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# Perceptions and Revitalization of Local Ecological Knowledge in Four Schools in Yasin Valley, North Pakistan

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Mountains are often recognized as sites of biocultural diversity, and local ecological knowledge (LEK) is an integral part of community life. Rapid cultural standardization and urbanization have threatened biocultural diversity, posing threats to LEK in mountain areas. The current study aimed to gather data on the status of LEK in the Yasin Valley, Gilgit-Baltistan, Pakistan, and discuss options with the local population for revitalizing LEK in future educational programs. We explored the perceptions of local communities on the importance of LEK and its possible revitalization and transmission in the school curriculum. Data were collected from students, teachers, and local knowledge holders in 4 schools located in the valley. In the area, LEK is considered an important part of the local biocultural heritage, playing a potential role in socioenvironmental sustainability, but we observed a lack of intergenerational transmission of LEK, using LEK of wild food plants as a proxy. Participants confirmed that the existing

environmental and food education does not cover the local cultural ecologies, and thus the prevailing centralized curriculum system has isolated students from learning LEK. Preliminary interactions with participants did not reveal any opinions on the transmission of LEK through teaching-learning processes. During group discussions, however, we discovered some potential strategies that could help in the revitalization of LEK in schools, such as study trips, traditional food day celebrations, developing herbaria, art competitions, and the introduction of food scouting. More importantly, place-based education, connected to the local biocultural heritage, could provide a useful foundation for the intergenerational transmission of LEK. Therefore, on the basis of our case study, we appeal to local policymakers to pay attention to the erosion of LEK and ask that it be given space in future development programs to achieve sustainable development and help mountain communities.

**Keywords:** biocultural heritage; mountain communities; scientific knowledge; place-based education; Nalla.

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## Introduction

Local ecological knowledge (LEK) refers to the knowledge, practices, and beliefs of local communities regarding ecological relationships (Charnley et al 2007). This is an important part of local community. Literature on LEK from mountain areas throughout the world continues to emerge (Mathez-Stiefel et al 2012; Son et al 2019; Sõukand and Pieroni 2019; Aziz et al 2020). These studies aim to devise concrete tools for fostering sustainable paths for rural development. In line with the agenda of the Convention on Biological Diversity (United Nations 1992), such studies recommend appreciating and protecting the knowledge, innovations, and cultural practices that local communities have developed in relation to the sustainable use of biological resources. Poole (2018) has argued that the significant role that LEK plays in underpinning sustainable management practices must be recognized because without

such recognition stewardship as a praxis will remain overlooked as a fundamental driver of sustainability.

Globalization has led to societal transition, resulting in cultural and linguistic homogenization (Streeten 1998; Van der Wusten 2020). While the speed of social change is rapid in lowland urban areas, it is slower in rural mountain communities. However, rural mountain communities are also adopting more standardized lifestyles and gradually giving up their traditional ways of life (FAO 2011; Homer-Dixon et al 2015). This, in turn, impacts LEK (Aswani et al 2018), which has played a key role in maintaining the natural ecosystem. Therefore, oral traditions and storytelling, which are crucial parts of local knowledge, are good ways to aid “regenerative development” (Sarmiento et al 2020) by maintaining biocultural diversity—the diversity of life in all its manifestations: biological, cultural, and linguistic (Maffi 2001)—in which LEK plays a crucial part (Antweiler 1998).

The 2030 Agenda for Sustainable Development calls for “quality education” (Sustainable Development Goal 4): all

learners should acquire knowledge and skills that are needed to promote sustainable development, including through educational programs (Abdrisaev et al 2020). The study of the association between LEK and schooling has significant policy implications for local communities (Berkes and Jolly 2001; Olsson and Folke 2001; Perales et al 2005). There are a few examples of the association of LEK with scientific knowledge in teaching-learning processes (Snively and Corsiglia 2001; Aikenhead and Michell 2011), but there is still a huge gap in the dialogue between daily life based on LEK and school life based on scientific content (Mack et al 2012; Bejarano et al 2014). Schooling and the knowledge acquired at school have been both blamed for the loss of indigenous knowledge (because they open pathways to the nonindigenous world and worldviews) and promoted as a potential remedy to its demise (if educational curricula are aligned with indigenous realities by giving instruction in local languages and incorporating local knowledge in school content) (Reyes-García et al 2010). Thus, we infer that it could provide a path to sustainable development in mountain areas, which are often considered sites of *biocultural refugia*: places where biodiversity finds shelter and human knowledge and experiences are a crucial part of the socioecological system (Barthel et al 2013).

