

Environmental education for agricultural development in a rural community

Abstract

An environmental education program was developed in the southern part of the Dolorita community, located 13 km from the city of Santiago de Cuba. The limitations in environmental management within the agricultural context, combined with the community's lack of environmental awareness, affect agricultural performance in efforts to conserve and improve environmental quality. To address the community's shortcomings, actions were implemented to foster environmental knowledge through agricultural practices in an integrated and systematic manner. The statistical analysis of the results allowed for an understanding of the behavior of the estimated variables in the study. The learning process in environmental training enabled community members to adopt responsible behavior in agricultural practices, within a framework for building environmental knowledge that fostered an understanding of environmental protection and the pursuit of agroecological transition in the southern zone of the Dolorita community.

Keywords: environment, agricultural context, sustainability, biodiversity

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Introduction

Population growth and low food production make food security a matter of great importance and global concern; since environmental problems such as inappropriate land use, climate change, and water scarcity, among others, have caused people suffer from food insecurity and hunger.¹ Thus, we are witnessing misguided and unsustainable human actions that exceed the environment's capacity to produce sufficient food and sustain an estimated global population of 9,700,000,000 people by the year 2050.²

For these reasons, environmental education for sustainable agriculture is a fundamental initiative that seeks to integrate ecological responsibility into contemporary agricultural practices and stands as a cornerstone for promoting sustainable agriculture by incorporating practices that strike a balance between production and environmental preservation.³

Furthermore, one of the current environmental problems is the loss of biodiversity, which has become one of the main threats due to the destruction of species' habitats, causing disruptions in many regions of the world. The conservation of biodiversity — as a factor in the sustainability of life on the planet and of agricultural production — highlights the repercussions that changes in biodiversity can have by compromising ecosystem functions and their capacity to provide essential services to society and the environment.⁴

Currently, nature is suffering from the ongoing abuse of its natural resources, caused by irresponsible human activity, such as indiscriminate deforestation, which leads to drought, soil degradation, and the irreversible loss of plant and animal species, among other ills. It is impossible to conceive that human beings could survive without nature.⁵ This means that humanity's irresponsible actions have led to increased environmental risks and impacts on nature, and environmental education must serve as a catalyst to promote learning aimed at the conservation and protection of the environment. Thus, today we must foster in people a new way of viewing the environment, providing education that addresses both concepts and attitudes, which contributes to the development of environmental quality, with the aim of fostering skills and values in people to achieve agricultural development.⁶

Thus, educational processes aimed at environmental education are implemented as strategic initiatives, designed to foster the capacity to protect the environment.⁷ Rodríguez⁸ asserts that the solution to environmental problems must be environmental education, and the goal is not only to understand environmental impacts but also to conduct a thorough analysis from social, political, economic, ethical, legal, and cultural perspectives.

The goal, therefore, is to ensure environmental education grounded in analytical thinking with an interdisciplinary approach, which can contribute — through environmental training initiatives — to the coordination of natural processes for environmental protection, the restoration and sustainable use of natural resources, and the mitigation of climate change, in accordance with Law 150 on Natural Resource and Environmental Systems GOC.⁹

In Cuba, Law 150 on Natural Resource Systems and the Environment⁹ is currently in force; it sets forth a set of institutional, legal, and regulatory subsystems that manage natural resources — both renewable and nonrenewable — as well as their internal interactions and their interactions with the environment, understood as the complex relationships of interconnection and interdependence established among natural resources to ensure sustainable development. The Natural Resources and Environment System is managed with a coherent institutional and regulatory vision, in which the Ministry of Science, Technology, and Environment acts as the governing body, thereby evaluating and monitoring the performance of natural resource users in accordance with environmental policy and management instruments.

In light of the above, the conceptual framework of the Republic of Cuba's National Environmental Education Strategy 2021–2025 focuses on increasing the efficient use of natural resources, expanding afforestation, and reducing environmental impacts and environmental degradation.¹⁰

This allows us to conclude that the residents of the La Dolorita community in the southern zone must be empowered through an educational process that fosters an inclusive approach to environmental education and provides solutions to environmental problems by striking an appropriate balance between theory and practice, while

promoting the comprehensive development of cognitive and affective abilities and a sense of social responsibility. Consequently, environmental education in this research must be approached through community participation to support agricultural development in the southern part of the La Dolorita community, with the conviction that it contributes to the protection of humanity and the rational use of natural resources, based on humanity's mastery of knowledge about the environment.

