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Project Report

Development of a Project to Strengthen Environmental Education in Educational Institutions in Bolivia: "Environmental Care with a One Health Approach"

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Abstract: In response to the urgent need for environmental education in the world, the Environmental Care with a One Health approach (ECOH) project aimed to promote sustainable environmental practices in educational institutions in Sucre, Bolivia. The ECOH project was implemented in four phases: (1) building alliances with local leaders and communities; (2) identifying practices and perceptions of the environmental situation among the general population and educational units (Online survey); (3) implementing educational interventions; and (4) disseminating educational materials. During the second phase, most of the participants (86%) identified the local environmental situation as poor and waste and solid waste management (SWM) as the main concern (64%). Although 70% of the participants were interested in environmental issues, only 44% practiced waste separation. Considering this, and the feasibility of implementing subsequent actions, educational interventions on SWM were developed in schools, and waste sorting bins were delivered. Educational materials were distributed through social networks, and a mobile app was launched to increase outreach. The project promoted cross-sectoral cooperation, raised awareness, and encouraged active participation in environmental protection focused in academic units. ECOH project demonstrated that participatory educational interventions can effectively address local challenges and promote sustainable practices, contributing to a healthier environment for people and animals.

Keywords: solid waste management; educational interventions; environmental education; One Health; institutional alliances

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1. Introduction

Globally, it has been reported that about two billion tons of solid waste are generated daily, of which only 19% are subjected to recovery processes such as recycling and composting [1]. Inadequate solid waste management has been linked to potential health risks, including infectious diseases, allergies, respiratory problems, and cancer risk, among other health problems [2,3], generating high economic, health, and social costs, especially in low- and middle-income countries [2]. Additionally, the improper management of solid

waste can contribute to the generation of greenhouse gases from the anaerobic decomposition of solid waste and during the transportation of solid waste, thereby exacerbating global warming and climate change [2,4]. In some countries, particularly in the Global South, common characteristics related to solid waste management have been identified that contribute to the emergence of environmental and public health problems, including inadequate infrastructure, open burning, and uncontrolled final disposal sites [5]. This situation is similar in Bolivia, which, despite having a low population density (10 people per square kilometer) [6], faces significant challenges in managing its solid waste. Additionally, informal recycling practices, often conducted without regulations or the use of personal protective equipment, and improper waste disposal lead to water and soil contamination, directly impacting environmental, animal, and human health [6], making it necessary to implement measures that strengthen community waste management.

Environmental education has proven to be an effective tool for acquiring knowledge, developing positive attitudes, and promoting behavioral changes [7]. Successful educational experiences have been reported to improve recycling practices in different countries and contexts. Some studies have emphasized that addressing beliefs and values is an effective strategy for improving behaviors [8], and similarly, interactive learning interventions have shown that they can trigger greater learning [9]. In this sense, the implementation of interventions that incorporate participatory methodologies, promoting action, reflection, and interaction among students, can enable them to understand the environmental problems in their community, thereby expanding their agency regarding climate change [10]. Likewise, it has been reported that incorporating environmental issues in formal education has shown sustainable practices in solid waste management in developing countries [11]. In Latin America, some experiences of non-formal environmental education have also demonstrated reduced waste generation in university educational institutions and promoted behaviors and attitudes that favor the care of the environment [12,13]. Likewise, environmental education requires a comprehensive approach that considers the collaborative work of various disciplines to solve problems. Thus, the One Health approach promotes the mobilization of disciplines and communities to communicate, articulate, and coordinate initiatives that seek animal, human, and environmental well-being [14].

In Bolivia, there are also some successful experiences of environmental projects focused on improving solid waste management to strengthen differentiated collection in higher education institutions and circular economy practices in urban recycling activities [15,16]. However, environmental education content has not yet been formally integrated into the curricular content of schools. The initiatives implemented on this topic have been punctual and have arisen mainly from non-profit organizations [17–19]. Although there were collaboration experiences between the national government and other entities, such as the United Nations Children's Fund (UNICEF), to address environmental problems [20], few concrete and sustainable actions involving community participation exist.