The mountain belt of North Pakistan is rich in biocultural heritage, and the associated LEK has played a pivotal role in social development and the nourishment of local communities across the area for generations (Bibi et al 2022). It is unfortunate that, in the face of considerable social change, LEK is gradually decreasing (Aziz et al 2020). Although an important feature of the social and practical daily life of communities in mountain areas (Parkes 1987; Ahmad et al 2021), LEK has never been a part of developmental support and has not found a place in policy infrastructure, including education. In Pakistan, the voices of ethnobiologists demanding the practical revival of LEK and its inclusion in educational opportunities have never been heard. The integration of LEK into school curricula provides a holistic learning framework of study through which students are able to understand the role of social and cultural contexts in the production of scientific knowledge (Kim and Dionne 2014; Seraphin 2014).

Educational institutions and local communities could find better solutions for sustainability if local and case-specific knowledge is integrated to coproduce development solutions and to bring research and teaching closer to addressing real-life challenges at local, national, and regional levels (Balsiger et al 2017; Barth et al 2019). Since LEK has played a major role in tackling many socioenvironmental challenges in mountain communities across Pakistan (Schmidt 2000; Kreutzmann 2004, 2006, 2020), it is essential to assess it and local inhabitants' perceptions of its role in the future of the area and the community. Moreover, participatory decision-making is needed to involve local communities, elicit their perceptions of the past, present, and future, generate social learning, find development solutions, and coproduce knowledge for community resilience (Gleeson et al 2016; Balsiger et al 2019). This study uses a participatory approach with the local community to determine strategies to revitalize LEK. The aim is to find ways of implementing educational strategies that can support rural development in the remote and bioculturally diverse mountain valley of Yasin. Following the argument of

Barth et al (2019), we hypothesize that the effective transmission of LEK through possible regenerative paths in educational opportunities could provide a foundation for future development programs in many other mountain areas. The main research questions of the study were the following:

- What are the opinions of teachers and local knowledge holders on LEK?
- What opinions do teachers and LEK holders have on potential ways in which LEK-based teaching instruction can become part of the biology curriculum, especially that devoted to female community members?
- Do the existing educational opportunities related to environmental and food education provide space for LEK?
- Is LEK an orally transmitted entity among the younger generations?

