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From Fear to Inquiry: Ecological Knowledge, Affective Change, and Behavioural Spillover in a Fungi-Focused School Environmental Education Programme in Himachal Pradesh of India

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Abstract:

Fungi occupy an ecologically vital yet culturally ambiguous position in many South Asian communities, where inherited narratives of toxicity and danger frequently mediate children's interactions with these organisms. This study examines how an experiential, fungi-focused environmental education program delivered by the Eco Vigyan Foundation (EVF) across 13 schools in Himachal Pradesh, India, influenced ecological knowledge, affective orientations, and pro-environmental behaviours among students and teachers, and whether these changes extended into household contexts. A descriptive pre-post survey design was employed, with data collected from students, teachers, and parents before and after program implementation. The study adopts an integrative theoretical framework drawing on Knowledge-Attitude-Practice model, Identity-Based Environmental Education, Social Learning Theory, and ethnomycological perspectives to examine the mechanisms through which behavioural change is initiated, sustained, and diffused. Findings indicate that the program generated substantial improvements in fungal ecology knowledge, near-elimination of mysophobia, and strong pro-environmental identity formation across both student and teacher cohorts. Evidence of intergenerational learning was also observed, with children frequently communicating ecological knowledge and observational practices within their households. The findings of the present study contribute to the growing body of evidence supporting experiential and culturally grounded approaches to environmental education, and highlight the potential of school-based programmes to function as behavioural learning ecosystems extending well beyond the classroom into families and communities.

Keywords: Environmental Education (EE), Fungi, Mysophobia, Behavioural change, social learning, Knowledge-Attitude-Practice

Introduction

Children's engagement with biodiversity is fundamental to the development of long-term environmental awareness and pro-environmental behaviour. However, interactions with certain organisms are often mediated by culturally acquired fear, stigma, or superstition rather than ecological understanding. Fungi represent a paradigmatic example of this phenomenon. Mushrooms and other macro fungi are ingrained in societal narratives of poison, danger, spiritual impurity, or avoidance in many South Asian and Himalayan societies. These perceptions, transmitted through family narratives and local belief systems, constrain children's curiosity, discourage responsible interaction, and undermine appreciation of the ecological roles that fungi perform as decomposers, nutrient cyclers, and mycorrhizal partners of forest systems (Dorjey and Sharma 2021; Boa 2004).Environmental Education (EE) is widely acknowledged as a way to overcome these perceptual barriers, particularly when it is delivered in immersive, location-specific, and context-specific formats that go beyond transient awareness campaigns (Bogner 1998; Chawla 1999). However, despite growing interest in the topic, most program evaluations continue to emphasise knowledge acquisition as the primary outcome measure, and many are restricted in their examination of affective, identity-related, and social dimensions of learning. This is a critical gap, since empirical data consistently show that information alone cannot produce long-lasting behavioural change, particularly when the target organism is associated with cultural stigma, fear, or disgust (Salas-Zapata et al. 2018; Slovic et al. 2007).

To address these gaps, this research looks at the Eco Vigyan Foundation's initiative, which is a fungi-focused environmental education intervention offered through experiential and observation-oriented learning embedded within regular school routines across 13 schools in Himachal Pradesh. The programme uses guided nature walks, games like fungal bingo, geotagging exercises, and hands-on activities such as spore printing and mushroom photography, combined with storytelling and myth-busting sessions to replace fear with curiosity for the species of mushrooms. In light of this, the study addresses a central research question, "How does a fungi-focused environmental education programme influence students' knowledge, attitude, and behaviour, and how do these changes extend through social interactions within schools and household contexts? Drawing on baseline and endline survey data from students and teachers alongside endline parent responses, the study analyses changes across knowledge, affective orientation, behavioural practice, environmental identity, and social spillover. The findings are then interpreted through four complementary frameworks, Knowledge-Attitude-Practice (KAP) models (Salas-Zapata et al. 2018), Identity-Based Environmental Education (IBEE; McGuire 2015), Social Learning Theory (SLT; Bandura 1986), and ethnomycological perspectives (Dorjey and Sharma 2021; Boa 2004), to explain not only what changed, but why and how.

This study makes three contributions to the environmental education literature. First, it moves beyond knowledge-based assessment to incorporate affective, identity-based, social, and cultural dimensions of change. Second, it adopts a systems perspective that captures mutual learning across students, teachers, and families. Third, it presents empirical evidence from fungi-based environmental education in a culturally specific Himalayan context, offering insights for the design of psychologically informed and culturally grounded educational interventions for organisms that are feared, stigmatised, or ecologically overlooked.

Literature Review

In order to understand how environmentally responsible behaviours of children are developed, in particular, when the responsibility is in relation to organisms that meet criteria of fear or stigma, an integrated approach that would incorporate cognitive, affective, identity-based, social, and cultural levels of learning is needed. According to empirical evidence that has been persistent and consistent, behavioural change in environmental education cannot be explained by knowledge increase alone; rather, it is a complex interaction of identity formation, modelling processes, and culturally embedded systems of meaning that influence children's emotional and behavioural responses to nature.

The literature reviewed here draws on four key bodies of research relevant to understanding children's engagement with environmentally sensitive or culturally stigmatised organisms, which are the Knowledge-Attitude-Practice (KAP) model, Identity-Based Environmental Education (IBEE), Social Learning Theory (SLT), and ethnomycological studies of fungi. Together, these frameworks and studies offer a multidimensional understanding of how fear, curiosity, and environmentally responsible behaviours develop through sustained learning processes.

Cultural History and the Meaning of Mushrooms

Ethnomycological research highlights that fungi are embedded within culturally specific systems of meaning that shape emotional responses and behavioural practices. Mushrooms frequently carry symbolic, moral, or spiritual connotations within folk taxonomies, often associated with danger, impurity, or taboo (Boa 2004; Dorjey and Sharma 2021). Vernacular naming practices and metaphoric associations reinforce avoidance and stigma, contributing to widespread mycophobia.

At the same time, ethnomycological studies document histories of culinary, medicinal, and ecological use of fungi, revealing an ambivalent coexistence of mycophobia and mycophilia (Hunn, 2007). Such cultural ambivalence produces emotionally charged risk perceptions that cannot be explained by lack of knowledge alone. This aligns with affect-based decision-making research demonstrating that fear and disgust powerfully shape judgements and behaviours, often overriding factual understanding (Slovic et al. 2007). From this perspective, mushroom avoidance reflects socially inherited meanings rather than ignorance, underscoring the importance of addressing cultural narratives and affective responses within environmental education.