These scientific findings, aimed at environmental protection and linked to agricultural development, should provide the necessary knowledge for the sustainable use of natural resources and bring about changes in the way the population in the rural settlement thinks and acts, with a focus on sustainable development.

The research was conducted with the objective of establishing an environmental education process that would enhance community members' environmental knowledge for the protection of the environment and the rational use of natural resources in the La Dolorita settlement in the southern region.

Materials and methods

The study area was identified in the southern part of the La Dolorita community, at an elevation of 160 meters above sea level, on loose sialitic brown soil without carbonates, according to Hernández et al.,¹¹ located 13 kilometers from the city of Santiago de Cuba. The rural community is home to farmers who are primarily engaged in agricultural activities (fruit farming), and its infrastructure includes a medical clinic, a grocery market, an elementary school, and a video room.

Water for human consumption is supplied from alternative wells, and some residents receive it through the state water supply network. An assessment of the community was conducted using a targeted sample based on the census technique described by Torres,¹² with study subjects selected from the population residing in the community's main settlement.

Population of the main settlement: 45 community members (16 households). Gender breakdown: males: 25; females: 20

Community members are primarily engaged in agriculture.

Experimental design

A pedagogical pre-experiment was conducted, involving the selection of a specific group, with a pre-treatment test (diagnostic) administered, followed by a post-treatment test. This provides an initial baseline (pre-test/diagnostic) to assess the group's level and a final baseline (post-test) after the stimulus or treatment was applied to the variables.¹³

The general expression for the experimental design could be: G: {(01pre, 02pos)IX}

where:

G represents the group undergoing the pre- and post-tests

01 pre is the dependent variable measured in the pretest 02post is the dependent variable measured in the posttest X is the treatment or stimulus applied between the two tests.

The experimental design allows for a comparative analysis of the level of knowledge in Group 01 (pre-intervention; 45 community members) relative to Group 02 (post-intervention; 45 community

members), which serves as a single control group of 45 community members. This knowledge is assessed using 15 indicators through surveys, interviews, and the transcription of results using the Likert scale.¹⁴

The surveys administered indicate responses in the categories of the Likert scale,¹⁵ which are presented below:

Categories

- 1 - Strongly disagree
- 2 - Somewhat disagree
- 3 - Neither agree nor disagree
- 4 - Somewhat agree
- 5 - Strongly agree

Actions were developed to reduce shortcomings in environmental management in agricultural work and to raise the level of knowledge among community members, across four stages of development in the environmental education process.

Research methods and techniques

Systemic-structural-functional.

For the analysis of environmental education as an integrated system, with its functional elements.

Empirical-analytical.

To analyze the development of the community members' environmental culture.

Analysis-synthesis.

To synthesize the theoretical framework and compare realities in environmental education processes.

Exploratory survey.

To explore the community members' level of environmental knowledge. Structured interview. To explore the community members' level of knowledge regarding environmental education and assess the current state of the issue.

Statistical analysis

Source: IBM SPSS Statistics 21.0 Basic System.¹⁶

Reliability analysis. To assess the reliability of the instruments used (measurement scale), Cronbach's alpha reliability analysis was applied to surveys G: 01 (pre-test), 02 (post-test), and interviews, using the results of the indicators evaluated in the pre-test and post-test.

Validation of the responses from the surveys and interviews conducted; Likert scale.¹⁴ Analysis of the pre-test and post-test in the pedagogical pre-experiment in the environmental education process for community members.

Statistical processing of the pre-test and post-test results administered to community members in the pedagogical pre-experiment.

Results and discussion

Actions were developed to reduce shortcomings in environmental management in the community members' agricultural work. To

achieve systematization in agricultural practice, the community members went through four essential levels:

First level

Integration of environmental content into the community members' agricultural processes

Specific objective: Identify environmental problems in agricultural practices and mobilize educational content among community members.

