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Education for sustainability toolkit: The new water culture approach

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ABSTRACT

The New Culture of Water (NCW) is a catalyst for sustainable transformation between political agreements and the unsustainability of the real world, thus requiring an integral participation for an efficient water management where the academy will try to make a substantial contribution. Therefore, this study aimed to design, implement and evaluate four competencies: Knowledge, Attitude, Perception and Practices (KAPP) of a formal program of Education for Sustainability (EfS) on the New Water Culture (NWC), addressing issues such as prevention of water quality, conservation and efficient use at home. To carry out the evaluation, a semi-structured survey of 47 items was conducted in three stages: at the beginning (diagnostic), during the development of the (EfS) (formative) and at the end (summative). A total of 103 nursing students participated in the (EfS), divided into two groups A and B, with the addition of group C as a control group. The results showed that group A had the best results, in general. Statistical tests to calculate the mean, standard deviation (SD) and a validation with the nonparametric Wilcoxon test showing a significant change in the participants of group A, which indicated an important impact of the (EfS). This study also provides an overview of the community situation that can help trigger early warnings to identify weaknesses in water management.

Contribution/Originality: The study contributes uniquely because the design and implementation adopted in this study would provide training facilitators a New Water Culture approach, to enable the academy to collaborate with the state and communities and promote improvements for the conservation, distribution and application of technologies for the efficient use and consumption of water.

1. INTRODUCTION

Water is essential for survival (Kasper, Hauser, Longo, Jameson, & Loscalzo, 2018) and a key element for the material and cultural well-being of societies worldwide (Shiva, 2003). Nevertheless, the current environmental problem has an epistemological consequence on the hegemonic ways of understanding the world, the imposition of a mode of knowledge production, and economic rationality (Leff, 2017). A serious concern about the consequences of the rapid and continuous environmental degradation exists as the situation leads to the sixth mass extinction (World Economic Forum, 2020). A precursor of this plight is water consumption, increasing at twice the rate of population growth.

Several international treaties, such as the Paris Agreement, have highlighted the possibility of water to connect the Sustainable Development Goals (SDGs) of the 2030 agenda and policy frameworks (UNESCO, 2020). The New Culture of Water (NCW) was introduced in Spain and provided a way to build citizenship concerning the country's management of water resources, which is a catalyst for sustainable transformation between political agreements and real-world unsustainability (Fuentes & Copitzy, 2012).

Hence, the concept of NCW fits the ecosystem management and conservation of water purposes. NCW is a concept that involves the culture of dialogue and peaceful debate towards sustainable development in the water management field through the 'water cultures' stories and water as a necessary resource and a source of spiritual well-being (Jiménez & Martínez-Gil, 2005). The concept is an exosystemic perception or interconnections between social settings that considers the relationships between water and the human spiritual facet, ethics, and knowledge.

The concept also encourages the intelligent and prudent application of modern technologies, social participation, optimization of reservoirs management and 'flood management' measures, and the knowledge and use of aquatic ecosystems. The NCW involves changing thoughts and practices with greater attachment to the ethical principles towards nature and human beings. Besides understanding the value of rivers as a key to social and territorial articulation, the study proposes to conceive the hydrographic basins comprehensively, including the towns and territorial characteristics (Arrojo, 2006; Fuentes & Copitzy, 2012).

In this context, the "Water Culture" program implemented by the local water agency in Mexico has been ineffective, as levels of efficient water management in cities have not yet been achieved (Ortega-Gaucin & Peña-García, 2016; Perevochtchikova, 2010). The program has been more concerned with the publicity of the institution itself, than with the formation of a real tool for organization and cultural change (Ortega-Gaucin & Peña-García, 2016), so a paradigm shift is needed. Training environmental promoters, is a necessity for a change of strategy in a program on the New Water Culture linked to the SDGs. Therefore, the study aims to design, implement and evaluate the knowledge, attitude, perception and practices (KAPP) competencies of EfS on the NCW. The study proposed no difference in students' KAPP competencies on NCW before and after the intervention. Besides, the study applied a socio-constructivist approach through competency-based learning to deconstruct the environmentally sustainable competencies regarding the prevention of water quality, conservation, and efficient use at home among undergraduate nursing students.

The study is of great relevance primarily to the health sector because of its relationship to water quality. Through an environmental education program, undergraduate students will be able to develop a comprehensive training as a social service, which will generate greater environmental awareness. On the other hand, the development of competencies for NCW also allows students at all educational levels to relate the SDGs during their intervention in formal education in previous semesters. Students will also be able to collaborate and guide the community to avoid being victims of corruption, mainly by private organizations, focusing on promoting distributive legitimacy, water technologies, professionalization and deep restructuring of the NCW led by the National Water Commission (CONAGUA) in Mexico.

