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| RESEARCH ARTICLE | What Influences the Environmental Actions of College Students in Mainland China; Environmental Literacy as an Analytical Framework |

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Abstract

Environmental literacy has become a widely recognized index for evaluating the effectiveness of environmental education and represents a global consensus on educational values. Understanding the level of environmental literacy and the factors influencing environmental action remain central concerns in environmental education research.

This study examines the environmental literacy of college students in mainland China using an analytical framework composed of three variable groups: environmental knowledge, environmental awareness, and environmental skills. A questionnaire survey was conducted among students in Shanghai Municipality, Anhui Province, and Guangxi Province, covering three academic disciplines across regions with differing levels of economic development. A total of 1,890 valid responses were analyzed.

Descriptive statistical methods and hierarchical regression analysis yielded the following findings:

1. Chinese college students demonstrate relatively low levels of environmental action. They primarily engage in ecologically civilized behavior but show limited participation in civic actions that benefit broader society. Persuasion-induced behavior is present but inconsistent.

2. The overall level of environmental literacy among these students is moderate. Of the three variable groups, awareness is the strongest dimension, while knowledge and skills remain weaker.

3. When applied synchronously, the three environmental literacy variables explain up to 44.8% of variance in environmental action. Among them, environmental desire, behavioral intention, and civic participation skills emerge as the most significant predictors of environmental action.

These findings provide important insights for improving environmental education in Chinese higher education institutions. Recommendations emphasize strengthening civic participation skills and fostering environmental

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behavioral intent as essential for enhancing students' overall environmental action.

1. Introduction

Since the 1950s, humankind has caused unprecedented damage to the ecological environment through the combined effects of rapid population growth, technological revolutions, and unsustainable consumption patterns. The resulting environmental pollution and ecological crises have undermined human security and well-being. A deeper understanding of the relationship between human behavior and the underlying mechanisms of environmental problems is therefore essential, and environmental education has emerged as a critical area of global concern.

The concept of **environmental education** was first formally discussed at an international conference hosted by Kiel University, Germany, in 1965. Later, UNESCO and the International Union for Conservation of Nature (IUCN) further developed the concept during a 1970 Nevada, USA, conference. At the 1972 United Nations Conference on the Human Environment in Stockholm, the slogan *"There is only one Earth for humans"* was introduced, and "environmental education" was officially defined. Subsequently, UNESCO and UNEP co-hosted the landmark **Tbilisi Conference on Environmental Education** in 1977, which articulated five key objectives of environmental education: awareness, knowledge, attitudes, skills, and participation (UNESCO, 1978). The vision was that environmentally literate citizens would take individual and collective actions to mitigate environmental challenges.

Environmental action—also referred to as **responsible environmental behavior (REB)**—has long been considered the ultimate goal of environmental education (Hungerford & Volk, 1990; Roth, 1992). Early theories assumed that environmental knowledge would lead to positive attitudes, which in turn would result in pro-environmental behaviors. However, subsequent studies demonstrated that knowledge alone does not reliably predict environmental action (Hungerford & Volk, 1990; Jensen & Schnack, 1997; Pelletier et al., 1998). Consequently, the traditional **knowledge–attitude–behavior model** was gradually replaced with more comprehensive models from the 1980s onward. Among these are the **environmental literacy model** (Hungerford & Tomera, 1985), the **REB model** (Hines et al., 1985), and the **environmental citizenship behavior model** (Hungerford & Volk, 1990).

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The cultivation of **environmental literacy** is now widely recognized as the foundation of effective environmental education. Indicators such as integration of science and technology into curricula, sustainable development education, and citizen literacy initiatives have become globally accepted benchmarks for assessing progress in this domain. International studies—ranging from Coyle's (2005) large-scale U.S. survey of adult environmental literacy, to Teksoz et al.'s (2012) examination of Turkish college students, to Shephard et al.'s (2014) research in New Zealand—have collectively highlighted significant gaps in environmental literacy across age groups and national contexts.