Theoretical Frameworks

The KAP model has been extensively used to measure learning outcomes in environmental education by assessing factual knowledge, attitudinal change, and self-reported practices over time. While useful as a descriptive tool, meta-analyses indicate that KAP frameworks often lack predictive validity and rarely account for affective or contextual factors that mediate behaviour change (Salas-Zapata et al. 2018). These limitations are especially pronounced in contexts where organisms are feared or stigmatised. Children may possess accurate knowledge while continuing to display avoidance behaviour due to culturally inherited risk perceptions shaped by fear and disgust (Slovic et al. 2007). As a result, KAP provides a helpful baseline for documenting change, but it is insufficient to explain how knowledge is internalised and sustained.

Identity-Based Environmental Education (IBEE) addresses these limitations by emphasising identity formation as a core mechanism of durable environmental behaviour. Rather than treating learning as a linear cognitive process, IBEE proposes that behavioural persistence emerges when environmental understanding becomes integrated into the learner’s self-concept, values, and sense of belonging (Clayton 2012; McGuire 2015). Identity-based approaches foreground affective meaning-making and self-categorisation processes through which learners begin to see themselves as nature observers, caretakers, or responsible ecological actors. Such shifts allow previously feared organisms, including fungi, to be re-categorised from objects of avoidance to objects of inquiry and care.

Where IBEE explains internalisation, Social Learning Theory (SLT) explains how behavioural competence is socially acquired. Bandura’s formulation of SLT emphasises observational learning, modelling, reinforcement, and self-efficacy as central processes through which behaviour is learned and maintained (Bandura, 1977, 1986, 1997). Research consistently shows that children are strongly influenced by peer modelling and visible social norms, often more than by direct adult instruction (Ata 2018). Such social learning processes are particularly important in contexts involving fear or uncertainty, as observing calm and competent behaviour in others can reduce anxiety and support behavioural adoption over time.

Synthesis

Across these bodies of literature, a consistent pattern emerges: knowledge acquisition alone is insufficient to explain perceptual and behavioural change in children participating in longitudinal environmental education interventions. KAP frameworks document cognitive and reported behavioural change but do not account for affective, social, and cultural processes. IBEE explains how identity formation enables internalisation, SLT clarifies how behaviours are socially learned and normalised, and ethnomycology situates fear and stigma within broader cultural systems of meaning. Taken together, the literature reveals a gap in empirical research examining how identity, social learning, and culturally embedded fear interact over time in relation to fungi and other culturally sensitive organisms within environmental education contexts.

Study Area

The study was conducted across 13 schools associated with the EVF programme in Himachal Pradesh, India, spanning the districts of Solan, Shimla, Kullu, and Bilaspur (Table 1). These districts lie within the Western Himalayan zone and encompass a heterogeneous mosaic of farmlands, village greens, forest fringes, and horticultural landscapes typical of the mid-hill region. The physical environment provides regular and informal encounters with local biodiversity, including macro fungi that colonise soil, leaf litter, decaying wood, and damp microhabitats along field and forest edges. The monsoon season (June-September) and post-monsoon period (October-November) generate moisture and temperature conditions that favour fungal fruiting, making fungi a seasonally visible and ecologically relevant component of the school landscape during the academic year. This situates environmental learning programmes within a live, location-specific context rather than an abstract or classroom-only context. The schools associated with the EVF programme have communities that are primarily agricultural or semi-agrarian, with direct economic ties to horticulture and forestry, reflecting a rural socio-economic context typical of the mid-hill Western Himalayan region.

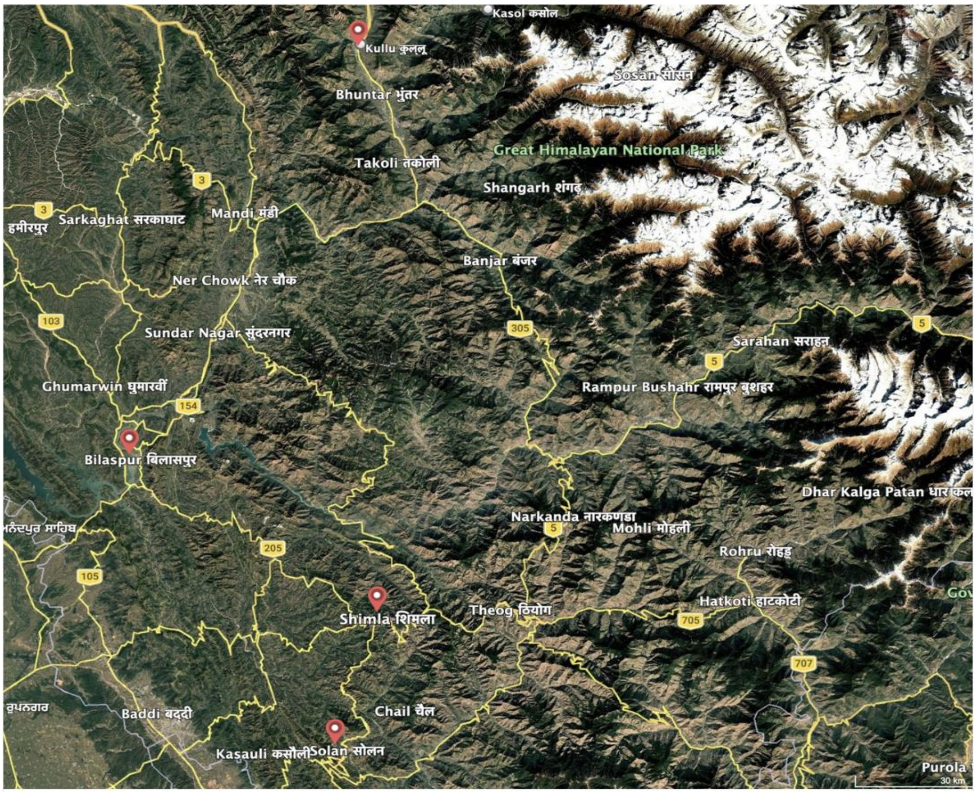

Figure 1. Map of Himachal Pradesh showing the four study districts – Solan, Shimla, Kullu, and Bilaspur – where the 13 EVF programme schools are located.