Considering this, the ECOH project, Environment Care with a One Health Approach, has been implemented to strengthen environmental practices in communities in Bolivia with a focus on educational units. The project hypothesized that a strategy for managing solid waste based on educational units involving decision-makers, public-private institutions, and the general population is feasible to implement and can foster community empowerment.

2. Project Overview

Between July 2021 and October 2022, a participatory study was conducted in Sucre, Bolivia. It was organized into four phases, as described in Figure 1.

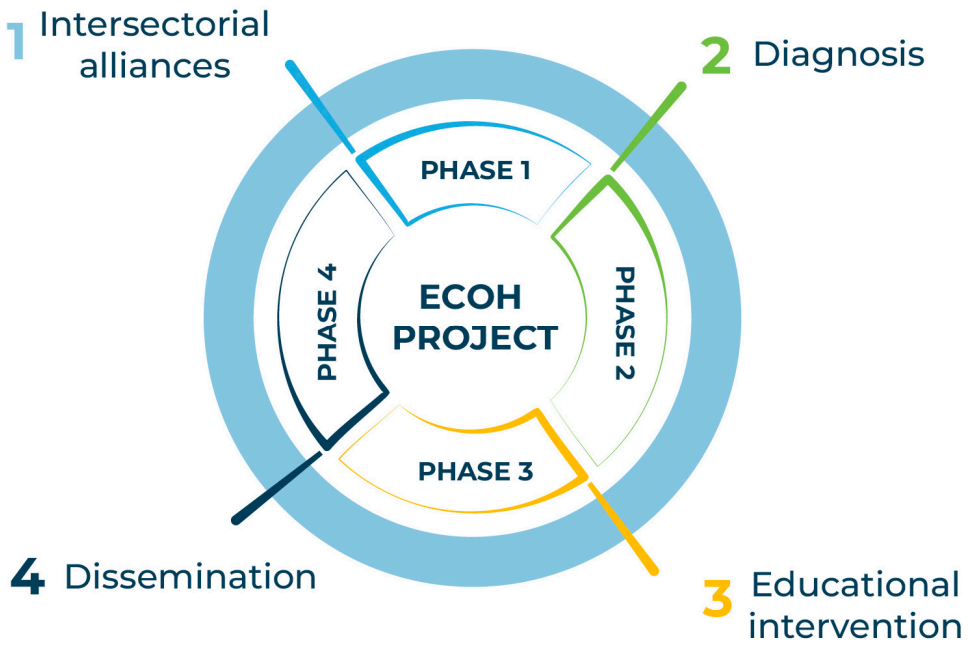

Figure 1. Phases of the ECOH project.

2.1. First Phase: Establishment of Inter-Institutional Alliances at the Local Level

The project team was integrated with professionals from different disciplines, including environmental engineers, nurses, biologists, and public health, from the public university San Francisco Xavier de Chuquisaca (USFX) in Bolivia, in collaboration with professionals from the Universidad San Carlos de Guatemala (Guatemala) and the Center for International Health network based at the Ludwig-Maximilians-Universität in Munich, Germany (CIH^{LMU}).

As a first step, inter-institutional alliances were consolidated at the local level, inviting representatives of public and private institutions to join the project. An open call, aimed at the general population and students from the Faculty of Science and Technology of USFX, was also made through social networks to join the project. The project was socialized into this group, and the following activities were planned jointly. Given the restrictions implemented in 2021 by the Bolivian Ministry of Health in response to the COVID-19 pandemic, some of the meetings were held via videoconferences (Zoom).