## Methods

### Study area

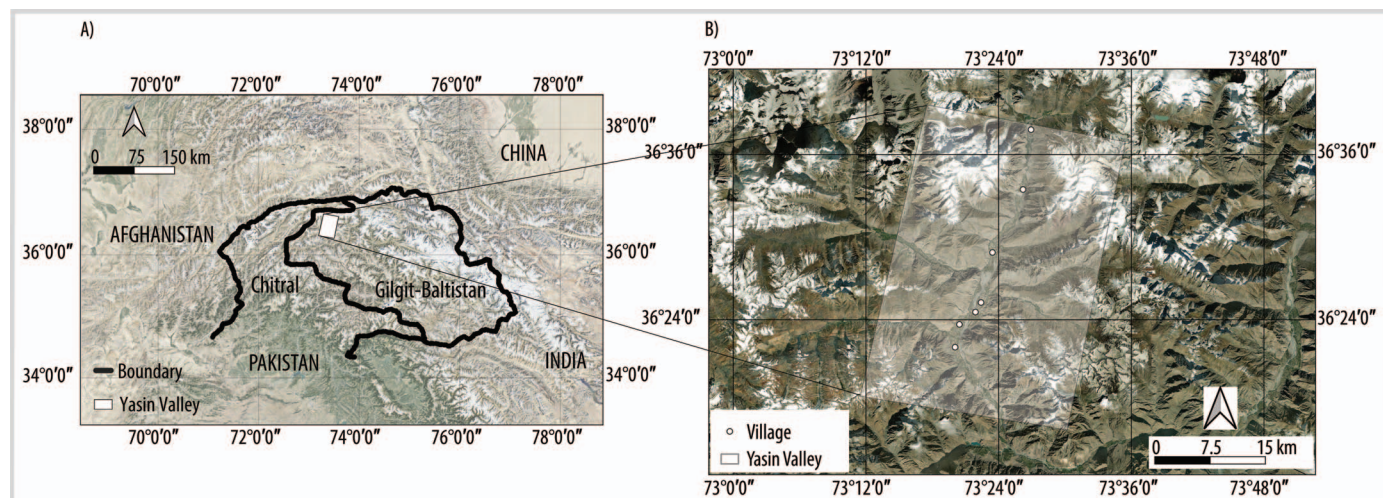
Yasin Valley (36°22'45.08"N, 73°20'02.03"E) is located in Ghizer District, Gilgit-Baltistan, Pakistan (Figure 1). The area is populated by several important cultural groups, including the Burusho, Kho, and Shina, who have retained knowledge of the local natural resources. In the study area, the Burusho are an isolated linguistic group.

The communities have historically practiced agropastoralism. The local inhabitants keep herds and use different pastures, locally known as *Nalla*, which are important socioecological spaces that they also use for plant foraging. In the valley, they grow different crops, such as wheat, corn, buckwheat, barley, pearl millet, and potatoes. Important vegetables that are grown include tomatoes, cabbage, turnips, cucumbers, carrots, radishes, lettuce, and amaranth. In more recent times, social change has disrupted the traditional lifestyle of the people. First, the completion of the Karakoram Highway in the region has had an impact on livelihoods, and now the China-Pakistan Economic Corridor has provided alternative nonfarm opportunities, which in turn has shifted the value perception of local people regarding the management of their natural resources. The younger generation is attracted by modernization and tends to move to urban areas for educational and job opportunities. In the valley, there are numerous places where girls have no restrictions on going to school and college. The majority of the people follow Ismaili Islam, while a few households are Sunni. Our previous field research has shown that LEK on wild food plants (WFPs) is gradually decreasing and is currently threatened (Aziz et al 2020).

### Data collection

We gathered qualitative and quantitative data in June 2021 in 4 schools located in 4 villages across the valley. Prior to the study, we were granted special permission by the administration of each school to conduct workshops, and we agreed upon data anonymity. The study participants consisted of 72 students (from grade 10), 10 teachers, and 40 local knowledge holders. In each school, we selected biology teachers, while the local knowledge holders were chosen on the basis of our previous interactions during food

FIGURE 1 Map of the study area. (A) North Pakistan; (B) Yasin Valley. (Map by Muhammad Aziz; background satellite image from Google Landsat Copernicus)



ethnobotanical surveys. Before starting the interview with the study participants, the first author explained the purpose of the research.

Teachers and local knowledge holders were approached through 2 different interactions, (1) pre-workshop and (2) workshop, to obtain their opinions on the transmission of LEK through educational activities in schools. Students also attended these sessions, but we involved them only in the teaching-learning activities.

Pre-workshop settings were arranged to avoid any potential bias, especially to prevent correcting social desirability and acquiescence biases. Both types of biases demonstrate the tendencies of participants to agree rather than disagree over a considered item during a survey (Lavrakas 2008; Anguiano-Carrasco et al 2013; Kreitchmann et al 2019). Teachers and traditional knowledge holders were fully allowed to express their opinions regarding the importance of biocultural heritage and its effective transmission within the current educational program.