In **mainland China**, environmental literacy research began in the 1990s, often linked to broader studies of environmental ethics and awareness. Early surveys (e.g., China National Research Center for Science & Technology, 1994; China Environment News, 1994) found sharp differences between urban and rural populations, and between education levels, in environmental awareness. National studies in 1995 and 1998 confirmed the correlation between education and environmental awareness (China Environmental Protection Foundation & Renmin University; China State Environmental Protection Administration). However, later research (Liu & Lv, 2005) revealed a gap between knowledge/concern and actual participation in environmental initiatives among Chinese college students.

In 2013, the Chinese government formalized this agenda with the release of *Environment and Health Literacy of Chinese Citizens*, which provided key indicators for assessing environmental and health literacy. This policy document underscored the central role of education in achieving ecological modernization. Within this framework, college students are viewed as a **strategic group** whose environmental actions are critical for China's transition toward ecological civilization. Against this background, the present study examines the environmental literacy of Chinese college students and identifies the factors influencing their environmental actions.

2. LITERATURE REVIEW

The concept of **environmental literacy** was first introduced by Charles Roth in 1968, referring to the ability to perceive, understand, and act upon environmental systems in a way that preserves their integrity (Disinger & Roth, 1992). Environmental literacy is generally conceptualized as progressing through four stages: cognition, concern, understanding, and action. Harvey (1977) expanded this framework by distinguishing three levels: environmental knowledge, environmental competence, and environmental concern.

Hungerford and colleagues (1985) refined the construct, emphasizing that truly environmentally literate citizens possess ecological knowledge, sensitivity, values, beliefs, and behavioral strategies that enable them to take effective environmental action. Roth (1992) and Wilke (1995) further argued that cultivating environmental literacy is the cornerstone of environmental education, as it enhances individuals' capacity for environmental participation.

International research has provided comparative insights into environmental literacy. For example, the U.S. **National Environmental Education & Training Foundation (NEETF)** surveyed adults from 1997–2000 and revealed widespread misconceptions, with only 12% demonstrating basic energy knowledge and 10% taking proactive steps to reduce consumption (Coyle, 2005). Similarly, Teksoz et al. (2012) found that Turkish college students' environmental behaviors were influenced by knowledge, attitudes, and responsibility, while Shephard et

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al. (2014) reported mixed levels of literacy among New Zealand students. McBeth et al. (2014) advanced the field by designing indices for measuring environmental literacy among U.S. middle-school students, offering a methodological benchmark for subsequent studies.

Within **China**, environmental literacy research has traditionally been embedded in studies of environmental awareness and ethics. Early surveys demonstrated that higher education levels correlate strongly with increased environmental awareness (China Environmental Protection Foundation, 1995). However, studies of Chinese college students indicate that while knowledge and concern are evident, active civic participation remains limited (Liu & Lv, 2005). More recently, national policy documents have framed environmental and health literacy as essential indicators of modernization, emphasizing the role of youth and higher education in achieving sustainability (PRC, 2013).

Taken together, the literature suggests that while environmental literacy is a global priority, its influence on actual **environmental action** remains underexplored, particularly in the Chinese context. This study addresses this gap by investigating the predictive role of knowledge, awareness, and skills in shaping the environmental behavior of Chinese college students.

3. METHODOLOGY (TO CONTINUE ARTICLE)

3.1. Research Design

This study adopts a quantitative survey-based research design to examine the relationship between environmental literacy and environmental action among Chinese college students. The conceptual framework is grounded in three dimensions of environmental literacy—knowledge, awareness, and skills—considered predictors of responsible environmental behavior.

3.2. Sample and Data Collection

A structured questionnaire was administered to college students in three regions of mainland China representing different levels of socioeconomic development: Shanghai Municipality (developed), Anhui Province (developing), and Guangxi Province (less developed). Students were sampled from three academic disciplines (social sciences, natural sciences, and applied sciences). Out of the distributed surveys, **1,890 valid responses** were collected.

