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From knowledge to action: ecotourism as a methodological framework for geographical competence in higher education

Akmaral Karabayeva[1], Akmaral Tazhekova[2], Imanaly Akbar[1,3], Emin Atasoy[4], Aiman Utemissova[1]
[1]Faculty of Geography and Environmental Sciences, Al-Farabi Kazakh National University, Almaty, Kazakhstan
[2]Department of Geography, South Kazakhstan Pedagogical University named after Ozbekali Zhanibekov, Shymkent, Kazakhstan
[3]Continuing and Professional Education Center, University of California, Davis (UC Davis), Davis, United States
[4]Department of Social Sciences and Turkish Education, Bursa Uludağ University, Bursa, Turkey

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ABSTRACT

Protected places increasingly serve as informal learning spaces that influence visitors' environmental understanding and behavior. This study examines the role of geographical knowledge (GK) in fostering sustainable behavior (SB) using educational methods in ecotourism contexts. A dual-path conceptual model is developed to investigate this, wherein educational influence mediates the links between GK and both cognitive (environmental attitude or EA) and affective (place attachment or PA) dimensions. Data were gathered from 340 individuals, comprising university students and visiting tourists at the Aksu-Zhabagly Nature Reserve in Kazakhstan, a UNESCO World Heritage site. The interactions among the constructs were analyzed using structural equation modeling (SEM). The findings demonstrate that GK substantially improves perceived educational impact (EI), subsequently reinforcing EA, PA, and SB. Although both location attachment and EA positively affect SB, emotional attachment proved to be the most significant predictor. The model accounts for 81% of the variance in SB, underscoring the significance of educational experiences in protected areas and illustrating that the development of sustainability encompasses both cognitive and affective processes.

Corresponding Author:

Imanaly Akbar
Faculty of Geography and Environmental Sciences, Al-Farabi Kazakh National University
71 Al-Farabi Avenue, Almaty, 050040, Kazakhstan
Email: yimanaili_akebaier@yahoo.com

1. INTRODUCTION

The convergence of biodiversity protection and tourism in protected areas has established sustainable development as an urgent worldwide imperative. The enduring preservation of ecosystems is fundamentally contingent upon human behavior; both tourists and residents must adopt ecologically responsible practices, including pollution reduction, adherence to rules, and active environmental stewardship [1], [2]. Nonetheless, despite increasing institutional investment in environmental education, a persistent "cognitive-action disconnect" weakens these initiatives [3], [4]. Individuals who obtain precise environmental knowledge during guided tours or interpretive programs generally revert to unsustainable behaviors quickly thereafter, frequently engaging in littering or disregarding trail boundaries. This gap reveals a significant deficiency in the dominant information-deficit model, which erroneously presumes that the mere providing of knowledge instigates behavioral change [5], [6]. This gap highlights the pressing necessity for educational frameworks that can successfully combine environmental knowledge with practical application.

Meta-analyses demonstrate that knowledge contributes to less than 10% of the variance in pro-environmental behavior [5], [7]. Nonetheless, environmental education persists in prioritizing information as the main intervention focus, neglecting evidence that protected landscapes serve as essential informal learning environments that can cultivate profound awareness and influence value orientations [8]–[10]. Although recent research indicates that environmental views and place connection may be more significant factors influencing sustainable behavior (SB) [11], [12], the current knowledge is still disjointed. Most studies analyze these variables in isolation instead of investigating their interactions within educational processes that collectively influence behavior. As a result, educators are unsure about which mediating processes to prioritize in program design [13], [14]. Furthermore, environmental education is often regarded as a fixed input rather than an evolving psychological process. The function of perceived educational impact (EI), serving as a transformative mechanism that translates information into action, is predominantly under-theorized and lacks empirical substantiation [15], [16]. This study investigates a dual-path sustainability formation approach to address these gaps inside Kazakhstan's Aksu-Zhabagly Nature Reserve. The study presents three contributions: i) the integration of cognitive and affective dimensions into a unified framework; ii) the identification of perceived EI as the pivotal mediating mechanism; and iii) the provision of substantial structural equation modeling (SEM)-based evidence from an underrepresented Central Asian informal learning context.