Actions

- Screening of educational videos. This facilitated dialogue among community members, helping them understand the connection between natural and agricultural processes and the need to preserve the resources provided by nature.
- Environmental conferences. The sessions delved into topics such as agriculture and environmental risks and impacts, crop rotation, soil-plant interactions, intercropping, and tillage and its environmental impacts.

The program highlights the tension between what has been learned and what still needs to be learned, seeking harmony with the environment through an engaging and motivating approach to finding solutions to environmental problems in agricultural processes.

- Environmental Seminars. Seminars for the presentation and analysis of environmental legislation in rural communities: this activity is carried out through seminars and workshops designed to teach community members basic educational content for the analysis and compliance with environmental legislation. In this way, they internalize content that contextualizes the legal framework of environmental law.

Second level

Involvement of community members in the environmental education process related to agricultural practices

Specific objective: engage community members in the development of environmental education related to agricultural processes.

Actions

- Environmental outreach with other rural communities. This initiative fostered connections between community members and other settlements whose residents were recognized for their high standards of agricultural performance and nature conservation, thereby facilitating the exchange of environmental experiences and knowledge among community members.
- Formation of an environmental group. Community members selected talented individuals to create an environmental group that facilitated reflection and analysis of environmental risks and problems in the community's areas.
- Environmental workshops. Activities were organized in which community members participated in workshops to share their perspectives and discuss developments in environmental issues.

The following topics were covered: ecological balance and pest management in plantations; the development of agroforestry systems; ecological animal husbandry; and the importance of family farming.

Third Level

Focus on environmental education for community members engaged in agricultural practices

Specific objective: to develop skills that will enable environmental education for community members engaged in agricultural activities.

Actions

- Community environmental planning. This involves forecasting activities with the participatory involvement of community members and evaluating efforts to achieve new objectives. Environmental planning enabled community members to make decisions to establish environmental commitments, objectives, and goals related to agricultural activities within the community.
- Updating legal requirements. Review of compliance with and application of legal requirements. This was carried out to analyze content regarding compliance with legal requirements, as a basis for environmental education. The content has an environmental legal foundation, and its essence lies in establishing mechanisms that identify, update, and guarantee access to legal and other applicable requirements in force regarding agricultural activities carried out in the community.
- Discussion workshop. This activity allowed community members to reflect on and explore new agricultural topics in greater depth, as well as analyze how to apply environmental concepts relevant to the community. The following topics were analyzed: crop fertilization from an agroecological perspective; alternatives for reducing soil degradation in Cuba; addressing climate change; agroecological management of agricultural production systems; and the importance of integrating livestock farming.

Fourth Level

Evaluation of results and consolidation of the environmental education process for community members

Specific objective: to evaluate the training content provided for the development of environmental education among community members.

The fourth level of evaluation allows for an assessment of the results of integrating the phases, which facilitates an evaluation of progress in the environmental education process for community members and reflects the actions taken to address the research objective.

Thus, the evaluation of the actions implemented is closely linked to the development and consolidation of environmental education among community members and to the evidence of the quality achieved in the agricultural environmental training process. The results of the evaluation of these actions are reflected in theoretical and practical assessments based on the arguments, demonstrations, and evidence provided by community members during the environmental education process. Results of the environmental education process among community members engaged in agricultural activities.

Actions proposed for the evaluation of community members.

- Systematically verify the progress and completion of the different stages of the actions in the environmental education process.
- Evaluate the community members' progress in the planned actions and activities to ensure compliance with the research objective.

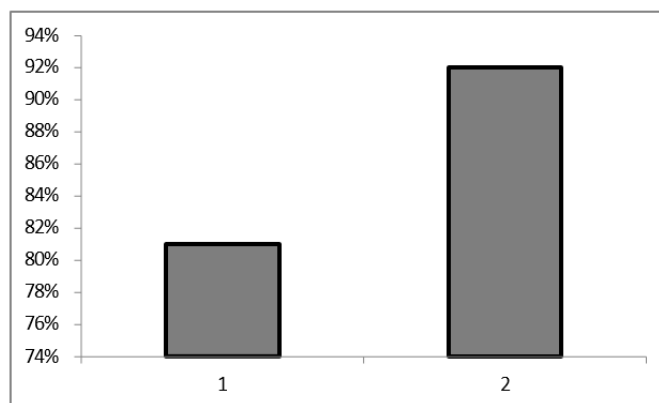
- Develop indicators that summarize the evaluation of the actions and activities carried out by community members during each phase.
- Fifteen evaluation indicators were developed to assess cognitive development during the community members' training process.