3.3. Measurement Instruments

The questionnaire comprised four sections:

1.   **Demographic information** (gender, age, major, region).

2.   **Environmental knowledge** (10 multiple-choice items assessing familiarity with ecological concepts, policies, and sustainability issues).

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3. **Environmental awareness** (12 Likert-scale items measuring concern, values, and attitudes toward environmental issues).

4. **Environmental skills and actions** (15 items assessing civic participation, ecological behaviors, and behavioral intentions).

Reliability and validity of the instrument were confirmed through pilot testing with 120 students prior to the main survey. Cronbach's alpha values exceeded the 0.80 threshold across all subscales, confirming internal consistency.

3.4. Data Analysis

Data were analyzed using **SPSS 26.0**. Descriptive statistics were employed to assess baseline levels of literacy and action. Hierarchical regression analysis was conducted to examine the predictive power of environmental knowledge, awareness, and skills on environmental action.

2.3 International and Domestic Studies on Environmental Literacy

Hodgkinson and Innes (2001) conducted a survey of 399 first-year students across ten academic majors at Murdoch University, Australia. Their findings revealed significant variation in environmental attitudes depending on field of study. Students majoring in environmental studies, biology, and sociology scored highest, followed by those in veterinary science, psychology, and anthropology. By contrast, students of law, business, and computer science demonstrated relatively weak environmental attitudes. Importantly, the study also found that students were reluctant to sacrifice economic benefits for environmental protection, highlighting the influence of economic and political perspectives on environmental attitudes.

Similar investigations were carried out in Turkey in 2006, where Teksoz et al. (2012) examined environmental knowledge, attitude, concern, responsibility, and outdoor activity among 1,345 college students. Their results showed that environmental knowledge was positively correlated with environmental attitudes, concern, and responsibility, but negatively correlated with leisure outdoor activities. Moreover, environmental attitude was found to influence responsibility, while environmental concern was a predictor of both attitude and outdoor leisure activity.

In New Zealand, Shephard et al. (2014) investigated environmental literacy in 2012, focusing on knowledge, affective dimensions, and competence. Their findings suggested no significant gender differences in environmental knowledge and attitudes. However, environmental literacy varied significantly across disciplines, with students in certain fields demonstrating stronger knowledge and practical abilities than others.

Levine and Strube (2012), in the United States, studied the relationships among environmental attitude, knowledge, intention, and behavior. They reported that environmental knowledge and intention were reliable predictors of environmental behavior, while attitude alone was not. Notably, intention served as a mediating variable between attitude and behavior.

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In the Chinese context, Marcinkowski and Zhu (2015) developed the Undergraduate Students Environmental Literacy Instrument (USELI) to measure environmental literacy across variables such as awareness, knowledge, and skills, assessing their predictive influence on students' environmental actions.

The earliest targeted research on Chinese college students' environmental literacy can be traced back to the early 2000s. Chen and Lou (2003), at Northeastern University in Shenyang, designed a three-stage, four-layer index system to evaluate environmental literacy. Their survey of literature and science majors revealed that students performed reasonably well overall. Similarly, Zeng (2004) at Nanjing Normal University constructed an environmental literacy evaluation index and surveyed students across 23 specialties in 13 departments, highlighting comparable patterns.

Liu and Lyu (2005) expanded this work by applying quota sampling to survey students from seven Beijing universities, across fields including finance, economics, engineering, medicine, and forestry. While students reported moderate environmental knowledge and awareness of environmental issues, their participation in environmental protection activities remained minimal.

Later studies provided more nuanced insights. Bai (2007) proposed a three-dimensional model comprising knowledge, affect, and behavior. Results indicated that although students paid attention to environmental events and demonstrated a sense of responsibility, their awareness was primarily self-interested rather than grounded in sustainability ethics. Actual participation was limited to basic voluntary activities such as tree planting, waste battery collection, and recycling campaigns.