Table 1. Name and locations of the schools participating in the EVF programme

Sr. No.	Schools	Town	District
1	Alpine Public School	Nalagarh	Solan
2	Cambridge International School	Mohal	Kullu
3	GGSSS Ghumarwin	Ghumarwin	Bilaspur
4	GMSSS Mashobra	Mashobra	Shimla
5	GSSS Bhont	Bhont	Shimla
6	GSSS Dhamandri	Dhamandri	Shimla
7	GSSS Kalhog	Kahlog	Solan
8	GSSS Kufri	Kufri	Shimla
9	GSSS Oachghat	Oachghat	Solan
10	GSSS Sarog	Sarog	Shimla
11	MRA DAV Public School	Solan	Solan
12	SDS DAV CPS Kumarhatti	Kumarhatti	Solan
13	Shivalik Valley School	Nalagarh	Solan

Methodology

Study Design

A descriptive pre-post intervention survey design was used to evaluate the Eco Vigyan Foundation (EVF) programme. Baseline surveys were administered to students and teachers before programme implementation, and endline surveys were given once the programme was completed. Parent surveys were conducted only at the endline to capture household spillover effects. Data collection (January-September 2024) coincided with the monsoon and post-monsoon fungal fruiting seasons, providing seasonal availability of macrofungi for programme operations and survey administration. It should also be noted that the baseline and endline samples were not individually paired due to a higher attrition rate among students as well as a lower rate of attrition among teachers. Therefore, all analyses were conducted at the group level, and baseline-to-endline comparisons reflect shifts in group-level proportions, rather than individual trajectories.

Participants and Sampling

The research involved 13 schools in four districts of Himachal Pradesh (Solan, Shimla, Kullu, and Bilaspur), including both government and private institutions in semi-agrarian mid-hill populations. Schools were carefully chosen from the 17-school EVF network based on programme participation and data quality. There are three stakeholder groups as part of the study: Students, Teachers and Parents. At baseline, 235 students and 59 teachers from 13 schools responded. At the endline, 121 students and 43 teachers from the same schools participated. Around 20 parents from 5 schools also became a part of the study at the endline. Moreover, students were enrolled in classes 6 through 12, ranging in age from approximately 11 to 18 years. Based on the data, the retention rate among students is 51.5% and among teachers is 72.9%. The attrition in this study was due to practical restrictions of school-based evaluation, such as shifting class schedules and staff migration. However, the distribution of schools and class levels at the endline was largely proportionate to the baseline, indicating no systematic bias.

Table 2. The distribution of the stakeholders (respondents) by school at baseline and endline

Sr. No.	**Schools**	**No. of Student Respondents**		**No. of Teacher Respondents**		**No. of Parent Respondents**
		Baseline	**Endline**	**Baseline**	**Endline**	**Endline**
1	**Alpine Public School**	9	5	5	1	
2	**Cambridge International School**	42	21	4	4	3
3	**GGSSS Ghumarwin**	11	6	1	1	
4	**GMSSS Mashobra**	29	18	8	8	3
5	**GSSS Bhont**	20	13	1	1	
6	**GSSS Dhamandri**	12	6	7	7	7
7	**GSSS Kalhog, Solan**	16	7	4	1	
8	**GSSS Kufri**	14	7	6	6	3
9	**GSSS Oachghat**	15	8	5	1	
10	**GSSS Sarog**	11	5	8	8	4
11	**MRA DAV Public School**	17	7	3	3	
12	**SDS DAV CPS Kumarhatti**	23	8	2	1	
13	**Shivalik Valley School**	16	10	5	1	
	Total	**235**	**121**	**59**	**43**	**20**

Survey Instruments

Printed questionnaires were developed in both English and Hindi languages. Content validity was established through expert review by EVF staff; formal reliability testing was not conducted, consistent with the descriptive programme evaluation orientation.

Student and teacher instruments

Both instruments contained a core set of 13 identical questions administered at baseline and endline. These assessed questions with respect to emotional responses to nature, curiosity and inquiry behaviour, social sharing about fungi, affective responses to touching wild mushrooms, weather preferences, weekly outdoor time, basic knowledge of local mushroom names, common toxicity misconceptions, fungal growth substrates, knowledge of fungi's role in climate change, nature observation habits, and independent nature-related skills. The endline for both students and teachers added 28 new items (totalling 41 items) designed to measure programme-specific outcomes aligned with the study's theoretical frameworks (Knowledge-Attitude-Practice, Identity-Based Environmental Education, Social Learning Theory).

These additional questions at the endline assessed factors influencing behaviour change, perceived programme helpfulness, preferred pedagogical methods, social sharing with family, observed behavioural change in others, environmental identity and values, barriers to behaviour continuation, self-efficacy and collective efficacy, social learning pathways, prior ecological knowledge, attitudinal change toward fungi, adoption of specific conservation practices, nature connectedness, and support for mushroom protection policies. Items used Likert, multiple-choice, multiple-select, and open-ended formats. The teacher instrument mirrored the student instrument exactly for the 13 core and 28 additional items, with the addition of demographic identifiers.

Parent instrument

An 11-item questionnaire assessed children's communication about fungi within the household, observed changes in the children's interest in nature, intergenerational knowledge transmission, parental attitudinal change, belief in children's influence on adult environmental awareness, personal attentiveness to nature, support for nature-based school activities, and qualitative accounts of surprising moments of child-led ecological learning.

Data Analysis

Quantitative data were entered into Microsoft Excel and analysed descriptively.

- Baseline-to-endline comparisons (13 core items). For students and teachers, we calculated frequencies, percentages, and percentage-point differences (pp) between baseline and endline group proportions. No inferential statistics were applied because the samples were non-paired and the study is descriptive.
- Endline-only items (28 items for students and teachers; 11 items for parents). These were reported as endline percentages without baseline comparison. They serve to characterise programme mechanisms, behavioural drivers, and spillover effects.
- Open-ended responses. Thematic coding was used to identify recurring themes; representative examples were selected to illustrate qualitative findings.

Anonymity was maintained throughout. No names were collected. Informed verbal consent was obtained from school principals, teachers, and parents; student assent was secured through programme opt-in.

Results and Findings

Students' Component

Student data were gathered from 13 schools at baseline (N=235) and endline (N=121), with a retention rate of 51.5%. Students were enrolled in Classes 6–12 (ages ~11–18). The attrition here reflects practical constraints of school-based longitudinal surveys (varying class schedules, student mobility) but was not systematically skewed. The distribution of classes and schools at the endline was broadly proportional to the baseline. Because the baseline and endline samples were not individually matched, all comparisons are provided at the group level as percentage-point differences. Moreover, the endline added 28 additional questions (totalling 41) to measure programme outcomes associated with KAP, IBEE, and SLT frameworks. The findings below summarise the changes found in students' connectedness with nature, ecological knowledge, outdoor behaviour, skills acquisition, social sharing, environmental identity, and barriers to behaviour change.