Evaluation indicators

- I. Reflections on the knowledge acquired regarding environmental issues.
- II. Development of skills, values, and assessments to address environmental issues and identification of applicable legal requirements in the community.
- III. Assessments of the analysis of the categorical system of the environment.
- IV. In-depth study of the content of environmental education and sustainable development.
- V. Knowledge for the development of Cleaner Production (CP) in agricultural processes.
- VI. The level of awareness among community members regarding the identification of environmental risks and impacts.
- VII. Participation in solving environmental problems in an agricultural context.
- VIII. Assessment of the role of environmental education in agricultural processes.
- IX. Knowledge acquired to implement an environmental management system.
- X. The know-how required for the design and development of environmental projects in the community.
- XI. Appreciation of environmental activities aimed at fostering education in environmental values among community members.
- XII. Assessments of analyses on sustainable development as a means of transition to harmonize human activities.
- XIII. Development of educational initiatives to ensure the continuity of environmental education within the community.
- XIV. Skills in applying legal requirements to ensure compliance with environmental legislation in an agricultural context.
- XV. The development of mitigation activities that address environmental issues in the agricultural context.

The results of the evaluation for the agricultural season show ratings ranging from 81 to 85% (20) among community members and from 86 to 95% (25) among community members across the 15 indicators evaluated. This demonstrates the level of satisfaction with the results of the cognitive evaluation among community members, following the implementation of actions in the environmental education process.

Results of the Environmental Education Program for Community Members Engaged in Agriculture. This illustrates the overall assessment level, which shows a potential range of 81% to 92% in the knowledge index, reflecting the cognitive development of community members in the environmental education process (Figure 1).



Post-test

Figure 1 Results of the environmental education process among community members engaged in agriculture

(1-2) – These figures show an increase in community members' participation in the environmental education process from 81% to 92%.

(1-2) – Assessment levels among community members following the implementation of the interventions (pre-test and post-test).

Thus, the overall assessment level is presented, showing a potential trend that reflects a knowledge index ranging from 81% to 92% in the results of the community members' cognitive development during the environmental education process. The post-test results demonstrate the community members' progress in the environmental education process.

Results of the pre-pedagogical experiment in the environmental education process for community members engaged in agricultural activities (Figure 2).

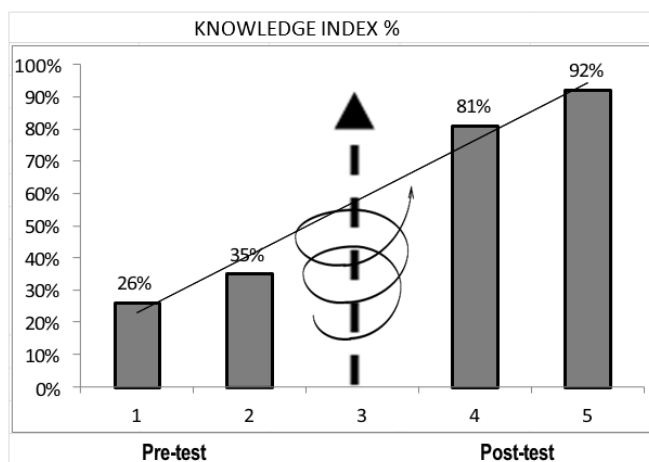


Figure 2 Results of the pedagogical pre-experiment in the environmental education process.

(/) - Potential Line; indicates the growth of community members in the environmental education process.

- (1-2-4-5)—Assessment levels for the pre-test and post-test.
- (3)—Implementation of actions in the environmental education process.