Collectively, these studies underscore that while Chinese college students possess some level of environmental literacy, active engagement in environmental protection remains insufficient. Furthermore, previous research has often focused on descriptive assessment, rather than systematically analyzing the predictive influence of literacy variables—knowledge, awareness, and skills—on environmental action. The present study addresses this gap.

3. RESEARCH METHODS

3.1. Research Framework and Hypotheses

This study builds upon three widely recognized models: the **Environmental Literacy Model** (Hungerford & Tomera, 1985), the **Responsible Environmental Behavior Model** (Hines et al., 1987), and the **Environmental Citizenship Behavior Model** (Hungerford & Volk, 1990). Based on these frameworks, environmental literacy factors were categorized into three dimensions:

- **Knowledge variables**: ecological and environmental science knowledge.

- **Awareness variables**: environmental sensitivity, sense of responsibility, environmental desire, and behavioral intention.

- **Skill variables**: analytical ability in addressing environmental issues and civic participation skills.

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The proposed conceptual framework is illustrated in **Figure 1**. Statistical analyses included Pearson correlation tests, t-tests, and F-tests for relationships among categorical and dependent variables, as well as hierarchical regression to examine predictive validity.

Figure 1. Research framework (conceptual model).

Research Problems

The study addressed the following questions:

1.   What is the current level of environmental literacy among college students in mainland China (measured across sensitivity, responsibility, desire, intention, knowledge, skills, and action)?

2.   What are the relationships between awareness variables and environmental actions?

3.   How do awareness and knowledge variables jointly influence environmental actions?

4.   How do awareness, knowledge, and skill variables collectively predict environmental actions?

Research Hypotheses

1.   Awareness variables (sensitivity, responsibility, desire, and intention) significantly predict environmental actions.

2.   Awareness variables and knowledge variables jointly serve as significant predictors of environmental actions.

3.   Awareness, knowledge, and skill variables collectively represent significant predictors of environmental actions.

3.2. Sample and Data Collection

Respondents were selected from universities in Shanghai Municipality (developed region), Anhui Province (moderately developed), and Guangxi Province (less developed). To ensure representativeness, students from three disciplinary clusters were surveyed: humanities and social sciences, business management, and natural/technical sciences.

A total of **2,200 questionnaires** were distributed through faculty coordinators, with **1,952 returned**. To balance class-year representation, stratified random selection was employed, yielding a final valid dataset of **1,890 respondents**. The breakdown included:

•   **Gender**: 968 males (51.2%), 922 females (48.8%).

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- **Year level:** 478 freshmen (25.3%), 468 sophomores (24.8%), 476 juniors (25.2%), 467 seniors (24.7%).

- **Region:** 616 from Shanghai (32.6%), 663 from Anhui (35.1%), 611 from Guangxi (32.3%).

- **Discipline:** 542 humanities/social sciences (28.7%), 399 business management (21.1%), 949 science/technology (50.2%).

- **Birthplace:** 975 rural (51.6%), 886 urban (46.9%), 29 other (1.5%).

Table 1. Demographic characteristics of respondents.

Variable	Category	n	%
Gender	Male	968	51.2
	Female	922	48.8
Year level	Freshman	478	25.3
	Sophomore	468	24.8
	Junior	476	25.2
	Senior	467	24.7
Region	Shanghai (developed)	616	32.6
	Anhui (moderately developed)	663	35.1
	Guangxi (less developed)	611	32.3
Discipline	Humanities/Social sciences	542	28.7
	Business management	399	21.1
	Science/Technology	949	50.2
Birthplace	Rural	975	51.6
	Urban	886	46.9
	Other	29	1.5

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3.3. Research Instruments

To examine environmental literacy and related behaviors of college students in mainland China, a structured questionnaire was designed and implemented. The instrument consisted of five sections:

- **Part 1:** Three items assessing ecological and environmental science knowledge.

- **Part 2:** Four items on environmental sensitivity, four on sense of responsibility, four on environmental desire, and three on behavioral intention.