2.2. Second Phase: Situational Analysis of the Environmental Situation

In agreement with the project team and local actors, a cross-sectional study was implemented to identify practices and perceptions about the environmental situation in the general population living in Sucre. The results guided the subsequent actions to address the main problems identified in the community. For this, an online questionnaire was implemented in Spanish, adapting the "Eco Barometer" questionnaire, which was previously used to evaluate the environmental practices of citizens in Andalucía [21]. The instrument included 14 closed questions which explored the following topics:

- *Socioeconomic information:* It included information regarding gender (female, male, other), age (≤30, >30 years), current employment (yes, no), and education level (up to high school, university studies, and postgraduate studies).
- *Information and interest in environmental issues:* This section included questions about the level of interest in ecological news (high, medium, low), the level of information on environmental matters (very/quite a bit, average/minor), and the primary media

used to access ecological information in the last 2 months (print media, audiovisual media, Internet/Social Networks, and others).

- *Concern about environmental issues:* In this section, participants were asked to assess the environmental situation in their home (very good/good, bad/very bad), their level of environmental concern (scale from 1 to 100 points), and to identify the most critical environmental problems of their community.
- *Practices in favor of environmental care:* This dimension explored the willingness and frequency of practices for environmental care, such as participation in protest marches, saving water, purchasing local ecological products, and preference for travel in the city. It also asked about the frequency and willingness to separate solid waste (e.g., clothing, household oil, batteries, paper/cardboard, glass, plastics).
- *Beliefs and perceptions about environmental issues*: We explored the level of agreement about different statements related to the environment, such as its impact on health, the role of modern science, and citizen participation in the search for environmental solutions.
- *Influence of the environment on different aspects of life:* The level of perceived influence on various aspects of life was explored, including health, availability of water, food, and energy, among others. Finally, participants were asked whether they considered the implementation of a solid waste management program in schools to be necessary (Yes, No).

To collect the information, the SurveyMonkey platform [22] was used, disseminating the survey on both personal and institutional levels from the local university (USFX) and other institutions supporting the project. It included social media (e.g., Facebook, WhatsApp groups) and institutional websites. We invite individuals aged 18 years and above to participate. The survey was anonymous and voluntary. The survey results were exported and analyzed using IBM SPSS V.29, with reporting of both absolute and relative frequencies.

2.3. Third Phase: Educational Interventions

Considering the environmental problems and practices identified in the meetings and the survey (Phase 2), educational interventions were designed to strengthen knowledge about the proper handling and separation of solids. For this, five educational units (three schools in urban areas, one in rural areas, and one university career) were selected for convenience due to the feasibility of access and the availability of resources. Considering the restrictions imposed during the COVID-19 pandemic, these educational institutions were selected due to their willingness to receive the research team in person. We aimed to include schools from both urban and rural areas, as well as public and private institutions.

The ARIPE model was used to design the in-person interventions, consisting of five phases (Adjust, Reactivate, Inform, Process, and Evaluate), which guided interventions for developing competencies [23]. Content and materials (including short videos) for educational interventions were developed collaboratively during regular meetings and based on literature reviews. Volunteer students from the Faculty of Science and Technology-USFX were recruited to implement the interventions together with the project team. The videos and other materials developed were piloted and adapted to the local context.

Additionally, each participating educational unit received two plastic (one for paper/cardboard and one for bio-infectious materials) and one metal (for plastics) container to promote waste separation practices following Bolivian environmental regulations. Also, two educational units (one urban and one rural) received worm colonies for composting practices as alternative management of organic waste. The participating educational units accepted the commitment to care for the respective containers. For the university academic

unit, the paper/cardboard waste container was replaced for waste electrical and electronic equipment due to the increased generation of this type of waste within the institution.

After the interventions, visits were conducted to the educational units to assess students' attitudes toward environmental issues, their waste classification practices using the installed containers (paper/cardboard, plastics, infectious), and their management of worm colonies.