1.1. Theoretical Framework

1.1.1. Education for Sustainability (EfS)

Education disseminates the idea of sustainable development, and the higher education institutions (HEIs) are keys to correcting the development paradigm (Cantú, 2017). Moreover, education effectively changes attitudes, values, and ways of life to achieve a sustainable future and create more just societies (Sampedro, Juárez, Bibiano, & Aparicio, 2012). Developing fundamental human capital competencies is crucial in managing complex governance problems (Kliskey et al., 2020).

Social constructivism is a tool in developing "knowledge communities" as a larger unit of analysis (Sharma, 2015). The aspect must connect to its effects on independent reasoning patterns for individual participants and a target unit of analysis. A social constructivist perspective for an instructional sequence begins with presenting a meaningful task or problem followed by an invitation to solve the problem in multiple ways. Subsequently, the sharing, justification, and discussion of the problem-solving strategies are formed in small or large group discourses.

The emerging academic field emphasizes sustainability locally and globally, as shown in Figure 1 (COMPLEXUS Mexican Consortium of University Environmental Programs for Sustainable Development, 2013). The sustainability system involves five principles and 17 key indicators including no poverty, zero hunger, good health and well-being, and others. The system also addresses complex problems with long-term implications and non-linear behavior, showing high degrees of urgency and potential for harm (Mochizuki, 2010). Education for Development (ED) was introduced through the sustainability system. The ED is an active learning process based on solidarity, equality, inclusion, and cooperation, which enables sustainable human development by understanding the causes and effects of global issues on personal participation and informed actions (Khoo & Lehane, 2008).

Eventually, Education for Sustainable Development (ESD) was introduced to improve ED. The ESD extends the aim to impart knowledge and raise awareness of social transformation (UNESCO, 2017). Besides, the success of ESD depends on the extent to which the SDGs are realized (Holfelder, 2019). Significantly, high-quality education enabled acquiring skills and values for life (UNESCO, 2017). Consequently, people could contribute towards achieving the SDGs by equipping them with the knowledge and skills needed to understand what they are and participate as informed citizens and achieve the necessary transformation.

The term EfS is often preferred to ESD as it offers a more open approach to alternative perspectives beyond the Western-dominated discourse of development (Centre for Global Education, 2008). The ESD and EfS try to deconstruct the society that places mass production, consumption, and disposal at the center of economic and social activities by integrating knowledge (Mochizuki, 2010; Skinner, Blum, & Bourn, 2013). The situation happens by adopting sustainability as a broad concept involving the need to debate the relationship between the environment and society from an ethical perspective based on human rights at the local and global levels and social and environmental justice (Wade, 2008).

Nonetheless, liberating EfS from environmental education (EE) and ED origins is necessary. The EfS requires a radical review of EE and ED instead of their simple addition and integration, as too many potential contradictions and conflicts of interest exist in the Western conceptions. The full adoption of the factors of EfS is crucial, such as sustainable design, alternative energy, earth, human rights, conflict resolution, anti-racism, and intercultural education (Wade, 2008). The adoption requires applying clear connections between sustainability and higher education (HE), such as campus environmental management, curriculum development, community participation, and global citizenship development (Hopkinson, Hughes, & Layer, 2008).

Figure 1. Sustainability complex system.

Source: COMPLEXUS Mexican Consortium of University Environmental Programs for Sustainable Development (2013); Dussel (2009); IPCC (2018); Šmajs (2019); Spinoza (2018).

1.2. Water Quality Prevention

Civilization has degraded and impaired the health of ecosystems and the poorest communities (Arrojo, 2006). Killing rivers, drying up wetlands, or polluting aquifers destroy fisheries and essential resources for millions of people and harm the health of communities that drink the waters and have close relationships with nature.

Currently, Mexico's population is 126 million, whereby poverty, lack of drinking water, poor sanitation services, and structural violence are common. The water scarcity in Guerrero results from the destruction of water sources, the high consumption of natural resources, and unsustainable society–nature relations. Nevertheless, 27.1% of the total population live without access to drinking water, and 23.3% remain without access to adequate drainage, causing biological, environmental, and social imbalances (PNH, 2018; Toribio & López, 2015).