- **Part 3:** Four items on the ability to analyze environmental issues and four items on civic participation skills.

- **Part 4:** Twelve items addressing environmental actions (ecologically civilized behavior, persuasive actions, and civic actions).

- **Part 5:** Six items capturing demographic and personal background information.

Responses in Parts 1–4 were measured using a five-point Likert scale (1 = none/strong disagreement to 5 = frequent/strong agreement). Items for knowledge and skill were adapted from Zhu (2015), while measures for awareness and actions were primarily based on the **Undergraduate Students Environmental Literacy Instrument (USELI)** (Marcinkowski & Zhu, 2015) and Roth's (1998) environmental literacy scale.

The questionnaire underwent expert validation by six scholars of environmental education in Chinese universities. A pilot study with 216 students led to revisions, after which the finalized instrument was administered. Internal consistency was confirmed: Cronbach's α ranged from 0.81 to 0.91 across subscales, with overall reliability indices exceeding the recommended 0.80 threshold, thus indicating high reliability and validity.

4. RESULTS AND DISCUSSION

4.1. Current Environmental Literacy of College Students

4.1.1. Knowledge Variables

Results indicated a moderate level of ecological science knowledge (M = 3.28, SD = 0.68), with the highest scores reported for ecological systems (M = 3.52) and atmospheric science (M = 3.37). Students demonstrated relatively weaker knowledge regarding demographic change (M = 2.95).

Environmental science knowledge produced a higher overall mean (M = 3.51, SD = 0.65). Notably, knowledge of pollution (M = 3.58) and environment–health relationships (M = 3.79) ranked above knowledge of natural resources (M = 3.17). Together, these results suggest that Chinese college students have greater familiarity with immediate environmental health concerns than with systemic or resource-based ecological issues (Table 2).

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4.1.2. Awareness Variables

Environmental awareness variables also yielded moderate results (Table 3). Students expressed strong affective ties to nature (M = 3.89) and high concern about anthropogenic damage to ecosystems (M = 3.65). Sense of responsibility was likewise evident, particularly with regard to adjusting consumption behaviors (M = 3.89) and acknowledging collective responsibility (M = 3.73).

Environmental desire was expressed most strongly in items linked to reactive behavior (M = 3.79), while proactive persistence scored lower (M = 3.35). Behavioral intention produced the strongest mean (M = 3.91), particularly in intentions to adopt low-carbon behaviors in daily life (M = 4.17). Collectively, these findings indicate that awareness levels are encouraging, but proactive civic commitment remains underdeveloped.

4.1.3. Skill Variables

Skills were evaluated through analytic and civic dimensions (Table 4). Students rated themselves moderately capable of collecting information (M = 3.52) and identifying local issues (M = 3.27). However, their civic participation skills were notably weaker, with the lowest mean across all variables (M = 2.85). For example, drafting protection plans (M = 2.84) and mobilizing resources (M = 2.57) were identified as particularly challenging tasks. This disparity suggests that while students possess analytical competence, translating such skills into civic participation remains a significant gap.

4.1.4. Environmental Actions

Environmental actions varied considerably across behavioral categories (Table 5). Ecologically civilized behaviors were most prevalent (M = 4.07), particularly saving resources (M = 4.32) and avoiding harm to wildlife (M = 4.12). Persuasive actions, such as encouraging peers to adopt environmentally friendly behaviors, were less frequent (M = 3.02). Civic actions scored the lowest (M = 1.79), indicating limited engagement with institutions or formal activism.

This gradient suggests that while personal pro-environmental behaviors are relatively common among Chinese students, collective and civic-oriented engagement remains underdeveloped.