2.4. Fourth Phase: Project Dissemination

A free-access computer application was designed to socialize educational materials developed by the project and draw attention to environmental issues. To this end, a graphic designer and programmer joined the work team and defined content, interactive activities, and container geolocation functions to facilitate the visibility of solid waste separation and disposal points. Once the creative process was completed, the application was reviewed and tested. Then, it was uploaded to the Play Store platform for free download on Android devices.

3. Results

The project's first phase was implemented from July 2021 to May 2022. In this period, inter-institutional alliances were strengthened, with representatives of public institutions (local urban cleaning company, municipal environmental department), private institutions (educational unit with an ecological vision), youth organizations, and students from the local university (Faculty of Science and Technology) joined the project. Regular meetings were held in virtual format (Zoom) and face-to-face to discuss project objectives, prioritize areas of intervention at the local level, and plan activities for educational interventions. The project team also had weekly meetings with the rest of the international network team to report progress, exchange experiences, and receive advice on specific topics.

The situational diagnosis (Phase 2) was implemented in June 2022, receiving responses from 236 people. Of these, 123 (52%) were excluded due to incomplete sociodemographic information (at the beginning of the questionnaire) or because people were living outside of Sucre. Most of the participants were women (63%) under 30 years of age (85%) with university or postgraduate studies (51%), and the majority reported not having a stable job at the time of the survey (85%).

A significant proportion of participants (70%) expressed an interest in environmental issues, but only 44% were practicing waste separation. The primary sources of information were the Internet and social networks (89%) and audiovisual media (65%). Participants reported strong environmental concerns, with an average score of 77.8 out of 100 (standard deviation 20.2), and 86.3% rated the environmental situation in their locality as regular, bad, or very bad. The main environmental problems identified were garbage and solid waste in streets and public areas (64%), the situation of stray dogs (28%), and air pollution (25%).

Among commonly practiced environmental behaviors, participants reported frequently buying local and seasonal products (60%), saving water at home (58%), and using eco-friendly modes of transport such as walking, cycling, or public transit (57%). Waste separation focuses on plastics (28%), paper and cardboard (23%), and clothing and footwear (20%). However, 35% stated that the absence of nearby containers limited this practice.

There was unanimous agreement (100%) on the importance of citizen involvement in improving the environment, including environmental education in school curricula and the health impact of inadequate waste management. High levels of disagreement were reported with statements such as "urban lifestyles do not affect nature" (86%), "water that is not consumed is useless" (76%), "modern science will solve all environmental problems" (63%), and "economic growth is necessary to protect the environment" (55%) (Figure 2).