Attaining sustainability in ecotourism settings necessitates the formation of intricate connections among environmental knowledge, psychological processes, and behavioral results. Historically, protected areas have functioned under the "information-deficit" paradigm, which posits that the mere provision of scientific information will inherently elicit pro-environmental behavior [17]. Nevertheless, a thorough analysis indicates that a continual knowledge-action split persists, even when visitors effectively obtain information [5], as meta-analytical evidence substantiates that knowledge effects conduct only indirectly through intermediary psychological elements [6]. Current frameworks frequently falter due to their disregard for the emotional aspect of learning, while SB arises from the intricate interaction between cognitive and emotional systems, rather than mere knowledge [7], [12], [18]. This study presents a dual-path conceptual model to address this gap, redefining informal teaching as a transforming experience rather than simply an information delivery mechanism.

This study incorporates two significant theoretical frameworks to support its conceptual structure. The value-belief-norm (VBN) theory asserts that environmental attitudes (EA) and personal norms influence moral obligations toward nature [19], thereby outlining the cognitive process that converts raw knowledge into an evaluative stance. Place attachment (PA) theory emphasizes the emotional connection between individuals and particular geographical locations [20]. This paradigm elucidates why emotional connection frequently acts as a more dependable predictor of conservation behavior than information alone [7]. The proposed model integrates these two perspectives, illustrating how EI serves as a vital conduit that engages both cognitive (VBN) and affective (PA) mechanisms, thereby elucidating the process by which knowledge converts into significant pro-environmental behavior.

Geographic knowledge offers the spatial and ecological framework necessary for environmental literacy [21]. Nevertheless, previous studies have often regarded this knowledge as a direct behavioral influence, so neglecting the fundamental instructional process. Knowledge operates as a perceptual filter rather than a definitive conclusion. Visitors possessing a robust geographic comprehension are more adept at interpreting the ecological value of a place, hence enhancing their educational experience [3]. Thus, knowledge functions as the cognitive basis for significant involvement, rather than the final aim of environmental education.

The perceived EI denotes the transforming influence of a learning experience on an individual's values and self-reflection [13]. According to transformative learning theory, significant behavioral change transpires solely through profound psychological transformations, rather than through passive learning [16]. UNESCO-designated areas, such as the Aksu-Zhabagly Nature Reserve, possess rare biodiversity and international acclaim, establishing a powerful "living classroom" that is very conducive to this transition [22]. These unique environments enhance education by involving participants on both cognitive and emotional dimensions. Thus, we suggest that perceived EI serves as a mediator in the link between fundamental knowledge and behavioral consequences. It accomplishes this by concurrently promoting EA via cognitive engagement and enhancing PA through emotional experiences.

In accordance with VBN theory, pro-EA cultivate human responsibilities for ecological stewardship [19], indicating that favorable perceptions of conservation enhance the probability of undertaking responsible activities [23]. Conservation intentions are substantially influenced by emotional links to natural ecosystems. Meta-analyses have confirmed that an emotional bond with nature often predicts conduct more reliably than knowledge alone [7]. Moreover, location connection and environmental views mutually reinforce each other. When individuals feel a sense of "oneness" with a particular site, their evaluative commitment to its conservation is enhanced, hence reinforcing both cognitive and affective pathways to pro-environmental action [12].

The dual-path sustainability formation model constitutes the principal academic breakthrough of this research. It demonstrates how geographical information concurrently engages cognitive and affective circuits through educational influence, representing a notable progression beyond earlier disjointed methods. The empirical evaluation of this concept in Kazakhstan's Aksu-Zhabagly Nature Reserve significantly increases its global significance. This UNESCO World Heritage site, located in a transitional economy, presents a distinctive intersection of post-Soviet visitor anticipations and remarkable biodiversity. Thus, it functions as a vital case study for comprehending how these unique variables can influence wider practices in informal schooling and protected area management globally.

2. METHOD

2.1. Research design and conceptual framework

This research utilizes a cross-sectional quantitative approach, employing SEM as the principal analytical framework. SEM facilitates the concurrent assessment of many mediation pathways, accommodates measurement error in latent variables, and offers extensive model-fit indices for the validation of the complete theoretical framework [24]–[26]. The empirical phase was place at the Aksu-Zhabagly State Nature Reserve, a UNESCO World Heritage site intentionally chosen for its contextual richness as a globally significant "living classroom" [15].