Nature connectedness and affective engagement

One of the most pronounced transformations between baseline and endline responses concerned students' emotional relationship with nature and fungi. The proportion of students reporting that they feel 'deeply connected to nature' rose from 29.8% at baseline to 98.3% at endline (+68.5 pp), while the proportion feeling 'calm but not very interested' fell to zero. Affective responses towards wild mushrooms showed equally dramatic change. Confidence in touching or handling a wild mushroom, the single largest shift in the entire dataset, increased from 3.8% to 95.0% (+91.2 pp). Fear and nervousness each decreased, and no student reported disinterest. Ecological attentiveness improved correspondingly. Around 95.0% of the students said that they loved observing nature at the end of the programme, up from 43.0% at the beginning (+52.0 pp).

Inquiry orientation and ecological knowledge

Students entered the programme with a strong baseline disposition toward inquiry, wherein 50.6% reported actively trying to find out more about unusual observations in nature, while 35.7% reported they would carefully observe or photograph the objects. By endline, 98.3% reported active inquiry, and no student reported ignoring unusual natural phenomena. Knowledge of fungal ecology improved substantially across all measured domains. Understanding that mushrooms can grow on a wide range of substrates, including insects, as in the case of *Cordyceps*, increased from 16.6% to 99.2% (+82.6 pp). Furthermore, several mushroom-related misconceptions were debunked throughout the process, including the belief that brightly colored mushrooms are deadly and the misperception that touching a poisonous mushroom causes poisoning. Climate literacy, one of the most conceptually demanding areas, also showed significant improvement. The proportion of students correctly identifying that fungi help forests stay healthy rose remarkably, while uncertainty about the relationship between fungi and climate change declined. Species-level naming, however, remained limited.

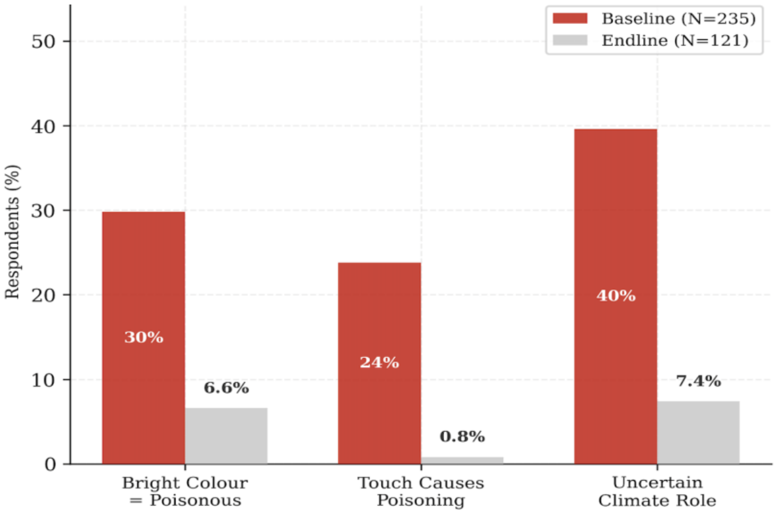

Figure 2: Elimination of Misconceptions surrounding mushrooms among students

Outdoor behaviour and nature skills

Concrete lifestyle-level changes were evident in reported time spent outdoors. The proportion of students spending 3-5 hours per week outdoors increased substantially, and those spending more than five hours per week also rose. No student reported avoiding outdoor time at the end of the programme. Skills acquisition was near-universal. At baseline, 28.1% of students reported having no nature-related skills; by endline, this proportion fell to zero. Every measured skill showed substantial gains. Knowing where to find mushrooms, knowing what tools to carry, knowing how to preserve specimens, knowing safety practices on a mushroom walk, and being able to take identification-friendly photographs showed a sharp increase.

Environmental values and self-efficacy

Near-universal strengthening of environmental identity was observed across five dimensions. 99.2% of students felt more confident to talk about nature at the end of the programme, compared to 21.7% at baseline (+77.5 pp). Similarly, almost all of the students reported a stronger desire to learn more and felt more responsible for the environment. High environmental self-efficacy was evident at the end of the programme.

97.5% of the students believed that personal actions have a huge environmental impact, and 99.1% agreed that small individual actions lead to community change.

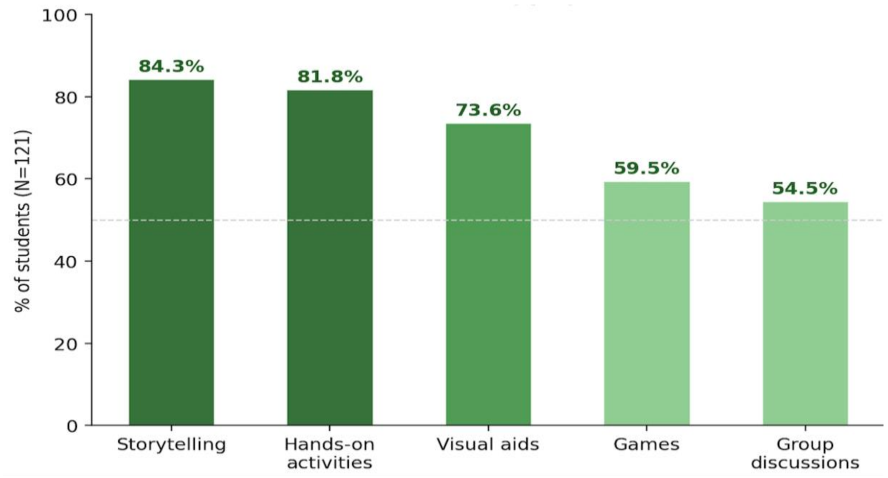

Figure 3: Pedagogical Methods rating as per the students at the endline

Further, 96.7% expressed willingness to support conservation rules or programmes for mushrooms, and 95.9% reported positive attitudinal change toward fungi, with no negative attitudinal change recorded. Program meme endorsement was strong as well. 94.9% of the students rated the EVF programme as very or extremely helpful, with storytelling (84.3%) and hands-on activities (81.8%) identified as the most impactful pedagogical elements.

Social Learning Pathways and Barriers to behaviour change

Social and communicative dimensions of learning were substantially enhanced. The proportion of students reporting that they love to share fungal observations and learnings after nature walks rose from 37.0% to 99.2% (+62.2 percentage points). Moreover, social learning through peer observation was confirmed as a primary adoption pathway. 91.7% of students at the endline reported having observed others practising nature-friendly behaviours before adopting those behaviours themselves, consistent with Bandura's (1986) observational learning model. Positive reinforcement was affirmed as sustaining behaviour, with 97.6% of students agreeing that recognition and appreciation had encouraged continued practice. Despite the breadth and depth of positive change, students identified persistent barriers to sustaining their practices. Insufficient time was cited most frequently, followed by forgetting. The influence of unsupportive peers was also cited as one of the reasons. These barriers are structural and habitual rather than motivational in character, mirroring those identified in the teacher dataset as well.