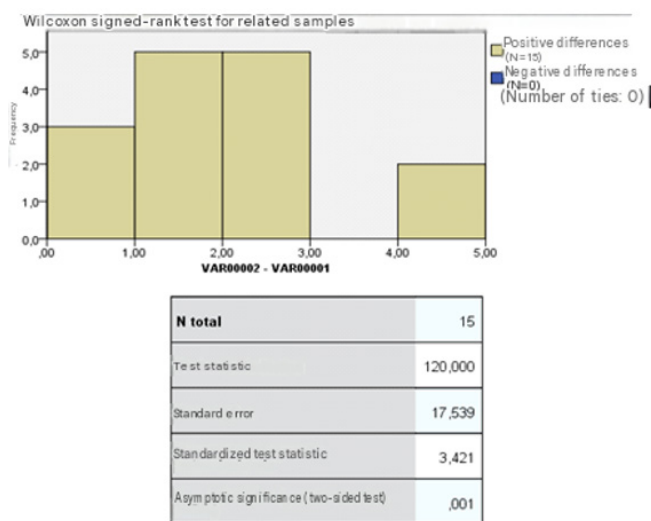


Figure 3 Wilcoxon signed-rank test for related samples.

The results of the pre-test and post-test evaluations in this study show a potential increase in environmental knowledge from 26% to 35% in the pre-test — which reflects the community members' limited knowledge regarding environmental management in agricultural processes — and from 81% to 92% in the post-test, which demonstrates progress in the community members' environmental education regarding agricultural practices.

Statistical analysis of the pre-test and post-test results from the pedagogical pilot study, conducted with community members engaged in agricultural practices

During the pedagogical pre-experiment, the results of the surveys and interviews conducted during the pre-test (diagnostic) and post-test with community members were transcribed. Thus, each community member surveyed was administered the Likert scale¹⁴ — an attitude scale with indicators and descriptive categories — to transcribe the verbal responses from the surveys and interviews into quantitative values corresponding to each category on the scale.

Transcription of the results of the surveys and interviews conducted with community members. Likert scale. Pre-test.

I	N					Cms
	1	2	3	4	5	
1	31	10	3	1	0	45
2	32	10	2	1	0	45
3	30	11	3	1	0	45

4	31	10	4	0	0	45
5	31	11	3	0	0	45
6	30	10	3	2	0	45
7	25	15	5	0	0	45
8	30	11	4	0	0	45
9	32	10	3	0	0	45
10	34	8	3	0	0	45
11	31	10	2	2	0	45
12	32	6	7	0	0	45
13	43	1	1	0	0	45
14	30	15	0	0	0	45
15	31	12	2	0	0	45

Legend: N - Attitude scale - descriptive categories; I - Indicators by community members; Cms - Community members.

Transcription of the results of the surveys and interviews conducted with community members. Likert scale. Post-test.

I	N					Cms
	1	2	3	4	5	
1	0	0	2	21	22	45
2	0	0	2	20	23	45
3	0	0	2	19	24	45
4	0	0	1	16	28	45
5	0	0	3	20	22	45
6	0	0	2	13	30	45
7	0	0	3	16	26	45
8	0	0	1	14	30	45
9	0	0	1	21	23	45
10	0	0	1	19	25	45
11	0	0	1	13	31	45
12	0	0	0	12	33	45
13	0	0	0	11	34	45
14	0	0	2	12	31	45
15	0	0	3	20	22	45

Legend: N - Attitude scale - descriptive categories; I - Indicators by community members; Cms - Community members.

Reliability analysis

To assess the reliability of the instruments used (measurement scale), Cronbach's alpha reliability analysis was applied to the surveys and interviews, using the results of the 15 indicators evaluated in the pre-test and post-test. The reliability results show a Cronbach's alpha coefficient of 0,991 in the pretest and 0,996 in the posttest for the standardized items, based on the estimates of the fifteen indicators (N) evaluated (Table 2), calculated using IBM SPSS Statistics 21.0.¹⁶

Table 1 Evaluation of the actions implemented among community members during the agricultural season

Indicators evaluation	Evaluation	Evaluation	Rating 86–95%	Rating	Total community
	60–80%	81–85%		96–100%	
15 indicators (Overall average)	0	20	25	0	45

Table 2 Reliability analysis of the surveys and interviews in the pre-test and post-test

Cronbach's Alpha	Cronbach's alpha (Standardized items)	Number of items (Evaluated indicators)
0,977	0,991	15

Pre-test: Reliability analysis of the surveys and interviews

Cronbach's Alpha	Cronbach's Alpha (Standardized Items)	Number of Items (Evaluated Indicators)
0,995	0,996	15

Post-test: Reliability analysis of surveys and interviews

Correlation matrix of the evaluated indicators from the pre-test surveys and interviews.