The conceptual framework depicted in Figure 1 synthesizes cognitive learning theory, transformative learning theory, and the dual-path (cognitive-affective) model of behavioral change. SB develops through a three-phase development. In phase 1, geographical knowledge (GK) acts as the epistemological basis: individuals with enhanced geographic awareness more effectively interpret ecological information, hence increasing perceived educational value (H1: GK positively influences EI). In phase 2, EI serves as the primary transformative mediator that transforms information into psychological change [16], while concurrently affecting SB directly (H2: EI→SB), EA (H3: EI→EA), and PA (H4: EI→PA). In phase 3, psychological transformation propels action through two avenues: the cognitive channel (H5: EA→SB) and the affective path, wherein emotional connections forecast behavior [7] and PA bolsters cognitive evaluations of conservation (H6: PA→EA; H7: PA→SB).

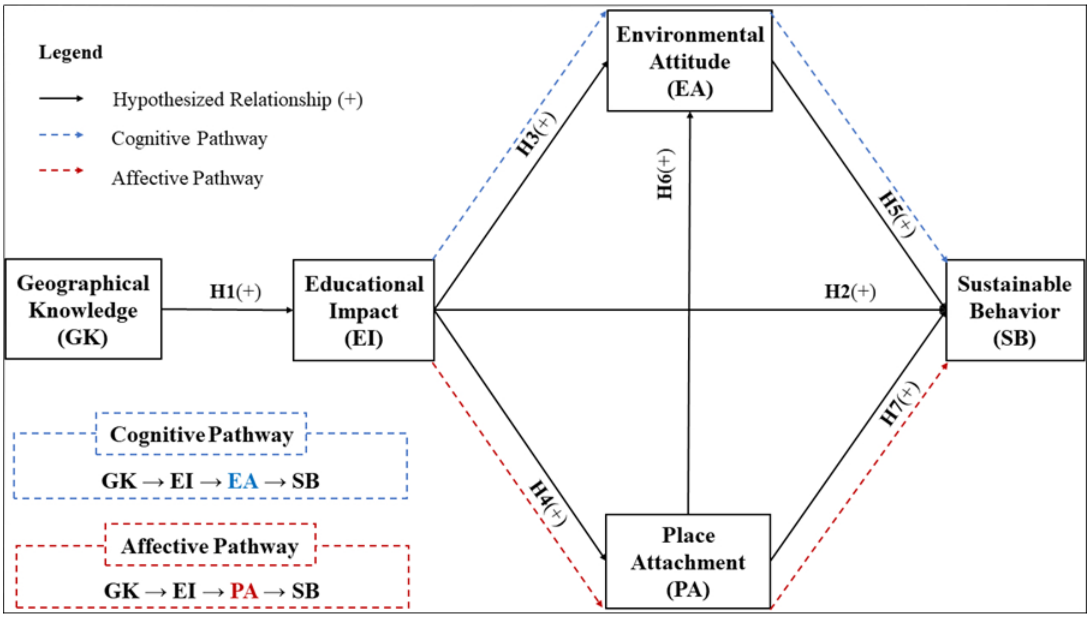

Figure 1. Conceptual framework of the proposed sustainability formation model

2.2. Participants and sampling

A purposive sample method was utilized to gather a total of 340 valid replies. The sample size is statistically enough for covariance-based SEM, exceeding the minimum requirement of 200 participants and the advised 10:1 ratio of observations to estimated parameters necessary for reliable estimation [24]. The dataset is comprised of two equally balanced cohorts: university students involved in academic field activities (n=170, 50%) and public visitors engaging in interpretative programming within the reserve (n=170, 50%). This intentional distribution enabled the study to encompass both formal educational experiences and informal experiential learning contexts, so broadening the analytical scope and improving the generalizability of the results.

The demographic profile of the sample illustrates the study's focused yet inclusive methodology for participant selection. Table 1 illustrates a somewhat balanced gender distribution, with 47.6% of participants identifying as male and 52.4% as female. 90% of respondents were aged 18 to 35, indicating a significant prevalence of educational tourism activities among younger demographics. Moreover, the data indicates that the educational backgrounds of participants were predominantly high, with 75% possessing a bachelor's degree and 20% having acquired postgraduate qualifications.