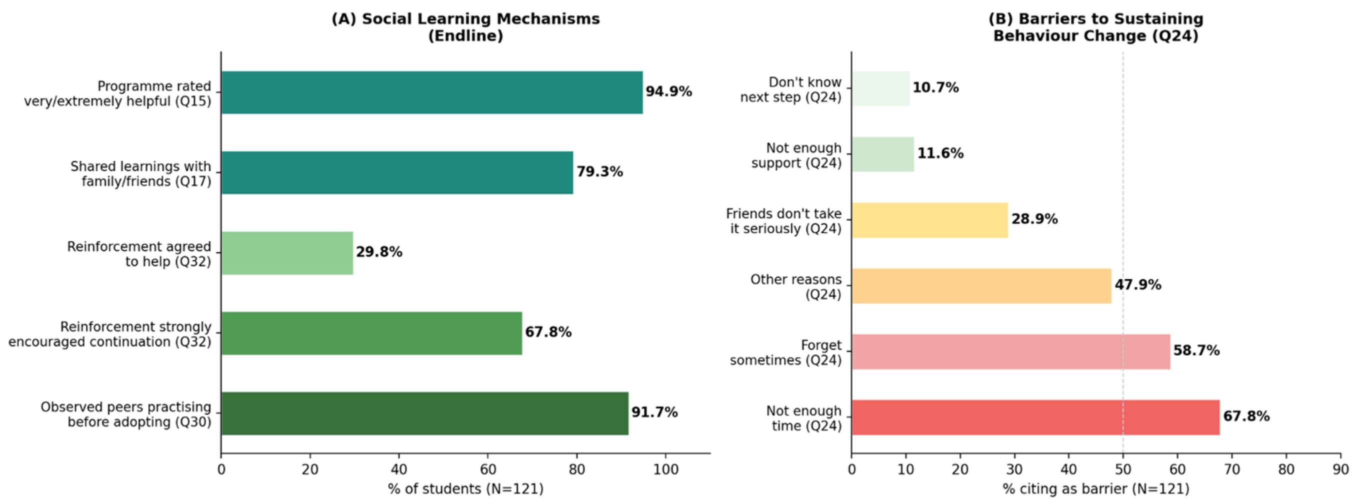

Figure 4: Social Learning Mechanisms and Barriers to Behavior Change based on Students' Responses

Teachers' Component

Teachers' data were collected at both baseline and endline from 13 schools, the same as the students' data. At baseline, 59 teachers responded, and at the endline, 43 teachers responded. This gave a retention rate of 72.9%. Attrition here reflects staff mobility and scheduling constraints between survey rounds. However, the data is not systematically biased. As with the student data, baseline and endline samples have not been paired at the individual level, so all comparisons are reported as group-level percentage-point changes. Moreover, the endline added 28 additional questions (totalling 41) to measure programme outcomes associated with KAP, IBEE, and SLT frameworks. The teachers' results below present the shifts in their ecological knowledge, affective responses, outdoor behaviour, skills, social learning, environmental identity, enablers, barriers, and evidence of household and community spillover.

Nature connectedness and affective engagement

At the end of the programme, all 43 of the teachers reported a deep connection with nature, compared with 57.6% at baseline (+42.4 pp). Affective responses towards wild mushrooms improved substantially, leading towards increased confidence in touching or handling a wild mushroom. Fear and nervousness each fell to zero at the endline, and no teacher reported feelings of disinterest. Ecological attentiveness also strengthened, wherein 100% of the teachers said that they loved observing nature, compared with 32.2% at baseline (+67.8 pp). When asked about how the teachers felt spending time in nature, the proportion selecting "deeply connected" reached 100%, while all other response categories, including 'feeling calm but not interested', 'enjoying and feeling relaxed' or 'curious and excited', were no longer reported.

Inquiry orientation and ecological knowledge

Teachers' proactive curiosity about nature grew from 57.6% at baseline to 100% at the endline, with all 43 teachers reporting that when they see something unusual in nature, they try to seek further information by finding out more, asking someone, or writing about it. The knowledge of fungal ecology among teachers improved substantially. Various misconceptions, such as the belief that poisonous mushrooms are always brightly coloured, declined from 23.7% at baseline to zero at the endline. Understanding that mushrooms can grow on a wide range of substrates, including soil, wood, dung, insects, and trees, increased from 28.8% to 97.7% (+68.9 pp). Climate literacy also showed large improvements with the proportion of teachers correctly identifying that fungi help forests stay healthy or take in extra CO_2 rose from 18.6% to 97.7% (+79.1 pp), while uncertainty or ignorance about mushrooms fell sharply. Species-level naming became widespread. All 43 endline teachers could name at least one recognisable local species (e.g., Split Gill, Wood Ear, Gucchi, Morel, puffballs, Bleeding Tooth fungus), compared with partial familiarity at baseline.