I	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1,000	,980	,995	,985	,996	1,000	,979	,978	,985	,709	,851	,709	,709	,917	,956
2	,980	1,000	,956	1,000	,994	,983	,919	,917	1,000	,834	,938	,834	,834	,978	,995
3	,995	,956	1,000	,963	,983	,994	,994	,994	,963	,636	,795	,636	,636	,874	,923
4	,985	1,000	,963	1,000	,996	,987	,929	,927	1,000	,820	,929	,820	,820	,972	,992
5	,996	,994	,983	,996	1,000	,997	,957	,955	,996	,768	,894	,768	,768	,949	,978
6	1,000	,983	,994	,987	,997	1,000	,976	,975	,987	,718	,858	,718	,718	,922	,960
7	,979	,919	,994	,929	,957	,976	1,000	1,000	,929	,649	,725	,649	,649	,816	,875
8	,978	,917	,994	,927	,955	,975	1,000	1,000	,927	,645	,721	,645	,645	,813	,873
9	,985	1,000	,963	1,000	,996	,987	,929	,927	1,000	,820	,929	,820	,820	,972	,992
10	,709	,834	,636	,820	,768	,718	,649	,645	,820	1,000	,974	1,000	1,000	,931	,885
11	,851	,938	,795	,929	,894	,858	,725	,721	,929	,974	1,000	,974	,974	,990	,968
12	,709	,834	,636	,820	,768	,718	,649	,645	,820	1,000	,974	1,000	1,000	,931	,885
13	,709	,834	,636	,820	,768	,718	,649	,645	,820	1,000	,974	1,000	1,000	,931	,885
14	,917	,978	,874	,972	,949	,922	,816	,813	,972	,931	,990	,931	,931	1,000	,994
15	,956	,995	,923	,992	,978	,960	,875	,873	,992	,885	,968	,885	,885	,994	1,000

Legend: I – Indicators evaluated in the correlation analysis.

Correlation matrix of the results evaluated in the post-test surveys and interviews.

I	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1,000	,985	,997	,997	,995	,882	,999	,965	,980	,992	,994	,944	,885	1,000	,981
2	,985	1,000	,995	,969	,997	,787	,976	,905	1,000	,999	,960	,873	,791	,987	1,000
3	,997	,995	1,000	,988	1,000	,842	,992	,941	,993	,999	,982	,915	,845	,998	,993
4	,997	,969	,988	1,000	,985	,915	1,000	,982	,962	,979	,999	,967	,918	,996	,963
5	,995	,997	1,000	,985	1,000	,832	,990	,935	,995	1,000	,978	,908	,835	,997	,995
6	,882	,787	,842	,915	,832	1,000	,903	,975	,771	,815	,929	,988	1,000	,875	,772
7	,999	,976	,992	1,000	,990	,903	1,000	,976	,970	,985	,998	,959	,906	,998	,970
8	,965	,905	,941	,982	,935	,975	,976	1,000	,894	,924	,988	,998	,976	,961	,895
9	,980	1,000	,993	,962	,995	,771	,970	,894	1,000	,997	,952	,861	,775	,983	1,000
10	,992	,999	,999	,979	1,000	,815	,985	,924	,997	1,000	,972	,895	,819	,994	,997
11	,994	,960	,982	,999	,978	,929	,998	,988	,952	,972	1,000	,975	,931	,992	,953
12	,944	,873	,915	,967	,908	,988	,959	,998	,861	,895	,975	1,000	,989	,940	,862
13	,885	,791	,845	,918	,835	1,000	,906	,976	,775	,819	,931	,989	1,000	,878	,776
14	1,000	,987	,998	,996	,997	,875	,998	,961	,983	,994	,992	,940	,878	1,000	,983
15	,981	1,000	,993	,963	,995	,772	,970	,895	1,000	,997	,953	,862	,776	,983	1,000

Legend: I – Indicators evaluated in the correlation analysis.