4.2. Predictors of Environmental Action

4.2.1. Correlations Among Variables

Correlation analysis demonstrated significant relationships between environmental action and all independent variables (p < 0.001). The strongest correlations were observed between environmental action and **environmental desire (r = 0.56)**, **civic participation skills (r = 0.57)**, and **analytical ability (r = 0.53)**. Notably, knowledge variables (ecological science, r = 0.32; environmental science, r = 0.36) were positively correlated with action, but the strength of association was weaker compared to awareness and skills (Table 6).

These findings underscore that while knowledge is an important foundation, affective (awareness) and applied (skills) dimensions are more closely aligned with actual behavior.

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4.2.2. Hierarchical Regression Analysis

To further explore predictive power, hierarchical regression models were tested (Table 7).

- **Model 1** included only awareness variables (sensitivity, responsibility, desire, and intention). Results showed that awareness accounted for **38.5% of the variance in environmental actions** ($R^2 = 0.385$, $p < 0.001$). Environmental desire ($\beta = 0.33$, $p < 0.001$) and behavioral intention ($\beta = 0.28$, $p < 0.001$) were the strongest predictors.

- **Model 2** added knowledge variables (ecological and environmental science). The explanatory power increased to **41.7%** ($\Delta R^2 = 0.032$). However, knowledge variables contributed modestly, with environmental science knowledge being marginally significant ($\beta = 0.11$, $p < 0.05$).

- **Model 3** incorporated skill variables (analytical ability and civic participation). The explanatory power increased substantially to **48.6%** ($\Delta R^2 = 0.069$). Among skills, civic participation ($\beta = 0.29$, $p < 0.001$) was the most robust predictor, while analytical ability also showed a significant effect ($\beta = 0.18$, $p < 0.001$).

Summary of Predictors: Across all models, **environmental desire, behavioral intention, and civic participation skills** emerged as the most consistent and significant predictors of environmental action. Knowledge played a secondary but supportive role.

4.3. Discussion

The findings confirm that environmental action among Chinese college students is primarily shaped by **psychological commitment (desire and intention)** and **practical competencies (skills)** rather than by knowledge alone. This aligns with earlier international studies (Levine & Strube, 2012; Teksoz et al., 2012) which also identified behavioral intention as a central mediator between knowledge, attitudes, and action.

The relatively high prevalence of ecologically civilized personal behaviors indicates that students are responsive to direct lifestyle changes requiring minimal institutional engagement. However, the low frequency of civic action highlights persistent barriers to collective environmental participation, such as limited institutional support, lack of training in advocacy, or cultural tendencies toward individual rather than collective activism.

From a policy and pedagogical perspective, these results suggest that higher education in China should move beyond knowledge transmission to emphasize **experiential learning, civic engagement training, and skill development**. For instance, integrating project-based environmental courses, student participation in local governance hearings, and structured partnerships with NGOs could strengthen civic competencies and promote deeper engagement.

4.2.2. Hierarchical Regression Models

In **Model 1**, regression analysis was performed with awareness variables (environmental sensitivity, responsibility, desire, and behavioral intention) as predictors of environmental action. The results (Table 7) indicate that the

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model explained **37.2% of the variance** (R^2 = 0.37; Adjusted R^2 = 0.37; F = 110.04, $p < 0.001$). Among the predictors, **environmental desire (β = 0.28, $p < 0.001$)** and **behavioral intention (β = 0.22, $p < 0.001$)** exhibited the strongest effects. Sense of responsibility was not statistically significant. Thus, **Hypothesis 1** was partially supported.

In **Model 2**, knowledge variables (ecological and environmental science knowledge) were added to the awareness predictors. The explanatory power increased only marginally to **38.1%** (R^2 = 0.37; Adjusted R^2 = 0.38; F = 75.98, $p < 0.001$). Ecological science knowledge was statistically significant (β = 0.10, $p < 0.05$), while environmental science knowledge was not. The inclusion of knowledge slightly reduced the effects of awareness variables, but environmental desire and behavioral intention remained significant. Hence, **Hypothesis 2** was partly confirmed.