Table 1. Sample characteristics (N=340)

Variable	Category	Frequency	Percentage (%)
Group	Students	170	50.0
	Tourists	170	50.0
Gender	Male	162	47.6
	Female	178	52.4
Age	18–25	211	62.0
	26–35	95	28.0
	36–50	34	10.0
Education	Secondary	17	5.0
	Bachelor's	255	75.0
	Postgraduate	68	20.0

2.3. Instrument development and data collection

The survey instrument was created using a theory-driven approach, with measuring scales modified from existing research and tailored to the Aksu-Zhabagly reserve situation. The instrument identified five fundamental constructs: GK, based on environmental literacy frameworks; EI, assessed through transformative learning indicators [13]; EA, employing the new ecological paradigm (NEP) scale; PA, derived from the two-dimensional identity and dependence model [20]; and SB, focusing on self-reported conservation actions. All items were assessed with a 5-point Likert scale. To guarantee content validity, the preliminary instrument was subjected to an expert evaluation by a panel of authorities in sustainable tourism and environmental education. Their feedback prompted modest adjustments to enhance item clarity and contextual relevance before comprehensive data collection commenced.

Data were gathered during organized educational and ecotourism activities held within the reserve. Participants filled out the questionnaire directly after academic field visits, guided tours, or interpretive workshops. This prompt method efficiently captured direct learning events and successfully reduced remembering bias [27]. Participation was wholly voluntary, with the research aims being communicated to all participants. Moreover, no identifiable personal information was gathered, therefore ensuring the confidentiality and anonymity of participants throughout the study.

2.4. Data analysis framework

The data analysis adhered to the two-stage SEM methodology by Anderson and Gerbing [26], which was augmented by an additional step for mediation analysis. This approach guaranteed the reliability and validity of the measurement tools before examining structural linkages and indirect effects. Initially, confirmatory factor analysis (CFA) was performed to evaluate the measurement model across three principal dimensions. Initially, internal consistency reliability was assessed using Cronbach's alpha (α) and composite reliability (CR), with acceptable thresholds surpassing 0.70 [28]. Secondly, convergent validity was evaluated using factor loadings ($\geq$0.70) and average variance extracted (AVE$\geq$0.50) [28]. Third, discriminant validity was assessed utilizing the heterotrait-monotrait (HTMT) ratio, with values below 0.85 signifying sufficient differentiation between components [29]. In the second stage, the structural model was calculated, and its fit was assessed using various indices, including χ^2/df (<3), comparative fit index (CFI) ($\geq$0.90), root mean square error of approximation (RMSEA) ($\leq$0.08), and standardized root mean square residual (SRMR) ($\leq$0.08), in accordance with published cutoff criteria [30].

In the third stage, a bootstrapping approach with 5,000 resamples was implemented to examine the indirect effects and mediation relationships within the model [31]. This non-parametric method is especially appropriate for intricate mediation analysis, as it does not presume normality of the sampling distribution and produces bias-corrected confidence intervals. Thus, these findings validate the existence of partial mediation effects within the structural model.

3. RESULTS

3.1. Measurement model assessment

The measuring model was meticulously assessed for reliability, convergent validity, and discriminant validity prior to evaluating structural correlations. Internal consistency reliability was evaluated with Cronbach's alpha and CR. Table 2 indicates that all constructs exhibited strong dependability, with alpha values between 0.90 and 0.94 and CR values from 0.93 to 0.96, exceeding the recommended criterion of 0.70. These reliability indicators affirm that the measurement instruments consistently capture intended constructs across all five latent variables. Table 3 demonstrates that all HTMT values were below 0.85, with the greatest pair being PA and SB at 0.82. The results validate that all constructs are empirically unique and fulfill psychometric criteria, so offering a robust basis for structural model assessment.

Table 2. Reliability and convergent validity of constructs

Construct	Item	Standardized loading	α	CR	AVE
GK			0.91	0.94	0.80
	GK_2	0.98			
	GK_3	0.81			
	GK_4	0.91			
	GK_5	0.80			
EI			0.90	0.93	0.77
	EI_2	0.96			
	EI_4	0.84			
	EI_6	0.96			
	EI_7	0.78			
EA			0.93	0.95	0.82
	EA_1	0.92			
	EA_2	0.84			
	EA_3	0.92			
	EA_4	0.96			
PA			0.94	0.96	0.85
	PA_3	0.86			
	PA_4	0.94			
	PA_5	0.96			
	PA_6	0.92			
SB			0.90	0.93	0.77
	SB_2	0.79			
	SB_3	0.89			
	SB_6	0.92			
	SB_7	0.91			

Notes: all factor loadings >0.70. CR>0.70. AVE>0.50.