In the workshops, we conducted focused group discussions with the participants and different questions were brought forward in these conversations to identify possible strategies for the revitalization of LEK (see Appendix S1, *Supplemental material*, <https://doi.org/10.1659/MRD-JOURNAL-D-21-00061.1.S1>). Group discussions largely centered on the participants' opinions on the role of indoor and outdoor teaching activities, the school-family relationship, teachers' training on LEK, the possibility of study trips, female involvement in LEK transmission, gender issues regarding access to LEK learning, the role of student scouting, artwork on LEK, and so forth. We also asked some follow-up questions during the discussion when necessary. In particular, we focused on the possible involvement of female community members in the renewal process of LEK, as in the study area women are considered the segment of the population that has potential knowledge of traditionally used plants and traditional agricultural practices.

We also recorded information from teachers on existing environmental and food education. With their help, we screened out the biology textbooks currently used in the 4 schools to assess the possible inclusion of local environmental and food education within the preexisting school curriculum. During the part of these workshops

related to the teaching-learning process, we presented the results of previous food ethnobotanical research (Aziz et al 2020) to highlight the importance of LEK on these natural resources in motivate people to take part in the study. To test the impact of different teaching strategies, teachers taught a topic on biodiversity from the biology textbook in a conventional classroom setting, and later the first author delivered a lecture on the subject from a local perspective, incorporating the concept of LEK and mainly presenting the results of the authors' previous research (Figure 2). After attending each lecture, students were subjected to a written test to assess their classroom learning, evaluating contextualized scientific learning, which was mainly connected to LEK, versus decontextualized scientific learning. We also examined LEK on WFPs among the students, learned from their elders, and used it as a proxy to determine the intercultural transmission of LEK to younger generations. We separately documented the data from each workshop, and the data recorded were grouped and managed according to the questions asked from each of the relevant participants' groups.

#### Analysis of qualitative data

We used the grounded theory approach to analyze qualitative data (Timmermans and Tavory 2012). We started by reading the interview transcripts and sorting out major themes. We used an inductive approach to identify the themes. We did multiple readings of the transcripts, and, after becoming familiar with them, we developed a system of codes and subcodes that we used to organize our results and discussion. For the data recorded in pre-workshop settings, we identified 2 major themes: (1) the importance of LEK and (2) problems in the transmission of LEK. For the workshops, we identified the following main themes: (1) possible strategies for the revitalization of LEK and (2) educational policy.

#### Statistical analysis

Data obtained from the free lists of WFPs were organized in MS Excel and then further analyzed using descriptive statistics. We identified the salient taxa mentioned in the free lists by using the cognitive salience index (Sutrop 2001),

**FIGURE 2** Interaction with students during a workshop in a local community school in Yasin Valley. (Photo by Rahim Khan)



$S = F/(NmP)$ , where  $S$  indicates the cognitive salience index,  $F$  represents the frequency of citation,  $N$  is the number of elements, and  $mP$  is the mean position of each element used in the free lists. The cognitive salience index varies between 0 and 1. The index is generally used to identify the most important plant species used in a specific community or cultural group.

## Results and discussion

### Local perceptions of LEK: pre-workshop outcomes

In the pre-workshop interactions, we recorded a consensus on the importance of LEK among teachers and local knowledge holders, who stressed its protection and possible revitalization through educational programs. Local knowledge holders were highly motivated to develop ideas for the effective incorporation of LEK into teaching–learning processes; they agreed to help the students and teachers in this regard. The local knowledge holders mentioned that besides getting a modern education, it is beneficial for their children to be connected to cultural practices, as they are currently more engaged in obtaining a modern education and they are no longer interested in acquiring LEK. One of the participants (a 55-year-old man) stated:

*It is a pity that our children go to school, getting an education, as they don't know how to grow and manage the local fields.*

Another participant (a 49-year-old man) added:

*One day I went out of the village and asked my son to water the field. Upon my return, I saw that the field was highly damaged and managed badly. Therefore, we want our children to be trained in cultural practices while teaching them in schools.*

Bowers (2001) explains that modern education has led learners to lose the sense of caring for a place and severed

their connections to the ecologically responsive cultural practices. These are therefore highly marginalized as a result of modern education (decontextualized learning). Place-based education should be focused on incorporating local realities of a multidisciplinary nature, providing effective learning about nature, and helping students learn beyond the walls of a school. Teachers expressed strong motivation to develop ideas for the effective transmission of LEK, and a few of them were able to provide a little feedback on outdoor teaching activities regarding its transmission. Pre-workshop discussions did not identify any potential ideas on the effective transmission of LEK in the teaching–learning process.