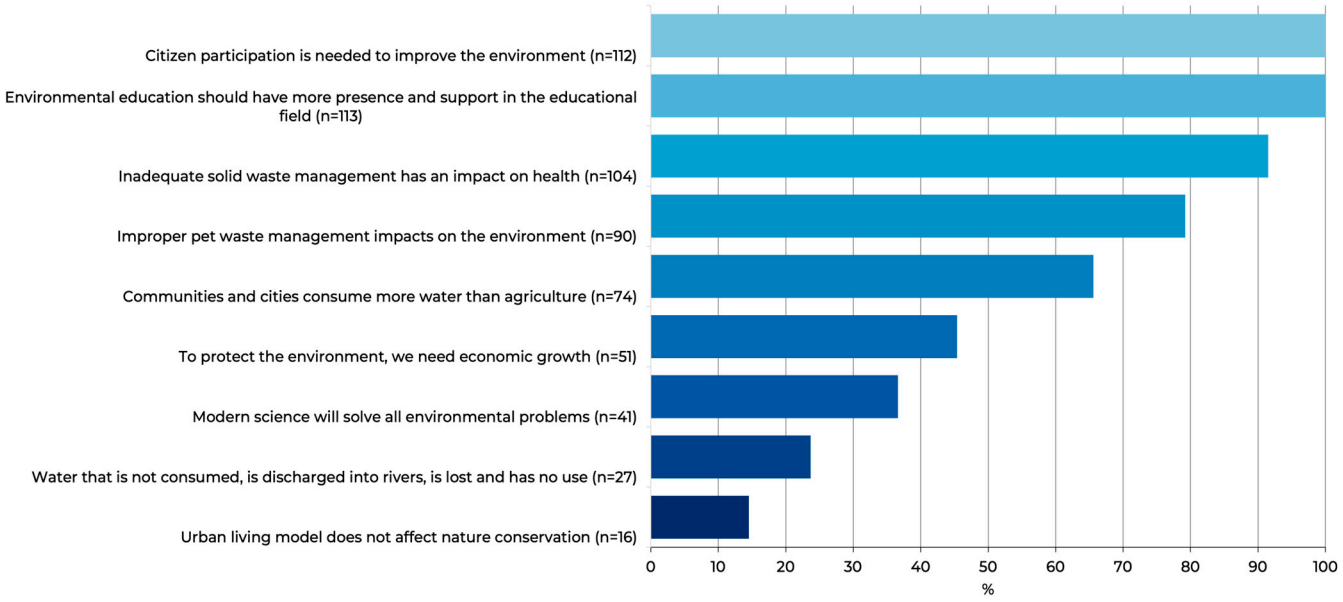

Figure 2. Beliefs and perceptions on environmental issues (% Agree/Strongly agree with the statements; n = 113).

Additionally, a high percentage of participants acknowledged a significant influence of the environment on various aspects of life, particularly on health (92%), the availability of resources such as water, food, and energy (92%), and daily activities (86%). In contrast, fewer participants (59%) perceived the environment as strongly influencing security and life stability. Nearly all respondents (98%) emphasized the need for interventions in educational units to promote proper solid waste management in the city (Figure 3).

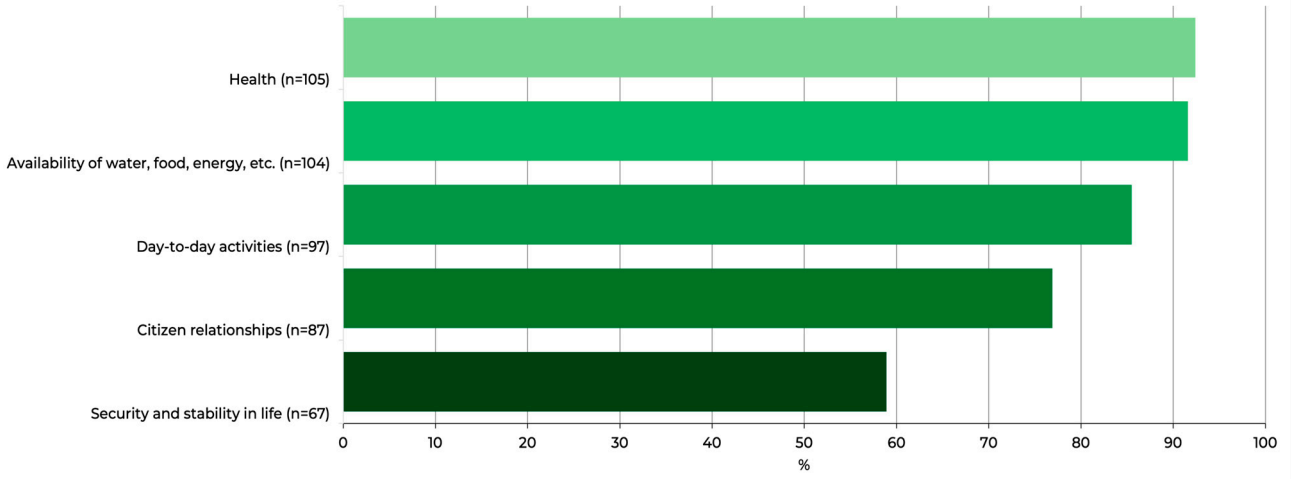

Figure 3. Level of influence (Quite a bit/a lot) of the environment on human life factors (n = 113).