Table 3. Discriminant validity assessment (HTMT criterion)

Construct	GK	EI	EA	PA	SB
GK	–				
EI	0.78	–			
EA	0.63	0.81	–		
PA	0.59	0.74	0.76	–	
SB	0.56	0.79	0.73	0.82	–

3.2. Structural model evaluation

The structural model was assessed to examine the suggested links among the constructs. Figure 2 illustrates the directed relationships among them. The model suggests a sequential process in which GK enhances EI, subsequently influencing both EA and PA. The constructs of EA and PA act as direct accelerators for SB. This network of relationships highlights the complex, interrelated paths via which knowledge and education yield concrete sustainable effects.

The model fit indices indicated a satisfactory fit (χ^2/df=2.31; CFI=0.93; RMSEA=0.056; SRMR=0.048). Table 4 indicates that all seven assumptions were validated ($p<0.001$). GK significantly forecasts EI (β=0.69), which then improves EA (β=0.57) and PA (β=0.62). SB is directly influenced by EI (β=0.35), EA (β=0.39), and PA (β=0.44).

A bootstrapping approach with 5,000 resamples was conducted to assess the indirect relationships within the framework. Table 5 indicates that all indirect pathways were statistically significant ($p<0.001$), with 95% confidence intervals not encompassing zero. The most robust indirect pathway was EI→PA→SB (β=0.27), succeeded by EI→EA→SB (β=0.22). The model accounts for 88% of the variance in EI (R^2=0.88), 78% in EA, 85% in PA, and 81% in SB (R^2=0.81).

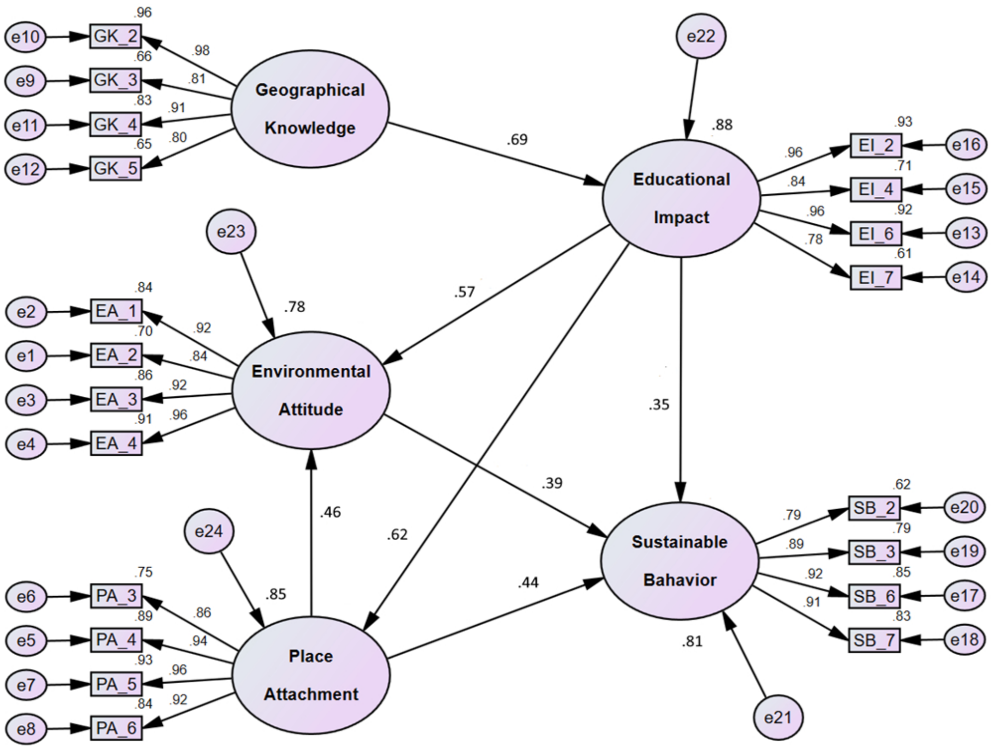

Figure 2. Presents the structural model with standardized path coefficients (model fit indices: $\chi^2/df=2.31$; CFI=0.93; RMSEA=0.056; SRMR=0.048)

Table 4. Structural path coefficients

Hypothesis	Path	Standardized β	t-value	p-value	Result
H1	GK→EI	0.69	12.41	<0.001	Supported
H2	EI→SB	0.35	5.87	<0.001	Supported
H3	EI→EA	0.57	9.76	<0.001	Supported
H4	EI→PA	0.62	10.84	<0.001	Supported
H5	EA→SB	0.39	6.42	<0.001	Supported
H6	PA→EA	0.46	7.88	<0.001	Supported
H7	PA→SB	0.44	7.15	<0.001	Supported