In pre-workshop discussions, local people asserted that the school's environment has dissociated their young people from local practices.

Study participants affirmed that one of the major hurdles leading to the decline of LEK in the study area has been the gradual detachment of local communities from *Nalla*, located in upper mountain pastures. People have started coming down the valley from *Nalla* in search of education, jobs, and better life opportunities, and therefore the younger generation no longer has close contact with nature. Among the participants, a 70-year-old woman stated:

*We want to tell the stories of old times to our children, but they do not take interest. Our girls don't know too many traditional things except for those who lived in Nalla.*

### Potential pathways for the revitalization of LEK in educational programs

Group discussions in workshops determined that student study trips to *Nalla* could provide a better foundation on which to base LEK instruction and offer hands-on experience. *Nalla* are important ecological spaces (Aziz et al 2020) that are considered a hub of natural resource

management. The relevant LEK in the study area, if properly revitalized, could help in enhancing the ecological experiences of both students and teachers. In the study area, an educational system that is more or less Westernized creates a gap between the student and the local community, as well as the student and the local environment. During focus group discussions on LEK linked to WFPs, we were told that the “traditional food day,” which is celebrated in some schools across the valley, could be adapted to provide a better opportunity to engage students in the revitalization of LEK of WFPs inside these schools. Responding to the question on the inclusion of LEK in the experimental part of the classroom setting, teachers recommended “art or drawing events.” These could provide a means to repair students’ broken relationships with nature and local ecology, as children need to experience the natural world before they are asked to save it (Anderson 2000; Erzen 2005). These competitions can also be viewed as research and discovery practice that allow students to use the processes of art to understand and appreciate the world (Marshall 2004). They are also a way to promote awareness and raise provocative questions about community and nature, reflecting the complex web of human–environment relationships (Wilson 2003). In discussions on community-based awareness programs for promoting LEK, especially those linked to WFPs, teachers asserted that “student scouts,” an active organization of students in the valley, could play an effective role in spreading awareness among local communities on the importance of LEK and “wild food plant gastronomy.”

Both male and female local knowledge holders were equally interested in sharing their LEK and agreed to provide their services voluntarily to pass on this knowledge to students and teachers. In particular, female knowledge holders agreed to teach students in the kitchen if they were involved in the process. To bind their commitment to the school administration, teachers suggested that specific honoraria should be allocated to local knowledge holders because they would need to spend some time getting involved in teaching–learning processes.

Home assignments focusing on the traditional importance of local resources and the development of local flora herbaria in schools could be better options, as parents and elderly family members are possible LEK holders. They could be engaged, along with students, in the process of the revitalization of LEK.

Participants agreed on the introduction of a minicourse on LEK in schools, and we believe that if it is designed by ethnobiologists, it will not only be an efficient source for the revitalization of LEK, but also provide a means of linking students’ learning to real-world experiences, helping the learners to construct meaningful connections with culture and nature. All the participants agreed to teach students local knowledge in schools. The literature indicates that place-based education strengthens connections between children and nature, which helps them to overcome their isolation from the natural environment (Gibbs and Howley 2000; Gruenewald 2002; Smith 2002). Place-based teaching has been advocated in science education because it fosters discussion around the local and regional environments and synthesizes different ways of knowing (Semken and Freeman 2008). LEK, if properly integrated into scientific education, could indeed be a potential pillar of “know-how.” We observed that women possess tremendous knowledge on

local natural resources. Because of the issue of gender segregation, we asked about any potential problems that could affect female involvement in teaching–learning processes. We did not observe any gender issues that could hinder the learning of LEK, as female community members had the chance to take part in the teaching–learning activities in girls’ schools.