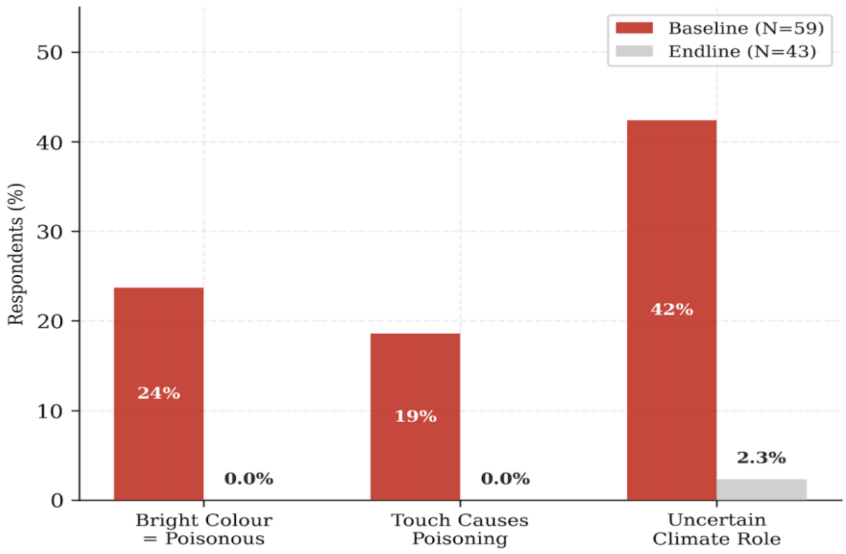

Figure 5: Elimination of Misconceptions surrounding Mushrooms among Teachers

Outdoor behaviour and nature skills

Time spent outdoors increased remarkably over the study period. The proportion of teachers spending 3-5 hours per week outdoors rose from 5.1% to 41.9% at endline (+36.8 pp), while those reporting more than five hours per week increased from 16.9% to 60.5% (+43.6 pp). No teacher at the endline reported avoiding outdoor time. Skills acquisition was universal by the endline. At baseline, 20.3% of teachers reported having no nature-related skills; by endline, this proportion fell to zero as teachers started possessing at least one good skill. All the assessed competencies, including knowing where to find mushrooms, confidently discussing the ecological roles of mushrooms, knowing safety practices on a mushroom walk, knowing what tools to carry, knowledge of basic preservation methods, and the ability to take identification-friendly photographs, were reported by all 43 teachers at the endline.

Environmental values and self-efficacy

High environmental self-efficacy was evident among all the teachers. On a scale of 1 to 5, all of the teachers assessed their own capacity to contribute to environmental sustainability as 5 (highest impact). All of them agreed that modest individual efforts can result in more significant communal transformation. They also expressed willingness to support rules, programmes, or activities that help protect mushrooms while also identifying that teaching children about nature, protecting forests, having better laws, awareness programmes, and community participation were the potential systemic changes that were required. The EVF programme was rated as very or extremely helpful by all 43 teachers. Hands-on activities, visual aids, storytelling, and games were identified as the most impactful methods or pedagogies.

Social Learning Pathways and Barriers to behaviour change

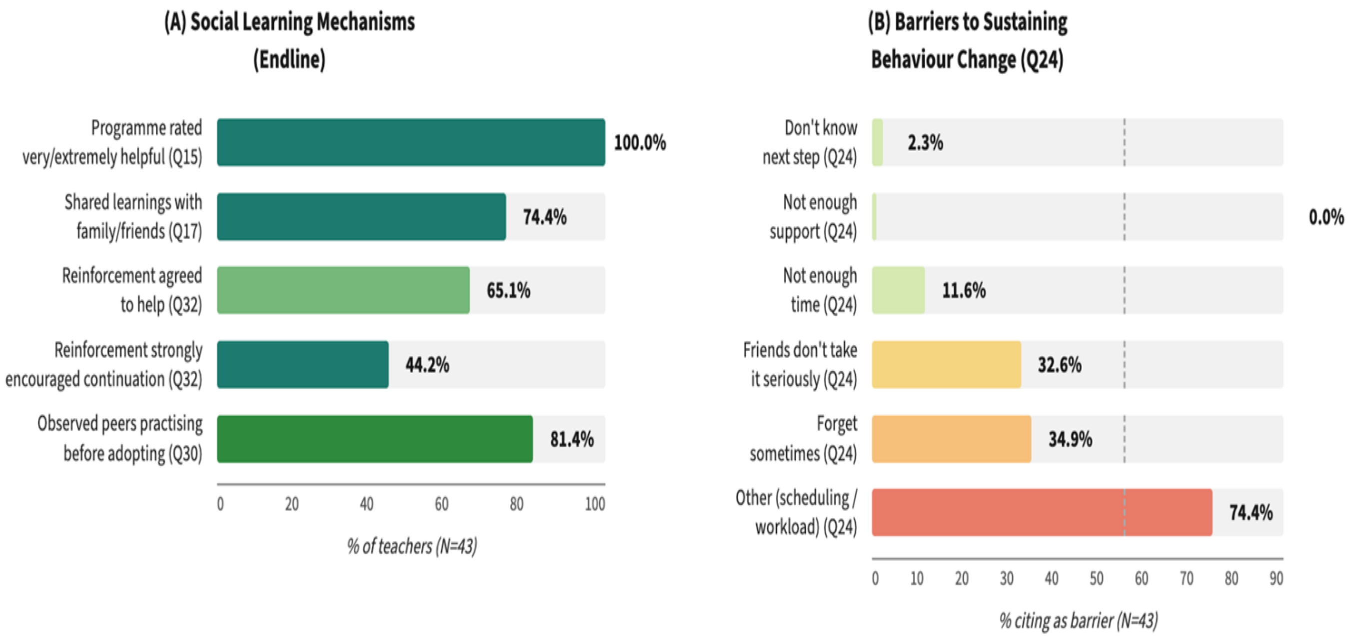

Figure 6: Social Learning Mechanisms and Barriers to Behavioral Change based on Teachers' Responses

The proportion of teachers who love sharing their fungal observations and learning after nature walks rose. Furthermore, the responses indicated that social learning through observation was the primary adoption pathway. 35 out of 43 teachers (81.4%) stated that they first adopted mushroom-friendly behaviours after witnessing others practising them. Positive reinforcement was widely endorsed as sustaining behaviour. 44.2%

strongly agreed, and 65.1% agreed that praise and recognition encouraged them to continue nature-friendly practices. Moreover, environmental identity was almost universally reinforced. All 43 teachers (100%) at the endline reported caring more about nature, feeling responsible for the environment, feeling more curious to learn more, wanting to protect living things, and feeling confident to talk about nature. Additionally, many stated that their perceptions and attitudes towards mushrooms improved. 42 out of 43 teachers agreed that protecting mushrooms is part of caring for their local environment. Despite strong motivation, teachers identified persistent barriers to sustaining their practices. The most frequently cited challenge was with respect to time constraints and scheduling pressures, a structural issue also present at baseline. Other barriers included forgetting (34.9%) and friends not taking nature practices seriously (32.6%). Only one teacher reported not knowing what to do next. However, none reported a lack of support as a constraint. These barriers are primarily structural and habitual rather than motivational.

Spillover to families and communities

Of the 43 endline teachers, 32 (74.4%) reported discussing new behaviours with family members or close friends. Several teachers reported that family members had adopted or changed behaviours. For example, noticing and avoiding the plucking of fungi by the family members was observed. Teachers also reported sharing ecological knowledge with neighbours and community members, indicating social diffusion extending beyond the school boundary.

Parents' Component

Parents' data were collected exclusively at endline from 20 respondents across five schools, namely, GSSS Sarog (n=4), Cambridge International School Kullu (n=3), GSSS Kufri (n=3), GMSSS Mashobra (n=3), and GSSS Dhamandri (n=7). Since parents were not direct participants in the programme, no baseline data were gathered from them, in contrast to the teacher and student components. Therefore, the parent responses shed light on indirect or spillover effects of environmental education, particularly how children communicate newly acquired ecological knowledge within their families.