Table 5. Indirect effects (bootstrapping results)

Indirect path	Indirect effect (β)	95% CI	p-value	Mediation type
GK→EI→EA→SB	0.15	[0.10, 0.21]	<0.001	Partial
GK→EI→PA→SB	0.19	[0.13, 0.25]	<0.001	Partial
EI→EA→SB	0.22	[0.16, 0.29]	<0.001	Partial
EI→PA→SB	0.27	[0.19, 0.34]	<0.001	Partial
PA→EA→SB	0.18	[0.12, 0.24]	<0.001	Partial

Note: indirect values computed based on multiplication of standardized paths

4. DISCUSSION

4.1. Dual-path mechanism

Landscape fragmentation caused by natural disasters and human activities can significantly undermine the environmental basis of place connection. This disturbance establishes a macro-ecological boundary condition that can compromise the psychological mechanisms facilitating pro-environmental behavior, as evidenced by volcanic eruptions in Virunga National Park that transformed 20 km² of vegetation into barren lava [32]. Conversely, data from the stable environment of the Aksu-Zhabagly State Nature Reserve, as seen in Figure 3, elucidate how SB is effectively cultivated through dual cognitive and emotional pathways. Emphasizing the cognitive pathway, EI significantly improves EA (EA, β=0.57). This result substantiates VBN theory [19], affirming that educational experiences stimulate personal belief systems to cultivate moral obligation. Consequently, EA enhances SB (β=0.39), indicating that the cognitive assimilation of information effectively elevates behavioral intentions, despite the occasional predominance of immediate local risk variables over value-oriented pathways [33].

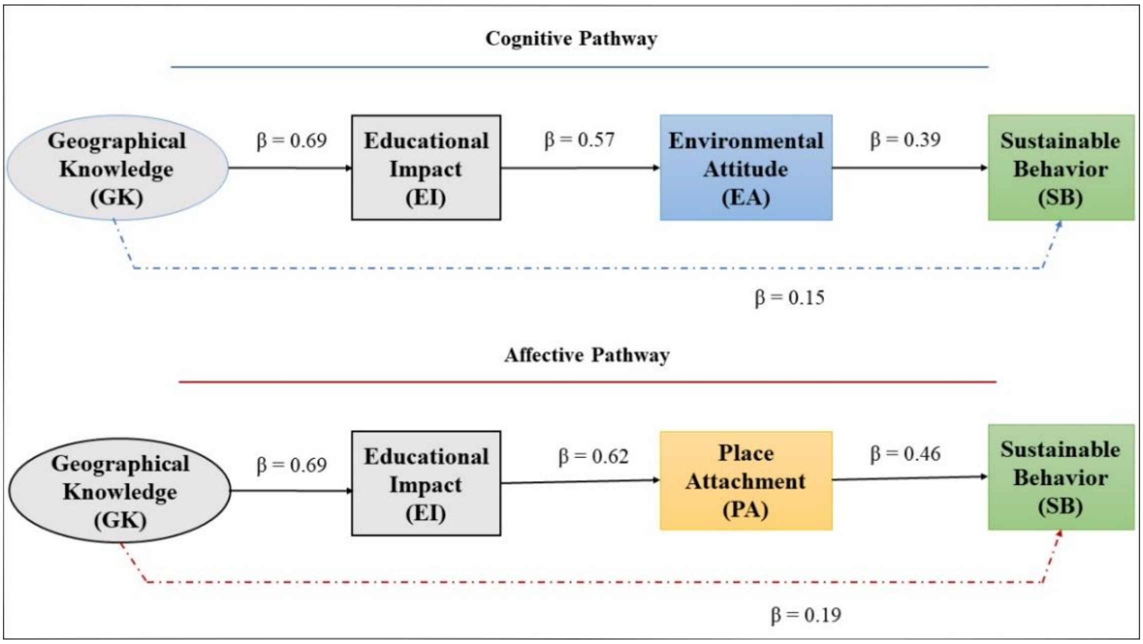

Figure 3. Dual-path sustainability formation model in Aksu-Zhabagly Nature Reserve

In the emotive pathway, EI significantly influences PA (β=0.62), which is the framework's most potent direct predictor of SB (β=0.46). This strong association highlights those emotional connections in ecotourism settings often have a more significant impact on long-term conservation than intellectual understanding alone. Moreover, this emotional pathway seems to function as a universal psychological mechanism in the management of protected areas, as demonstrated by empirical convergence across regions. In the Middle East, Torabi *et al.* [34] discovered that place identity within Iranian heritage communities moderates the intention-behavior association (β=0.155) and mediates the connection between attachment and environmental behavior (β=0.163). In South America, Vera *et al.* [35] demonstrated that visitor happiness strongly influences site attachment, which in turn fosters long-term conservation allegiance among Peruvian visitors.