### Locals’ perceptions of existing educational opportunities

Teachers related that the existing biology classroom teaching practices do not help the students to learn about the local environment and LEK. They suggested in workshop discussions that there should be a course on local biodiversity, to gain practical experience and relate scientific knowledge to LEK. Zidny et al (2021) stated that indigenous science can provide relevant contexts for students to learn scientific concepts, as well as help them to recognize the value of promoting sustainability. Screening of the existing curriculum materials indicated that food and environmental education does not complement LEK on local biodiversity. Teachers affirmed that decontextualized teaching prevented students from becoming familiar with LEK, cultural ecology, and the local flora. Environmental education is a powerful tool for conservation and is the only way to translate Sustainable Development Goals (United Nations 2015) and Aichi targets (CBD 2011) from paper to the everyday life of people (Vilá et al 2020). In this case, LEK has simply been ignored in recent times by the younger generation, and even among the elderly, due to a change in value perception. We know that “valued from the outside, neglected from the inside” (Vilá et al 2020) is a precarious situation for any natural resource, and therefore without active and informed local communities, the needed transformative change becomes an unattainable goal.

As accurately stated by Ralph Waldo Emerson in the 19th century (McLaughlin 2010: 34):

*We are shut up in schools and college recitation rooms for 10 or 15 years and come out at least with a bellyful of words and do not know a thing. We cannot use our hands or our legs or our eyes or our arms. We do not know an edible root in the woods. We cannot tell our course by the stars nor the hour of the day by the sun.*

Studies conducted elsewhere have shown that it is not impossible to integrate LEK into a standard curriculum. LEK generates a culturally centered science curriculum, particularly for Aboriginal students, which helps teachers to engage students in a more efficient way in school science and generates better outputs (Cajete 1986; Aikenhead 2006). Working with Aboriginal students, Aikenhead (2006) affirmed that when Western science material is presented along with local knowledge, students are more attentive in the relevant science course as the science no longer remains information simply to be memorized. McGregor (2000) claimed that developing a *coexistence model*, which is culturally sensitive, effectively involves students in science classes, even to the point of staying after school to complete projects when necessary. The lack of cultural knowledge among students also reveals that the decontextualized course material has drawn students away from thinking about place and environment. However, learning competencies are, in fact, enhanced through a curriculum when it is linked to the

biogeographical, historical, and sociocultural context of a given community (Nuqui 2017).

### Obstacles in incorporating LEK in the school curriculum

To our knowledge, there are 2 major issues that prevent the incorporation of LEK/place-based education into the school curriculum. First, people are unaware of the possibility of including LEK in the classroom, and they do not know about its preservation through educational institutions; thus they do not tend to intervene and/or to provide feedback on the outcomes of the prevalent educational policy. Second, the existing centralized curriculum makes it difficult to incorporate LEK into the school curriculum. Considering the cultural and geographical diversity of the country, policymakers always tend to devise a curriculum that generally follows a broader view on education, which is equally suitable in a variety of socioecological circumstances, ignoring local environmental and cultural ecologies. Consequently, local inhabitants are not consulted in formulating educational materials. While this approach aims to provide a shared and useful knowledge across all of Pakistan, the curriculum becomes decontextualized by design (Jennings et al 2005). Therefore, the standards-based reforms draw educators away from the needs and interests of local areas. At the same time, one of the many pressures that teachers face is to finish the relevant courses within a set time. This leads to teachers only keeping to the predesigned syllabus and recommended textbooks, and not having sufficient time to involve students in outdoor activities that would create an initial interface, useful for introducing students to the specificities of the local environment. Since the local school administration is not authorized to make any changes or additions to the recommended course materials, the only systemic prospect of introducing the study of LEK in schools appears to be the implementation of extracurricular courses. This solution, however, presents objective logistical and financial limitations, requiring additional resources for the schools to develop and offer these classes. In addition, it risks not creating a common and general knowledge of LEK among the students, considering that participation in these activities is linked solely to the individual desire of the students and their ability to attend.