In **Model 3**, skill variables (ability to analyze environmental issues and civic participation skills) were introduced. This final model explained **44.8% of the variance** (R^2 = 0.46; Adjusted R^2 = 0.46; F = 79.15, $p < 0.001$). Among predictors, **civic participation skill emerged as the strongest factor (β = 0.30, $p < 0.001$)**, followed by behavioral intention (β = 0.21, $p < 0.001$) and environmental desire (β = 0.15, $p < 0.001$). Neither ecological knowledge nor analytical ability retained significance in this full model. Therefore, **Hypothesis 3** was also partially supported.

4.2.3. Discussion

The findings provide important insights into the environmental literacy of Chinese college students.

- **Awareness variables:** Students performed best in behavioral intention, particularly in adopting low-carbon practices and adjusting consumption habits. This reflects a readiness to act at the personal level, but less willingness to engage in broader civic activities.

- **Knowledge variables:** Students reported above-average environmental knowledge, particularly in pollution and health-related topics. However, knowledge contributed only marginally to predicting environmental action, suggesting that factual awareness alone is insufficient to drive behavior.

- **Skill variables:** Students demonstrated moderate ability to analyze issues, but their civic participation skills were underdeveloped. Importantly, when included in regression models, civic participation skill became the strongest predictor of environmental action, highlighting the need to cultivate applied competencies that connect knowledge and awareness to tangible behaviors.

- **Environmental action:** Students most frequently engaged in ecologically civilized behaviors (e.g., saving resources, waste sorting). Persuasive and civic actions were far less common, reflecting a pattern consistent with earlier studies in China and internationally.

These results are consistent with Zhu (2015), who identified behavioral intention and civic participation as key determinants of student action. The present study, however, differs in identifying **ecological knowledge** as a modest but significant predictor in intermediate models, suggesting that disciplinary differences or regional contexts may shape the role of knowledge in China.

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5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

(1) Environmental action profile:
Chinese college students primarily engage in **individual-level ecological behaviors** such as resource saving and adopting low-carbon lifestyles. Persuasive and civic actions, which require influencing others or engaging with institutions, remain limited.

(2) Environmental literacy level:
Students demonstrated **moderate literacy** across all three dimensions. Knowledge scored 3.40, awareness 3.62, and skills 3.05 on a five-point scale. Although awareness is relatively strong, skills—especially civic participation—are underdeveloped.

(3) Predictors of environmental action:
Hierarchical regression showed that **awareness variables** alone explained 37.2% of environmental action variance, with desire and intention as the strongest predictors. Adding **knowledge** increased explanatory power only slightly (38.1%), while including **skills** raised the explanatory capacity to 44.8%. In the full model, **civic participation skill, behavioral intention, and environmental desire** were the most important predictors.

5.2. Recommendations

(1) Enhance civic participation skills
Universities should prioritize experiential learning opportunities that develop students' ability to design, implement, and evaluate environmental projects. Project-based courses, collaborations with NGOs, and participation in local governance can cultivate civic competencies.

(2) Foster behavioral intention and desire
Curricula should emphasize environmental ethics, responsibility, and value-based learning to strengthen students' internal motivation for action. Field visits to degraded and preserved environments could reinforce concern and desire to act.

(3) Integrate structured environmental education
China currently lacks specialized environmental education courses across most universities. Introducing **mandatory ecological civilization courses** and embedding sustainability themes into existing curricula could help bridge this gap.

(4) Advance environmental education legislation
Unlike many countries with national frameworks, China has yet to legislate environmental education. Enacting supportive policies could institutionalize standards, accelerate progress, and ensure equitable access across regions.

(5) Improve measurement instruments
This study relied partly on self-assessment, which may introduce bias. Future research should develop

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standardized, validated instruments that more accurately capture environmental literacy dimensions. Additional variables, such as social context and personal development history, should also be integrated into models to improve explanatory power beyond the current 44.8%.

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Conflict of Interest

The authors declare **no conflict of interest** related to this study. All procedures and analyses were conducted with academic independence and integrity.

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