This allows us to conclude that there is a high reliability coefficient in the results of the surveys and interviews regarding the pre-test and post-test variables in the study.

Statistical analyses

T-test analysis for paired samples: To determine the differences and compare the pre-test and post-test variables in the sample studied. A test prior to the experimental treatment (pre-test; variable 1) and a test after the treatment (post-test; variable 2). The results were calculated for the N-15 indicators evaluated using IBM SPSS Statistics 21.0.¹⁶

Table 3 shows the results of the pre-test (variable 1) and post-test (variable 2) in the T-test analysis for paired samples. The results indicate that the mean of variable 2 (38.400 0) is higher than the mean of variable 1 (36.933 3). This reveals the progress made by community members in the process of environmental education for agricultural development in the community, the application of environmental knowledge to agricultural practices, a more thorough analysis of environmental realities, and a high degree of creativity in solving environmental problems in the southern areas of the La Dolorita community.

Table 3 T-Test analysis for related samples.

	N	Mean	Standard deviation	Standard error of the mean
VAR 1	15	36,933 3	1,486 45	,383 80
VAR 2	15	38,400 0	1,338 98	,345 72

Behavior of means of two variables estimated from a single sample.

Legend: Variable 1—Pre-test Indicators; Variable 2—Post-test Indicators; N—Indicators of cognitive development in the community training process.

Pre-test

Results of the inter-item correlations for the evaluated indicators.

Inter-item correlations	Mean	Minimum	Maximum	Range	Maximum/minimum	Variance
	,886	,645	1,000	,455	1,836	,016

Post-test

Results of the inter-item correlations for the assessed indicators.

Inter-item correlations	Mean	Minimum	Maximum	Range	Maximum/minimum	Variance
	,947	,771	1,000	,229	1,297	,004

Nonparametric analysis of related samples hypothesis testing

Null hypothesis	Test	Sig	Decision
The median of the differences between Var-1 and Var-2 = 0	Wilcoxon signed-rank test for paired samples.	0,001	Reject the null hypothesis

Asymptotic significance levels are shown. The significance level is 0.05.

Difference between the means of the variables for a 95% confidence interval.

Test statistic = 0					95% confidence interval	
	T	GL	Sig. (two-tailed)	Difference In means	for the difference	
					Lower	Upper
VAR 1	96,231	14	,000	36,933 33	36,110 2	37,756 5
VAR 2	111,072	14	,000	38,400 00	37,658 5	39,141 5

To advance environmental education in rural areas of Cuba, training programs were developed, but there were limitations in implementing

environmental initiatives through education. The foundation of environmental education in rural communities revealed a lack of educational and curricular approaches with an environmental focus, which hindered the resolution of environmental and agricultural problems, leading to technical and environmental shortcomings and irresponsible behavior in rural settings.¹⁷

For these reasons, it is important to develop the environmental education process within these communities to raise the level of knowledge and achieve the integration of agricultural and environmental processes in the La Dolorita community.

Furthermore, environmental interpretation in the rural context is a conscious, guiding, and mobilizing process aimed at fostering an awareness of risk in the agricultural sphere—an awareness required among community members engaged in agricultural practices to recognize environmental risks and impacts. This, in turn, motivates them to learn about environmental conservation and protection and contributes to the development of environmental awareness and attitudes.¹⁸

It can be stated that, from an agricultural-environmental perspective, a process of conscious development is mobilized and strengthened

within the community through the incorporation of environmental content into agricultural practices, revealing the assimilation of the new environmental knowledge and expertise required by community members.