### Intergenerational transmission of LEK

Students were very eager to learn, and they expressed their passion for learning LEK. We empirically measured the intergenerational transmission of LEK linked to the local nomenclature of WFPs among the students. A total of 18 plant species were reported by the students in the free lists. We found the highest cognitive salience index values for *Thymus linearis* (0.197) and *Bergenia stracheyi* (0.122), which indicate that these 2 plants are culturally the most important species in terms of use in the valley. In our previous food ethnobotanical survey in the valley (Aziz et al 2020), we recorded 40 WFPs, but here students provided less than half that number, which clearly indicates the lack of intergenerational transmission of LEK (Table 1). We observed that students whose parents were strongly attached to *Nalla* were more familiar with the local plant nomenclature. Thus, we argue that *Nalla*, which are recognized as a hub of LEK, could provide an opportunity for students to learn LEK.

Overall, looking at the results of the written test, students received higher marks after having participated in the decontextualized biology teaching–learning process as compared to the contextualized teaching method mainly linked to LEK (Table 2), which could be due to their familiarity with the presented course materials, while the subject of LEK and biocultural heritage was new to them. These results also reveal the lack of a true sense of ownership of the traditional knowledge that local people should possess, in some way leading them toward considering local knowledge as inferior to scientific knowledge. Brayboy and Castagno (2008) stated that indigenous ways of knowing are neither inferior nor superior to Western ways; they are different perspectives that need to be acknowledged, rather than trying to justify their inclusion in the realms of Western education. In fact, the indigenous/local/traditional ways of knowing and learning are about preparation for life rather than a measure of achievement and control.

These findings suggest that teaching methods combined or somehow replaced with contextualized teaching linked to LEK will not only help to raise awareness of local ecological practices among young people but will also be an effective step in securing long-term social sustainability. We argue that, in these remote mountain areas, social sustainability could be achieved through the effective transmission of LEK, which local communities have shaped around natural resources and which is an important part of their daily life. A limitation of this study is that the student participants were randomly selected without considering their ability to understand and complete the assessment, which may have produced a mosaic pattern of results.

### Sustainable paths—lessons learned

The promotion of integrative and pluralistic educational approaches should be encouraged, involving all stakeholders including the local communities, to tackle complex challenges that are hampering social sustainability in these fragile mountain areas. Scientists should value multiple knowledge systems to facilitate collaboration and mutual learning between different actors and to integrate knowledge across social and ecological systems, as well as to achieve sustainable development goals (Tengö et al 2007; Barbier et al 2011). As mentioned above, communities in the region have retained a strong link with the local cultural ecologies. For centuries, the people have instrumentalized the local environment and shaped different ecological attributes within local ecosystems. Historically, the completion of the Karakoram Highway in 1979 has had an impact on these communities, and there has been remarkable economic change. This has led to the diversification of local livelihood sources (Kreutzmann 1991; Spies 2019). In more recent times, the China–Pakistan Economic Corridor has accelerated the process of urbanization, which has caused many households to undergo economic transition (Mirza et al 2019; Spies 2021). In particular, the economic corridor has generated many alternative economic opportunities, resulting in a strong influx of socioeconomic drivers, and has created a horizon for economic competition among the local people to develop better nonfarm economies. Consequently, the strong intercountry and interregional connectivity has influenced many local ecological practices (Ali et al 2021).