Communication of programming learning within households

All 20 parents reported that their child had spoken to them about mushrooms or fungi following school activities or nature walks. The most common topics communicated by students were about observing mushrooms in nature (17/20), learning new ecological facts (16/20), and expressing curiosity or excitement (13/20). One parent also mentioned that the child discussed safety around mushrooms. When asked if they had seen a difference in their child's interest in nature, 18 of the 20 parents responded positively. Among these, the most frequently noticed improvements were that the children talked more about plants and fungi, displayed greater interest in nature, and spent more time outdoors.

Intergenerational knowledge transmission

There was considerable evidence that children served as informal ecological educators within households. Twelve parents (60%) reported learning something new about mushrooms or nature through their child; seven parents (35%) were not sure whether they learned anything new, and only one parent reported no new learning. Children conveyed ecological concepts such as decomposition, nutrient cycling, the role of fungi in supporting plant growth and agriculture, and the seasonal appearance of mushrooms during the monsoon. Several parents also mentioned acquiring new practical skills, such as how to take good photographs of mushrooms and how to spot fungi in natural surroundings. These responses indicate that the children not only communicated factual information but also shared observational and experiential aspects of their learning.

Parental attitude change and attentiveness

The majority of parents said that interactions with their child had favourably influenced their own opinion of mushrooms. Importantly, 18 out of 20 parents said that these interactions had increased their awareness of the natural world around them, including plants, trees, fungus and soil. When asked whether children can influence adults' awareness about nature and the environment, 11 parents strongly agreed, six agreed, and three were neutral, yielding 85% agreement overall. These results demonstrate that student-mediated spillover *extended* beyond knowledge transfer to reshape parental environmental attentiveness and attitudes.

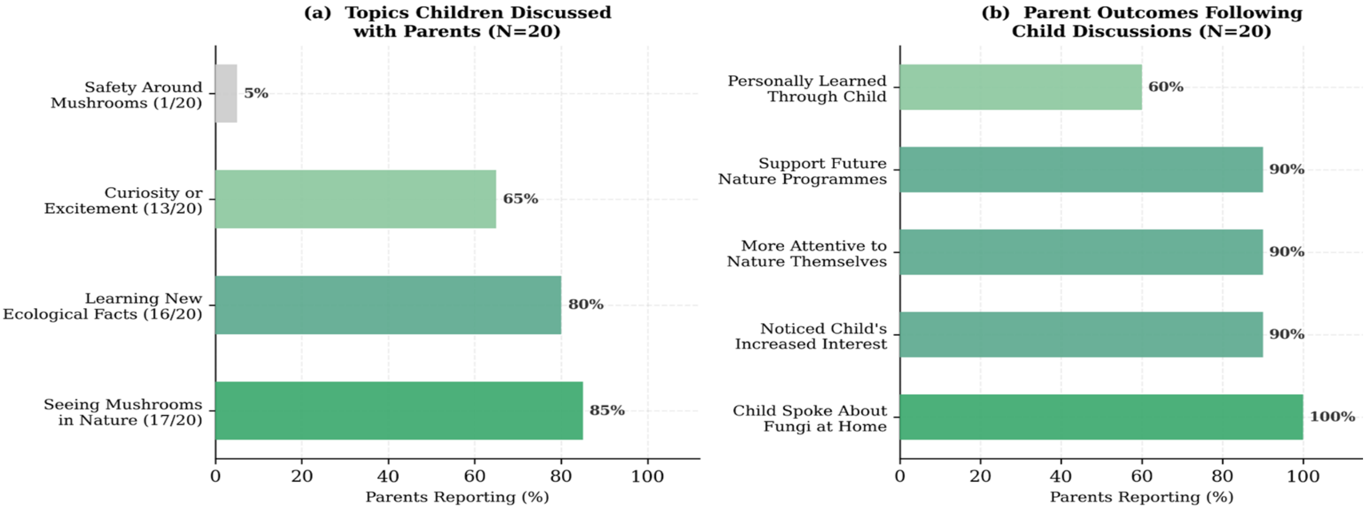

Figure 7: Household Spillover and Intergenerational Knowledge Transmission among Students and Parents

Surprising moments and ecological appreciation.

When asked to share a moment when their child surprised them with something they had learned about nature, 13 of 20 parents responded, and 11 provided detailed examples. Several parents described being surprised by their children's ability to explain the medicinal role of mushrooms, the importance of fungi in maintaining ecological balance, and the potential of fungal networks to facilitate communication between trees. One parent stated that their child "knows names of mushrooms", while another expressed wonder at how their child understood the importance of the smaller species, such as mushrooms, playing a big role in sustaining life on Earth. Other responses highlighted children developed observational skills, such as spotting mushrooms quickly in nature, recognising seasonal patterns of mushrooms, and understanding that mushrooms can grow on diverse substrates. These responses indicate that the programme stimulated not only factual learning but also curiosity, observation, and emotional appreciation of ecological relationships, and that these outcomes were sufficiently striking to be noticed and remembered by parents.

Attitudes Toward Environmental Learning and Conservation

Overwhelming majorities of parents expressed support for the continuation of similar programmes. 18 out of 20 said they would support nature-based learning activities in schools in the future, while two (10%) were unsure. No parent opposed such activities.

Discussion

The findings of this study demonstrate that the EVF programme produced substantial and multidimensional changes in students' and teachers' engagement with fungi, and that these changes extended into household contexts through student-mediated knowledge diffusion in their respective environments. While clear gains in ecological knowledge were observed, the magnitude and pattern of affective, behavioural, and identity-related shifts observed cannot be adequately explained through cognitive acquisition alone. This pattern is consistent with well-established critical analyses of linear Knowledge-Attitude-Practice (KAP) models, which, while useful for documenting factual gains, are limited in accounting for sustained behaviour change, particularly when target organisms are associated with fear or cultural stigma (Salas-Zapata et al. 2018; Slovic et al. 2007).

The student data align strongly with the Identity-Based Environmental Education (IBEE) framework (McGuire 2015). Students demonstrated not only improved conceptual understanding of fungi but qualitative shifts in emotional orientation and self-perception, reflected in near-universal expressions of environmental responsibility, curiosity-driven observation, and confidence in ecological engagement. IBEE suggests that durable environmental behaviour is more likely when learning is integrated into the learner's self-concept. The programme's repeated, and emotionally salient encounters with fungi across seasons (guided observation, specimen handling, spore-printing, and nature walks) appear to have facilitated this internalisation, transforming fungi from objects of avoidance into objects of inquiry and care. The near-zero retention of mysophobia responses at the endline, contrasted with their presence at baseline, is consistent with the identity-based internalisation processes described by McGuire (2015) and Mateer (2023).