3.1. Teaching Interventions

The educational interventions were designed and implemented in each of the selected educational units, reaching approximately 700 participants, including teachers and students between 5 and 65 years old. Each intervention addressed three topics: (a) Basic concepts of solid waste management with a One Health approach, (b) Negative effects on the human, animal, and environmental health of inadequate solid waste management, and (c) Alternatives that reduce solid waste generation, promote reuse, and facilitate recycling. Each intervention lasted approximately 60 min, adapting the language and depth of the content according to the target audience (primary, secondary, university education).

Five educational videos were also developed at this stage, which addressed the following topics: (a) the origin of solid waste, (b) its classification and management, (c) the role of the city's garbage collectors and cleaning personnel, (d) the effects of inadequate waste management, and (e) vermiculture as an option for managing organic waste. These materials were shared and used during the educational interventions at schools [24]. The basic structure of each intervention is shown in Table 1, which describes the activities carried out in each stage suggested in the ARIPE model. Supplementary Table S1 presents the structure of the intervention, tailored to the age groups targeted in the educational units.

Table 1. Planning educational interventions.

Activities/Methods/Materials	Description	ARIPE Model Phase, Duration and Objective
Photovoice Materials: laptop and digital projector to show photographs taken by members of the research team and contextualized to the environments near each participating academic unit.	We discuss photographs from different parts of the city showing waste collection points with inadequate management, clandestine dumps, dogs in garbage dumps, waste-burning, and waste collectors, among other common situations.	Phase: Adjust 3 to 5 min. Objective: To stimulate students' interest and engagement by linking the issue to local and familiar realities
Open questions Materials: laptop and digital projector to show the guiding questions or colored paper with questions printed	Knowledge, experiences, perceptions, and practices regarding waste management in their homes and educational units were explored.	Phase: Reactivate 3 to 5 min. Objective: to explore prior knowledge on the topics to be discussed
Presentation of contents Materials: laptop and digital projector to show new information and educational material (videos) developed in the project	Information on the selected topics was presented, and some of the educational videos produced during the project were shown and discussed.	Phase: Inform 10 to 15 min. Objective: Introduce new information on the topics to be addressed resuming prior knowledge (reactive phase) and promoting analysis considering the impact on animal, environmental and human health.
Games and dynamics Materials: Aluminum containers (according to national regulations) and various types of waste. Laptop to display images related to the topics covered. Containers, nets, organic waste, and worms (*Eisenia fetida*) to teach about vermiculture. Colored paper, pencils, poster-sized paper (for sticking the commitments made)	Various activities and games were carried out to deepen and process the topics seen in the previous stage. Some activities included exercises for segregating waste in colored containers, which were delivered to the educational units. Some interventions focused on managing organic waste, and the students reinforced some techniques for breeding small colonies of worms, detailing the optimal conditions for their development, such as adequate humidity and temperature. One educational unit received a colony of worms. The participants wrote a commitment to implement what they learned in their daily activities.	Phase: Process 20 to 30 min. Objective: Put into practice what was learned, reflecting on its applicability in daily activities
Call ball Materials: Ball (cloth or plastic), and written questions on the topics reviewed	To close the interventions, various questions were asked about the contents reviewed in the activity, clarifying and reinforcing them.	Plase: Evaluation 5 to 10 min Objective: to evaluate the fulfillment of the session's learning objectives and clarify necessary concepts.

At the end of each intervention, the students wrote a commitment to improve environmental care practices in their homes and educational units, capturing them in a "solutions tree" in a visible place in their class. They also assumed responsibility for taking care of the provided containers and worm farms.