Based on the foregoing, there is a commitment to protecting nature, along with the responsibility and attitudes that foster an understanding and appreciation of the relationship between humans and the environment; decision-making that enables the formulation of codes of conduct in agricultural practices; the development of solutions to environmental problems; and the integration of agricultural practices in rural communities.¹⁸

These results suggest that fostering responsible environmental behavior requires a shift in mindset regarding the consequences of each decision and action taken, in order to take responsibility for the outcomes.¹⁹

Final Project: Machinery and Workshops- Cortés³ explains that environmental education stands as a fundamental pillar for promoting sustainable agriculture, integrating practices that seek a balance between production and environmental preservation; it also becomes an indispensable tool for developing an agricultural system

that not only seeks productivity but is also committed to sustainable development and the well-being of the planet, ensuring a greener future for future generations.

For these reasons, an environmental education program was developed for community members to promote responsible environmental practices in agricultural activities in the La Dolorita community in the southern region.

Regarding these arguments, Orgaz²⁰ argues that environmental education fosters reflection on the need to move toward a new educational perspective that strengthens the bond between the environment and humankind and contributes to achieving sustainable development.

Based on the foregoing, there is a commitment to protecting nature, fostering responsibility and attitudes that promote an understanding and appreciation of the relationship between humans and the environment, making decisions that enable the formulation of codes of conduct for environmental stewardship with solutions to environmental problems, and integrating agricultural practices in the southern La Dolorita community.

The National Institute of Adult Education²¹ conducts research on environmental education, which helps to understand the effects of conventional agriculture on the environment and the need to adopt ecological practices through specialized training programs.

Galarza-Schoenfeld²² explains that the world's population is moving ever closer to the irreparable destruction of the natural environment; people contribute directly or indirectly to its destruction, and many forget the reality that humankind is entirely dependent on nature. The research findings reveal that community members possess a greater environmental awareness for addressing environmental problems in the community and promote new experiences through the introduction of new agricultural practices.

These are the reasons why it is necessary for environmental educators to implement actions that promote participation in activities that help mitigate, in some way, the damage caused to the environment and identify appropriate methodologies that allow their students to acquire knowledge that facilitates the recognition of the importance of the natural environment for life.²³

In light of the current problems resulting from the misuse of natural resources, agriculture is one of many effective alternatives that contribute to environmental conservation; thus, this activity serves multiple purposes: it provides food, drives the country's economic development, is a source of employment for many people, and significantly reduces poverty rates.²⁴

The results obtained show that environmental education was implemented in the La Dolorita community in the southern region, with the participatory involvement of community members in agricultural activities to enhance the community's capacity for transformation.

Sources of knowledge were identified to foster transformation and achieve a transformative impact in environmental education among community members, who have successfully developed an educational process focused on environmental knowledge to find practical solutions for agricultural practices, bring about cognitive changes in response to environmental realities, and foster greater analytical skills and creativity to address environmental problems and their impact on the La Dolorita community.

Results achieved in the community through the environmental education process for community members in agricultural activities

Educational impacts: community members

- Progress in the environmental education process, as evidenced by satisfaction levels ranging from 81% to 92%.
- An integrated approach to environmental management in response to the environmental risks and impacts arising from agricultural processes.
- The updating of environmental knowledge and comprehensive actions to harmonize agricultural activities in the community.
- Progressive behavior aimed at generating ideas, fostering motivation, developing environmental values, and increasing responsibility and commitment to the protection of flora, fauna, surface waters, and soil, to mitigate environmental problems in the community.

Scientific and social impacts

- Participatory action by community members to identify species of flora and fauna in the community.
- The degree of independence in carrying out agricultural work from an agroecological perspective.
- The creativity of community members in designing an environmental program that serves the interests of the region to promote scientific development.
- Identifying and minimizing environmental impacts in the settlement to harmonize agricultural activities.
- Skills in afforestation using shrub and tree species to protect the community's soils.

Conclusions

The environmental education process fostered cognitive changes among community members, leading to responsible behaviors for the resolution of environmental problems related to agricultural work in the rural settlement.

The knowledge acquired by community members will enable them to achieve a degree of independence in carrying out agricultural work, coordinate environmental and agricultural processes, and adopt a holistic approach to environmental management in the face of environmental risks and impacts originating within the community.

Community members will develop the creativity needed to design an environmental program aimed at promoting scientific agricultural development in the rural settlement.

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Conflicts of interest

All authors declare that there is no conflicts of interest.

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