Social Learning Theory (Bandura, 1986) provides a complementary explanation for the reinforcement and maintenance of these changes within school environments. The observation that 91.7% of students had observed peers practising nature-friendly behaviours before adopting them themselves confirms that observational learning, rather than direct instruction alone, was the primary pathway of behavioural adoption. Teachers' data further reinforces this pattern of observation learning, as around 81% of the teachers reported adopting mushroom-friendly behaviours after observing them in others, and they also cited EVF facilitators, students, and peers, rather than top-down instruction, as primary behavioural influences.

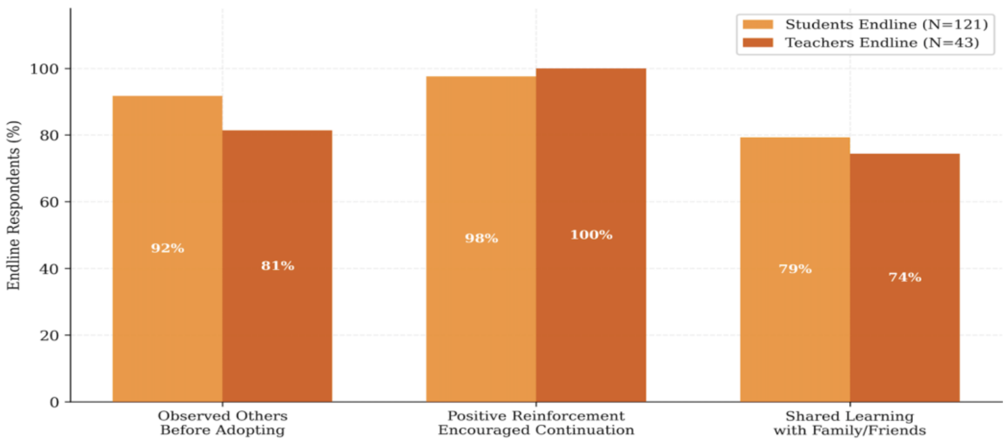

Figure 8: Social Learning Processes and Knowledge Diffusion among Students and Teachers at Endline

This reciprocal modelling across student-teacher interactions challenges assumptions of unidirectional environmental education and highlights the school as a co-constructed behavioural learning space. Ata (2018) similarly found that children's environmental behaviour is more strongly influenced by peer observation than by adult instruction, particularly when modelled behaviours are visible, repeated, and socially reinforced.

The cultural specificity of fungi in Himalayan communities makes ethnomycological perspectives particularly important for interpreting these findings. In this study context, fungi are embedded within locally specific narratives of spiritual impurity, danger, and avoidance that are socially inherited rather than knowledge-based (Dorjey and Sharma 2021). These culturally established meanings were immediately addressed by the programme's emphasis on guided observation, safety clarification, and ecological role description. The near-elimination of safety-critical myths is indicative of both a cultural reframing and an information correction, wherein inherited fear was replaced with locally based ecological awareness. This change is consistent with the Behaviour Change for Nature (BCfN) framework (Rare and Behavioural Insights Team 2019), which emphasises that ease, socialisation, and motivation must all function concurrently. As a result, the environmental education intervention was socialised through peer and teacher modelling and motivated behaviour change through identity and ecological narrative.

The parent data extends this analysis to the household level. According to the results, all 20 parents said that their child talked about fungus, and 60% of them learned something new about ecology from their child. This positions students as the main agents of norm dissemination outside of the classroom. The idea of the school as a 360-degree behavioural learning ecosystem is supported by this pattern of intergenerational transmission. Knowledge and ecological values extend via EVF facilitators and teachers, circulate, and are amplified through peer learning, and exit through students into families and communities. This trend suggests that student-mediated information transmission should be considered a purposeful programme output rather than an accidental spillover, which has important consequences for programme design.

Despite the significance of these findings, various methodological constraints should be noted. The baseline and endline samples were not fully paired at the individual level, making it difficult to track individual learning trajectories over time. The primary dependence of the study on self-reported measures, which may be subject to social desirability bias in a school setting, where usually pro-environmental norms are actively promoted. Constructs such as affective response and environmental identity were captured and measured using single items or qualitative indicators rather than proven psychometric instruments. Future studies should use longitudinal designs that track the same participants over several years of programme exposure, include validated environmental identity and self-efficacy measures (like the Nature Relatedness Scale and Connectedness to Nature Scale), and compare self-reported behaviour with external indicators like geotagged photos or classroom observation procedures. Peer recognition systems, norm-messaging interventions, and structured reminder prompts are examples of behavioural design aspects that might be tested experimentally to see which programme elements best maintain change.

Conclusion

This study shows that, in a culturally specific Himalayan setting, an experiential, fungus-focused environmental education programme can produce significant and long-lasting changes in school students' ecological knowledge, affective orientation, pro-environmental behaviour, and environmental identity. These changes also extend to teachers and nearby communities. Students at the endline showed nearly universal transformation, starting from a baseline marked by partially formed knowledge, safety-critical misconceptions, and variable affective responses. Students grew deeply connected to nature, confident when interacting with wild fungi, actively shared ecological learnings, and were proficient in all measured nature-related skills. Safety fallacies were all but eradicated, and climate literacy increased substantially. In a multidirectional social learning ecosystem, teachers demonstrated parallel gains by implementing conservation-aligned pedagogical practices and serving as reciprocal models. According to parent responses, students acted as unofficial ecological educators in their homes, creating knowledge transfer across generations and extending the programme's influence outside of school. Taken together, these results indicate that fungi-based environmental education achieves durable outcomes when it simultaneously addresses affect, identity, cultural meaning, and social reinforcement, not only knowledge acquisition. The theoretical integration of KAP, IBEE, SLT, and ethnomycological perspectives provides a robust interpretive architecture that goes beyond what any single framework can offer. The study further identifies a persistent gap in the literature: few studies have examined the long-term effects of culturally specific meanings on identity formation and social learning in school-based fungi education, and fewer still have systematically tracked household-level spillover. Filling this gap is essential for developing programmes that foster safe, responsible, and culturally grounded environmental practices, and for ensuring that these practices diffuse through the peer and family networks that shape long-term ecological citizenship, thereby validating the role of school-based environmental education programmes as multi-stakeholder interventions with impacts extending beyond the classroom.

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