This study positions EI as a transformative mediator, directly addressing the "knowledge-action gap" [5], and proving that educational experiences engage both pathways concurrently. This differs from passive instruction: a student-led climate initiative in Hong Kong resulted in a 38% decrease in single-use plastics through participatory, co-designed learning [36], while research in India's national parks demonstrates that PA influences recreation involvement and pro-environmental behavior [37]. Collectively, these data substantiate our perspective that protected areas serve as transformative learning environments rather than solely conservation zones.

4.2. Pedagogical and managerial implications

Our findings necessitate a transition from mere fact dissemination to comprehensive cognitive-affective programs across three phases. During the pre-visit phase, GK is stimulated via educational videos, biodiversity fact sheets, and digital mapping (GK→EI, β=0.69). The visit fosters emotional connections through guided inquiry, sensory observation, and place-based storytelling. During the post-visit period, PA is maintained through digital platforms and citizen science initiatives. Table 6 juxtaposes these dual-path tactics with traditional methodologies, grounding each prescription in a particular model coefficient. We advocate for a design ratio of 30/40/30 (30% cognitive, 40% emotive, and 30% behavioral), implemented in the 90-minute interpretive tour template presented in Table 7. This template is versatile for protected locations by maintaining the cognitive-affective-behavioral sequence while incorporating site-specific information.

Three strategic priorities arise for management of protected areas. Initially, allocate resources for interpretative staff training that emphasizes emotional connection development, narrative formulation, and guided contemplation. Secondly, establish post-visit infrastructure via digital follow-ups, alumni networks, and citizen science initiatives. Third, implement dual-path evaluation frameworks that assess both cognitive and emotive outcomes. These findings nationally endorse Kazakhstan's Green Economy 2050 Strategy and the Aksu-Zhabagly Management Plan (2018–2028). The dual-path model offers an empirical framework for (sustainable development goals) SDG 4.7 (transformative education) and SDG 15 (terrestrial environment protection) on a global scale, consistent with interpretive frameworks at other UNESCO reserves like Dinghushan, China.

Table 6. Comparison of information-deficit versus dual-path teaching strategies

Current practice	Recommended strategy	Empirical basis
Information-only lectures	Experiential, emotion-based learning	PA→SB (β=0.46)
Passive knowledge transmission	Reflective activities (journals, group discussion, storytelling)	EI R^2=0.88 mediates GK→SB
Generic environmental facts	Place-based narrative interpretation (local ecological/cultural stories)	PA→EA (β=0.46) and PA→SB (β=0.44)
One-time information delivery	Post-visit reinforcement (digital follow-up, citizen science)	EI→PA (β=0.62)

Table 7. 90-minute guided tour template for Aksu-Zhabagly Nature Reserve

Time	Activity	Targeted mechanism	Specific technique
0–10 min	Introduction: biodiversity facts + maps + UNESCO significance	GK→EI	Visual aids, distribution maps
10–25 min	Sensory walk: "Listen, smell, touch" at 3 stops	EI→PA	Guided silence, sensory journaling
25–45 min	Interpretive talk: ecological significance + conservation stories	EI→EA	Storytelling with local rangers
45–60 min	Group reflection: How does this place matter to you?	PA→EA	Facilitated discussion, empathy building
60–75 min	Commitment card: writing a specific pro-environmental action	EA/PA→SB	Written pledge, peer sharing
75–90 min	Closing ritual: collective reading of commitments + symbolic action	SB reinforcement	Ceremonial closure, memory anchoring

5. CONCLUSION

Empirical evaluation of the dual-path model at Aksu-Zhabagly State Nature Reserve indicates that geographical information alone is inadequate for fostering ecologically responsible behavior. Knowledge must be mobilized through educational influence, which concurrently activates a cognitive channel via EA and an emotional one through PA. The emotional connection was identified as the most significant direct predictor of SB (β=0.46), with the integrated model accounting for 81% of the total variation (R^2=0.81). These findings demonstrate that the knowledge-action gap is not unavoidable; instead, it signifies a fundamental design deficiency in programs that emphasize passive information dissemination rather than active emotional involvement.