Two months and one year after the interventions, visits were made to the participating educational units, and semi-structured interviews were conducted with the principals and teachers. They observed a better attitude towards environmental issues among the students. At the same time, it was verified that the containers were well-maintained and used to classify the daily paper and plastic waste generated in the educational unit. Teachers reported increased student motivation and spontaneous classification of recyclables. In one school, they started an internal recycling competition to promote waste classification. One school reported that students brought materials from home to fill a container they called "the giant bottle", turning it into a collective challenge. Although the vermiculture systems faced difficulties during the school holidays, the recycling bins remained in use and were integrated into regular routines; Likewise, at the university, the dean reported that the containers support campus cleanliness, especially in green areas.

In the two schools where worm colonies were implemented, and training was provided on their breeding, teachers noted that primary school children (aged 5 to 15) showed great interest in feeding the worms and recognizing the value of using their organic waste.

3.2. Dissemination Activities

The mobile application, called "ECOH Ambiental", was launched to the public in November 2022 in collaboration with local authorities. The content and activities were organized into four sections (Figure 4):

Figure 4. Screenshot of the mobile application called "ECOH Ambiental". (**A**) Locations: It showed the city map with the geolocation of the waste containers of the local solid waste management company. Each point has a comment option, which allows for reporting the container status and any problems. Other places that have enabled waste collection points (paper/cardboard, plastics, glass) were also geo-referenced. (**B**) Learning: It offered access to infographics and educational videos developed by the project. (**C**) Let's Play: This included educational games to encourage waste. (**D**) News: It allowed users to report events or activities related to waste management or environmental care in their communities.

Users and authorities highly appreciated the implementation of the application, and its administration was entrusted to the university in collaboration with local authorities. In the first year of implementation, 512 downloads were recorded.

4. Discussion

The paper describes the experience of a participatory project that addressed a relevant problem affecting the health of humans, animals, and the environment within the framework of the One Health approach [25]. The four phases of the project allowed the establishment of inter-institutional working alliances, identifying and prioritizing environmental problems, and implementing and disseminating educational interventions focused on waste management in educational units.

The diagnostic phase of our project allowed us to make visible and prioritize problems perceived by the population. It showed a high concern for environmental issues and a high interest in environmental news, considering social networks as the primary sources of information for these issues. The survey results in our project were consistent with other studies where greater interest and concern were related to higher levels of education [12,26]. On the other hand, some studies found it challenging to assess the credibility of information sources related to waste management, suggesting that there is uncertainty and little clarity about the effectiveness of policies and interventions to promote environmental protection [27,28]. In this sense, mobile applications could be a good solution for environmental issues, as reported previously [29,30]. While our project proposed implementing a mobile app primarily to disseminate information, it is important to consider the potential that mobile apps can have in the learning process and in raising awareness on environmental, animal, and health topics. In future interventions, a plan for their evaluation and monitoring that allows visualization of the scope of these tools and implementation of continuous improvements in their operation is necessary.

Respondents in the diagnosis part of our study (Phase 2) were willing to carry out practices in favor of the environment and recycle their waste. However, a lack of accessible sorting containers or waste collection services could limit these practices. These difficulties have also been reported in other contexts [7,31,32]. Likewise, most of the participants in Phase 2 of our study agreed that it is necessary to consider citizen participation and environmental education as crucial factors for ecological protection, which is consistent with other studies [21,33,34]. In this sense, environmental education faces different challenges in Latin America regarding proper implementation. These include limited institutional prioritization, insufficient teacher training, a lack of context-specific teaching materials, fragmented curricular integration, and weak articulation with local environmental and sustainability policies [35]. The need to understand and adapt interventions that consider cultural contexts has been highlighted [35] so that values, community forms of organization, and available resources are respected, among other aspects.

In our study, educational interventions were positively valued, highlighting the use of active methodologies that promote learning, such as the ARIPE model [23], which allowed the introduction of new concepts based on the participants' existing experiences and knowledge, as well as considering a "processing" and "evaluating" stage, which allows the incorporation of new knowledge into day-to-day activities. In that sense, working with educational units to strengthen environmental education topics seems to provide favorable conditions that favor adopting sustainable practices [7,9,10,36]. In our case, the educational units showed a willingness to incorporate these topics. This reflects the awareness of the need to implement practices that seek sustainable development in the region. However, in many cases, teachers are not sufficiently prepared to facilitate these topics, or there are no conditions in the infrastructure of the educational units (e.g., containers) that allow for strengthening environmental care practices.