**TABLE 1** Plants mentioned by students in the study area along with their cognitive salience index values.

Botanical name	Frequency of citation (F)	Rank (mP)	Cognitive salience index (S)
<i>Allium fedschenkoanum</i> Regel	7	3.40	0.039
<i>Amaranthus cruentus</i> L.	16	3.00	0.102
<i>Bergenia stracheyi</i> (Hook.f. and Thomson) Engl.	20	3.15	0.122
<i>Capparis spinosa</i> L.	18	3.94	0.087
<i>Carum carvi</i> L.	5	5.00	0.019
<i>Cotoneaster nummularius</i> Fish. and C.A. Mey.	8	4.87	0.031
<i>Echinops echinatus</i> Roxb.	20	3.55	0.108
<i>Eremurus himalaicus</i> Baker	9	3.11	0.055
<i>Lepyrodiclis holosteoides</i> (C.A. Mey.) Fenzl ex Fisch. and C.A. Mey.	16	3.56	0.086
<i>Medicago sativa</i> L.	10	3.40	0.056
<i>Mentha longifolia</i> L.	18	3.83	0.090
<i>Portulaca quadrifida</i> L.	3	4.60	0.012
<i>Rheum maximowiczii</i> Royle	10	2.40	0.080
<i>Rheum</i> sp	9	1.60	0.108
<i>Taraxacum campylodes</i> G.E. Haglund	11	3.18	0.066
<i>Thymus linearis</i> Benth.	29	2.82	0.197
<i>Urtica dioica</i> L.	11	4.72	0.044
<i>Vicia sativa</i> L.	4	4.50	0.017

These, in turn, have changed people's preferences and value perceptions on the local environment and natural resources. We believe that, on the one hand, developmental infrastructure could have ameliorated economic stability to a certain extent, while, on the other hand, it has indirectly resulted in the erosion of LEK, posing a challenge to people's ability to manage the local environment. Therefore, for sociocultural sustainability, the proper revitalization of LEK through future educational programs is crucially needed. Otherwise, if not properly considered, the fragile nature and remoteness of mountain regions could threaten the resilience and self-sufficiency of local communities, especially in times of environmental hardship. LEK is a local

skill that has always helped communities to find solutions and better use the natural resources in these landscapes.

## Conclusions and policy recommendations

LEK is a crucial part of the daily life of local communities living in the study area. The current study recorded important information on some possible local strategies for transmitting LEK in future educational activities: study trips, traditional food day celebrations, developing herbaria, art or drawing events, and the introduction of minicourses on local natural resources and LEK. The introduction of food scouting was also identified as an important strategy for creating awareness about WFP-centered cultural heritage. In

**TABLE 2** An empirical comparative analysis of students' learning ability according to different classroom teaching methods.

Name of school	Number of students	Students' familiarity (%) with the local names of important WFPs	Average marks (%) obtained by students through contextualized teaching linked to LEK	Average marks (%) obtained by students through conventional teaching on biodiversity
Learning Resources High School	18	30	44.50	55.40
Yasin Higher Secondary School	25	43	72.60	64.30
Local Community School	18	47	54.10	62.20
Sun Rise Public School	11	44	51.40	63.90
Average	<b>18</b>	<b>40</b>	<b>55.65</b>	<b>61.45</b>



addition, the study revealed that the centralized curriculum on environmental and food education does not cover the local cultural and landscape ecologies, which has prevented younger generations from getting involved in ecological practices and learning LEK. We therefore observed the lack of intergenerational transmission of LEK among students, using the LEK of WFPs as a proxy.

This study provides important baseline data on the incorporation of LEK in educational activities, and it is an important step forward toward making policy recommendations for the proper revitalization of LEK through the school curriculum in the mountain areas of Gilgit-Baltistan. We argue that if the curriculum is aligned with local cultural and ecological realities, it will promote children's connection to science, which is crucial but missing in schools where examples are infrequent and usually used only as a way to illustrate isolated concepts (Aikenhead 2002).

The interpretation of the findings of the current study may also be inferred for other mountain areas, and we hope that incorporating LEK knowledge into actual classroom practices will not only promote cultural knowledge but also have important policy implications for future development programs in mountain areas. We strongly recommend that teachers, who represent a fundamental component in the search for education that values knowledge diversity and establishes connections, should be trained to ensure the effective transmission of LEK in classrooms. It would be prudent to involve ethnobiologists in the designing of a culturally ecologically responsive curriculum to give LEK a chance to survive, evolve, and play a role in the future sustainability of resilient mountain communities.

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## Supplemental material

### APPENDIX S1 Questions asked during workshops.

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