This study theoretically integrates PA theory and VBN theory, illustrating that cognitive evaluation and emotional connection function synergistically rather than as conflicting mechanisms. The 30/40/30 paradigm and 90-minute interpretive tour template offer educators and program creators flexible, evidence-based resources. The findings advocate for managers and policymakers to invest in interpretative staff training, post-visit interaction infrastructure, and dual-path outcome evaluations, establishing UNESCO biosphere reserves as dynamic labs for SDG 4.7 and SDG 15.

Numerous constraints indicate prospective avenues for future investigation. The cross-sectional approach limits causal inference; longitudinal research is necessary to monitor the evolution of PA and SB over time. Self-reported measures include social desirability bias, and the sample's concentration at a single location and predominance of younger, educated visitors restrict generalizability. Comparative analyses across various biological locations and cross-cultural validation of the 30/40/30 model among different biosphere reserve categories would enhance empirical robustness. Subsequent research should assess digital post-visit interventions and broaden dual-path validation to encompass local buffer-zone inhabitants. Knowledge serves as the seed, while emotional connection facilitates the establishment of sustainability.

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AUTHOR CONTRIBUTIONS STATEMENT

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Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Akmaral Karabayeva	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Akmaral Tazhekova	✓	✓				✓		✓	✓	✓	✓	✓		
Imanaly Akbar	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Emin Atasoy	✓	✓				✓		✓	✓	✓	✓	✓		
Aiman Utemissova		✓			✓	✓	✓			✓		✓		✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationship that could have appeared to influence the work reported in this paper.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study. Participants were informed about the purpose of the research and their right to withdraw at any time.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [IA], upon reasonable request. Due to ethical and privacy considerations, the dataset containing respondent information cannot be made publicly available.

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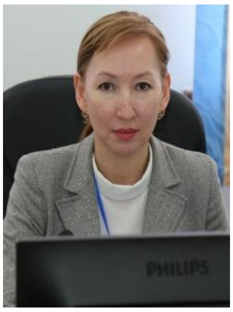
BIOGRAPHIES OF AUTHORS

Akmaral Karabayeva is a Ph.D. student in Geography at Al-Farabi Kazakh National University, Almaty, Kazakhstan. Her academic work focuses on advancing knowledge in environmental education and its role in promoting sustainable practices within ecotourism destinations. She is particularly interested in ecotourism development and sustainable tourism in protected areas, with an emphasis on fostering environmentally responsible behavior. She can be contacted at email: akmaralkarabayeva1@gmail.com.



Akmaral Tazhekova is an associate professor at the South Kazakhstan Pedagogical University named after Uzbekali Zhanibekov, Shymkent, Kazakhstan. She is actively engaged in teaching and research in the field of geography and environmental education, contributing to the development of innovative educational practices in higher education. She holds a Ph.D. and is head of the Department at South Kazakhstan State Pedagogical University. Her research focuses on geography education, environmental sustainability, and educational methods in environmental studies. She can be contacted at email: tazhekova.akmaral@okmpu.kz.

Imanaly Akbar is an associate professor of Social and Economic Geography at Al-Farabi Kazakh National University, Kazakhstan, and a visiting scholar at UC Davis Continuing and Professional Education, University of California, Davis, USA. His research focuses on environmental education, sustainable tourism, and smart city development. He is an active researcher focusing on the intersection of sustainable tourism, smart city development, and environmental planning, particularly in the context of developing countries and transitional economies. He can be contacted at email: yimanaili_akebaier@yahoo.com.

Emin Atasoy is a professor at Bursa Uludağ University, Turkey, working within the Faculty of Education, particularly in the Department of Social Sciences Education. He is a well-established academic with extensive international collaboration, especially with Central Asian universities, including Kazakhstan. His academic contributions include supervising doctoral students and participating in joint research projects that resulted in numerous publications indexed in Scopus and Web of Science. He can be contacted at email: eatasoy@uludag.edu.tr.

Aiman Utemissova is a Ph.D. student at Al-Farabi Kazakh National University, Almaty, Kazakhstan. Her academic work focuses on the intersections of tourism geography and environmental education, with particular attention to promoting sustainability within tourism development. She is engaged in research that explores innovative approaches to fostering environmentally responsible practices in tourism contexts. Her research interests include tourism geography, environmental education, and sustainable tourism development. She can be contacted at email: aimanutemissova6@gmail.com.