Although previous studies have reported an interdisciplinary and participatory perspective to address solid waste management, strengthening alliances with local institutions [37,38], in Bolivia, the reported experiences have focused more on specific or technical aspects of

integrated solid waste management [15,16,39]. Few reported experiences have addressed environmental education issues by involving different actors in the community, working with a multidisciplinary team, and emphasizing the impact of environmental care on human and animal health, as the ECOH project did. This approach was essential to understand the city's environmental problems better and plan educational actions adapted to the specific context, considering a more comprehensive approach, highlighting the interconnection between animal, human, and environmental health.

However, our study has limitations that need to be acknowledged. One of them is the low representativeness of the participants in the diagnostic phase (survey). The project was implemented during 2021/2022 when some restrictions remained due to the COVID-19 Pandemic; therefore, an online survey was analyzed as a good alternative. However, this can explain the higher participation of young people (under 30 years old) with higher educational levels than the region's general population. In this way, our results may overestimate the level of environmental concern and environmental care practices. Also, some more prevalent problems in population groups that did not participate in the survey could not have been prioritized. It would be important to reinforce the results of the diagnostic stage with a representative sample of the population or triangulate findings with mixed-methods approaches including complementing the information from the surveys (quantitative approach), with qualitative methods such as focus groups, interviews with key people (e.g., community representatives) in order to reduce potential selection and information biases that may have been introduced into the study. It will allow us to better identify practices and perceptions regarding environmental care and to develop new interventions or educational materials that address problems that have not been considered. Furthermore, although our Phase 2 assessment primarily focused on the general population, accessibility issues limited our educational interventions to academic units, highlighting opportunities to integrate these initiatives into the training of students at various levels. On the other hand, since the academic units included in the interventions were chosen for convenience, it is possible that they were more receptive to the content of the interventions, and their students were more willing to change their behavior in relation to the environment. However, given the COVID-19 restrictions still in place during this period, these units were chosen because they agreed to host the research team to conduct the educational interventions in person. Nevertheless, we sought to ensure some variability in the characteristics of the schools, including those in urban and rural areas, as well as public and private schools. Another significant limitation is the weak monitoring of mobile app usage and the lack of an objective evaluation of the educational interventions, pre-post interventions, and their long-term effectiveness in improving attitudes and environmental care practices (e.g., waste separation at 6–12 months), as other studies have done [9,10,36,40]. This information is necessary to include in future interventions to generate more substantial evidence of their effectiveness, sustainability, and scalability.

5. Conclusions

The ECOH project has allowed the strengthening of environmental care practices in Sucre, Bolivia, by incorporating a participatory approach and developing interventions focused on problems identified at the local level, emphasizing the importance of environmental health and its interdependence with human and animal health. Critical factors for accepting these interventions in educational units included the involvement of decision-makers, students, and professionals from different fields of knowledge during the planning and implementation phases, which promotes a more comprehensive approach and the adaptation of interventions to local contexts. Evaluating the interventions carried out in the

long term is essential to measure the interventions' effectiveness in promoting sustainable environmental practices.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su17083464/s1, Table S1. Adaptation of the educational activities and the contents according to the level of the participants.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of the Faculty of Science and Technology of Universidad San Francisco Xavier de Chuquisaca, Bolivia (September 2021).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors upon request.

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Abbreviations

The following abbreviations are used in this manuscript:

ECOH	Environmental Care with a One Health Approach
SWM	Solid Waste Management
UNICEF	United Nations Children's Fund
USFX	university San Francisco Xavier de Chuquisaca
CIH^{LMU}	Center for International Health network based at the Ludwig-Maximilians-Universität in Munich

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