A high degree of marginalization in housing (21%) also contributes to a high percentage of people without access to pipe water (32%) (PNH, 2018). The tourist port of Acapulco de Juárez includes 234 localities, with a total population of 789,971, whereby 673,479 people live in urban areas. Table 1 shows that approximately 18.38% of the population suffers from high marginalization (43 localities, 11,867 people). Additionally, the social backwardness index is 0.69 (INEGI, 2020; SEDESOL, 2013) indicating that water scarcity is a social problem impacting the entire municipality (Toribio & López, 2015).

Table 1. Degree of marginalization in the tourist port of Acapulco de Juárez.

Localities	Population	Percentage	Degree of marginalization
43	11.867	18.38%	Very high
132	99.057	56.41%	High
1	5001	0.43%	Medium
3	673.662	1.28%	Low
54	349	23.08%	No data available

Source: SEDESOL (2013); INEGI (2020).

At the regional level, the public administration mostly focused on the issues of over-exploitation, over-concession, and contamination of water resources, the lack of financial resources for the construction, rehabilitation, and maintenance of infrastructure for treatment, and the lack of training of operational personnel (PNH, 2018). Nevertheless, the sanitation issue has often been overlooked. Besides, the lack of access to sustainable, adequate, and affordable water supply and sanitation and hygiene services causes rivers and streams to receive untreated municipal wastewater (UNAM Water Network, 2014). Consequently, around 1.5 billion people annually are exposed to toxic heavy metals associated with significant morbidity and mortality from Neglected Tropical Diseases (NTDs) derived from the complex relationship between 'Society–Water' (Amor, José, & Pablo, 2019; Perevochtchikova, 2013; WHO World Health Organization, 2015; World Economic Forum, 2015).

1.3. Ecosystem Management and Conservation of Water

Water and forests are closely linked, with the soil as the medium and water as vehicles forming the production unit. The determining factor of their functional balance is vegetation that forms an insoluble triptych holding the key to human life (Bustamante, 2006). Arrojo (2006) stated that forests are not managed as simple wood stores. An essential aspect is establishing adequate priorities, rights, and management criteria based on the ethical principles of equity, participatory governance, and water sustainability.

Water sustainability is the population's right to healthy rivers and aquifers. Water for life – water life should be a priority and guaranteed from the human rights perspective of basic survival functions for human beings and other creatures in nature (Arrojo, 2005). Besides, the second level of priority should be water for activities of general interest – water-citizenship, in public health and social cohesion functions regarding the citizen's social rights and general interest of society. The third priority level is water for growth – water-business in legitimate economic functions is linked to productive activities regarding the individual's right to improve living standards. Accordingly, the NCW announced strict compliance with established environmental laws, the preservation and improvement of river heritage, and the implementation and efficient use of 'demand management' policies (Jiménez & Martínez-Gil, 2005).

The water scarcity in Guerrero results from the destruction of water sources (forests of the Sierra Madre del Sur), high consumption of natural resources, and unsustainable society–nature relations. An example of unsustainable practices is seen in the Omiltemi basin (Bustamante, 2006). Nevertheless, 27.1% of the total population survived without access to drinking water, while 23.3% remained without access to adequate drainage, causing biological, environmental, and social imbalances (PNH, 2018; Toribio & López, 2015).

The movement emphasized the need for an NCW (Figure 2) linked to the origins of integrated water resource management (IWRM), which requires the co-responsible participation of everyone involved. Presently, sustainable management is imperative to guarantee everyone sanitation and water availability with the associated environmental benefits and economic-social-local development (Arrojo, 2006; Valdes & Garcia, 2018). The IWRM is responsible for water supply and sanitation projects, financing drinking water committees, collaborating the management, administration, and water distribution, creating structures that form social changes (Brito & Ríos, 2015) and closing the gap created by local structural violence (Ventura-Dias, 2018).

Figure 2. The new culture of water.

Source: Arrojo (2006); Valdes and Garcia (2018).

1.4. Implementation of NCW in HEIs

The HEIs must recover, assume, enrich, and promote discourses regarding sustainability, solidarity, equity, inter culturalism, dialogue, collectivism, and spirituality in defining and exercising their functions (COMPLEXUS Mexican Consortium of University Environmental Programs for Sustainable Development, 2013). The approach to HEIs sustainability reaches a 'mature state', which dispenses with structure and becomes a part of everyday life (Beard & Rodríguez, 2010).

All HEIs mention sustainability in their study programs by decree, indicating a relationship between the context and identity of each institution. Besides, most HEIs with ambitious sustainability programs are reinforced by administrative structures (vice-rectories, departments, centers) dedicated to their application (Martinez-Fernandez, Meira-Carteo, & Gaudiano, 2015). The understated sustainability in HEIs into a concept of 'social responsibility' transferred from the private business world between a formally pro-environmental strategic discourse and some political, economic, and academic practices, imposing bias criteria and interests of the market (Martinez-Fernandez et al., 2015). HEIs' resistance in making substantial changes in their academic and management structures worsens the conflict by placing sustainability proposals against a "glass ceiling" inside the university.

