motivate—but cannot empirically resolve—the central question of why ecological knowledge, affective dispositions, and awareness do not necessarily translate into autonomous, sustained, and developmentally appropriate ecological civilization behavior.

The framework addresses this question by distinguishing literacy foundations from the conditions required for behavioral enactment. Ecological knowledge, af-

fective dispositions, and awareness support problem recognition and value judgment, but they do not by themselves ensure that students endorse responsibility, identify feasible strategies, possess implementation skills, or receive meaningful opportunities to act. Behavioral translation may therefore remain incomplete when motivational conditions, action-related capabilities, contextual supports, and feedback are not coordinated.

The principal theoretical contribution of this framework lies in reorganizing the general knowledge-action gap into a context-sensitive educational process. By integrating the foundational components of the Model of Responsible Environmental Behavior (REB), the self-determination account of motivational internalization, and the action competence approach, the framework does not aim to add new constituent dimensions to ecological civilization literacy or construct a universally applicable model of behavioral prediction. Instead, it distinguishes literacy foundations, motivational internalization, capability development, contextual support, behavioral enactment, and outcome feedback as analytically distinct yet mutually shaping processes. Ultimately, the framework's primary significance is not to declare a uniquely isolated "Chinese model" nor to assume the uncritical cross-cultural transfer of Western theories. Rather, it offers a Chinese-contextualized analytical reconstruction of behavioral translation by interpreting autonomy, participation, and responsibility in relation to the collective and institutional features discussed in Chinese ECE scholarship (Chen & Yuan, 2024). The framework should therefore be understood as a context-sensitive theoretical reconstruction that opens up new paths for empirical examination rather than as a closed or fully validated prescription.

The educational-stage perspective further reframes differences among grades as a question of developmental alignment. Educational stage is not an independent causal variable, and progression should not be judged only by whether older students report more frequent performance of the same low-cost behaviors. The relevant question is whether the reasons, capabilities, opportunities, and forms of participation available to students are adjusted in coordination with changes in cognition, autonomy, and social participation. Progression may involve increasingly self-endorsed responsibility, more complex and transferable action-related capabilities, greater opportunities for deliberation and collaboration, and more autonomous and sustained action across contexts. Everyday practices, collaborative action, and age-appropriate public participation are analytical categories rather than a fixed hierarchy; later development expands students' repertoire of action without making everyday practices unimportant or requiring every student to follow the same behavioral sequence.

Educationally, this means that stage differentiation should not be reduced to adding more difficult knowledge or more activities. Across primary, lower-secondary, and upper-secondary education, ECE can instead coordinate the development of self-endorsed responsibility with progressively more complex action tasks, appropriate participatory authority, contextual supports, and opportunities

for reflection, while retaining basic everyday practices throughout.

The conclusions of this study must be interpreted in light of the methodological boundaries of the underlying evidence. Because the primary survey dataset is cross-sectional and relies predominantly on student self-reports, it can identify descriptive group differences but cannot establish individual developmental trajectories or causal mechanisms. The focal item-level percentages for ecological affect, volunteering willingness, and self-reported behavior analyzed herein reflect specific cohorts (Grades 4, 7, and 10) and must not be generalized to all educational stages, although broader course-provision metrics across seven sampled grades are documented (Ma, 2022). Observed patterns may also be confounded by cohort characteristics, social desirability bias, differential item interpretation, and unequal structural opportunities for action. Furthermore, because the source publications describe sampling and geographic coverage at varying levels of detail—and omit school-level sampling frames, recruitment protocols, nonresponse handling, and weighting adjustments—national generalizability should be approached with caution (Ma, 2022, 2025). Psychometrically, while overall instrument reliability and basic response formats are noted, complete scoring rubrics, subscale or grade-specific reliability estimates, and formal tests of measurement invariance across age groups are absent (Ma, 2025). Given that both publications draw upon the same 82,438-response dataset, they represent a single empirical baseline rather than independent corroborating sources (Ma, 2022, 2025). Finally, although the source instrument contains items nominally addressing responsibility, action skills, course provision, and family support, it does not operationalize these constructs as distinct variables aligned with the proposed framework or test their interrelationships. Consequently, the present framework represents a theory-guided reorganization rather than an empirically validated structural model, and its educational implications remain to be evaluated through prospective interventions.

Future research should first operationalize the three analytical propositions by developing measures that distinguish motivational conditions, action-related capabilities, contextual supports, and different forms of ecological civilization behavior, and by testing their reliability, discriminant validity, score comparability, and measurement invariance across educational stages. Sampling plans should also specify school-level sampling frames, recruitment procedures, nonresponse handling, and weighting procedures so that regional and grade-level comparisons can be evaluated. Longitudinal and multi-source designs involving students, teachers, parents, and schools are needed to distinguish age-related development, educational experience, and cohort differences. Situational tasks, process observation, project portfolios, and school operational records can supplement self-reported behavior. Once the constructs and their relationships have been established, stage-differentiated curricular and participatory interventions can examine whether responsibility deliberation, problem-solving tasks, authentic participation, and outcome feedback influence the occurrence, persistence, and transfer of

ecological civilization behavior.

Ecological civilization literacy is therefore more likely to be enacted as autonomous, sustained, and developmentally appropriate behavior when motivational conditions, action-related capabilities, contextual supports, and opportunities for behavioral feedback develop in coordination across educational stages. The central educational task is not simply to increase what students know or endorse but to enable them to assume appropriate responsibility, determine how to act, participate within meaningful contexts, and learn from the consequences of action.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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