The state, academia, and citizens must understand that the lack of an NWC causes inefficient practices in water management and environmentally unsustainable attitudes and increases the epidemiological panorama of the local origin of water deriving from the complex interrelation of 'Society–Water' (Perevochtchikova, 2013; Shiva, 2002). Therefore, the United Nations Decade of Education for Sustainable Development Summit urges HEIs to resume their responsibilities of translating environmental policies and guidelines and creating secure and healthy conditions in its processes. The HEIs were also implored to assume the challenges in their role as promoters of sustainability: congruence within its academic and administrative entities, and relevance to include sustainability in their functions, emphasizing social commitment (Nieto Caraveo & Medellín Milán, 2007).

2. METHODS

2.1. Sampling

The present study was conducted at Nursing School No. 2 of the Autonomous University of Guerrero in Acapulco de Juárez, Guerrero, Mexico. The participants were selected from the Bachelor of Nursing Programme 2011–2018, elective term 2019 (February–July semester) during the fourth and final year of the university course.

A semi-structured survey was conducted among 103 undergraduate nursing students (conveniently sampled from the total population, N = 2,490). The students were divided into three groups: intervention group A (38 undergraduate nurses), intervention group B (32 undergraduate nurses), and control group C (33 undergraduate nurses), as shown in Figure 3.

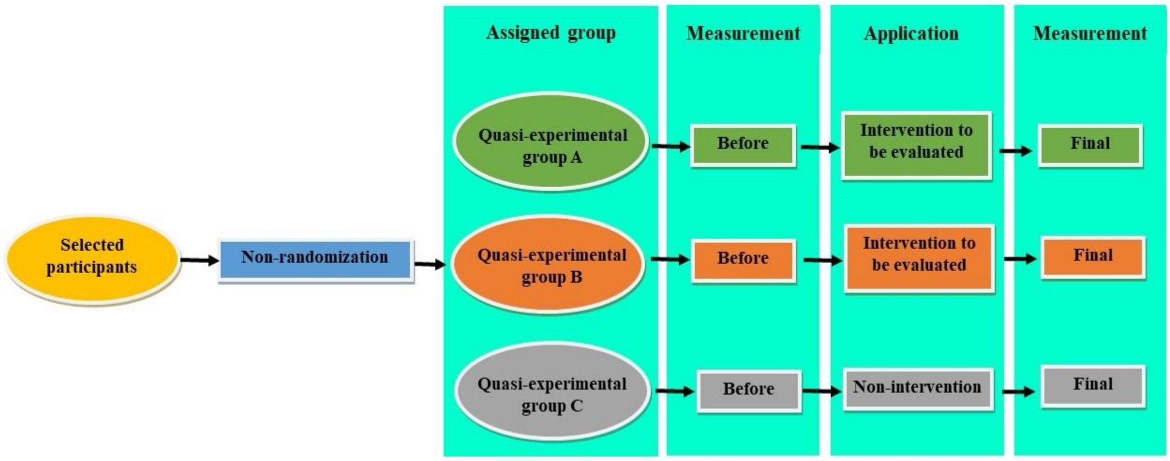

Figure 3. Community trial scheme of quasi-experimental educational intervention used for the study.

2.2. Research Type and Design

Exploratory-descriptive research was performed to clarify the research problems. Meanwhile, the participant's response was measured prospectively using a semi-structured questionnaire. Besides, a non-randomized intervention using the quasi-experimental design evaluated before and after the intervention to deconstruct the environmental sustainability competencies concerning the prevention of water quality, conservation, and efficient use at home in undergraduate nursing students (Figure 3).

The intervention was completed only among groups A and B (Figure 4), starting with 'The spider web' that aims to integrate the group, countercriticism of the environmental problems in their community, including home and school, and probable causes and solutions. The approach was applied by implementing two didactic sequences involving undergraduate nurses throughout the semester in a different but complementary manner. Overall, two didactic sequences were developed in 16 curricular weeks (128 hours), lasting 2 hours per session. In the first didactic sequence, 20 sessions were developed: 46 hours with a facilitator and 20 independent hours (Table 2). In the second didactic sequence, 20 sessions were developed: 42 hours with a facilitator and 20 independent hours. Finally, the study conducted a descriptive (summative) evaluation of the level of knowledge, actions, perceptions, and practices on the prevention of water quality, conservation, and efficient use at home (Table 3).

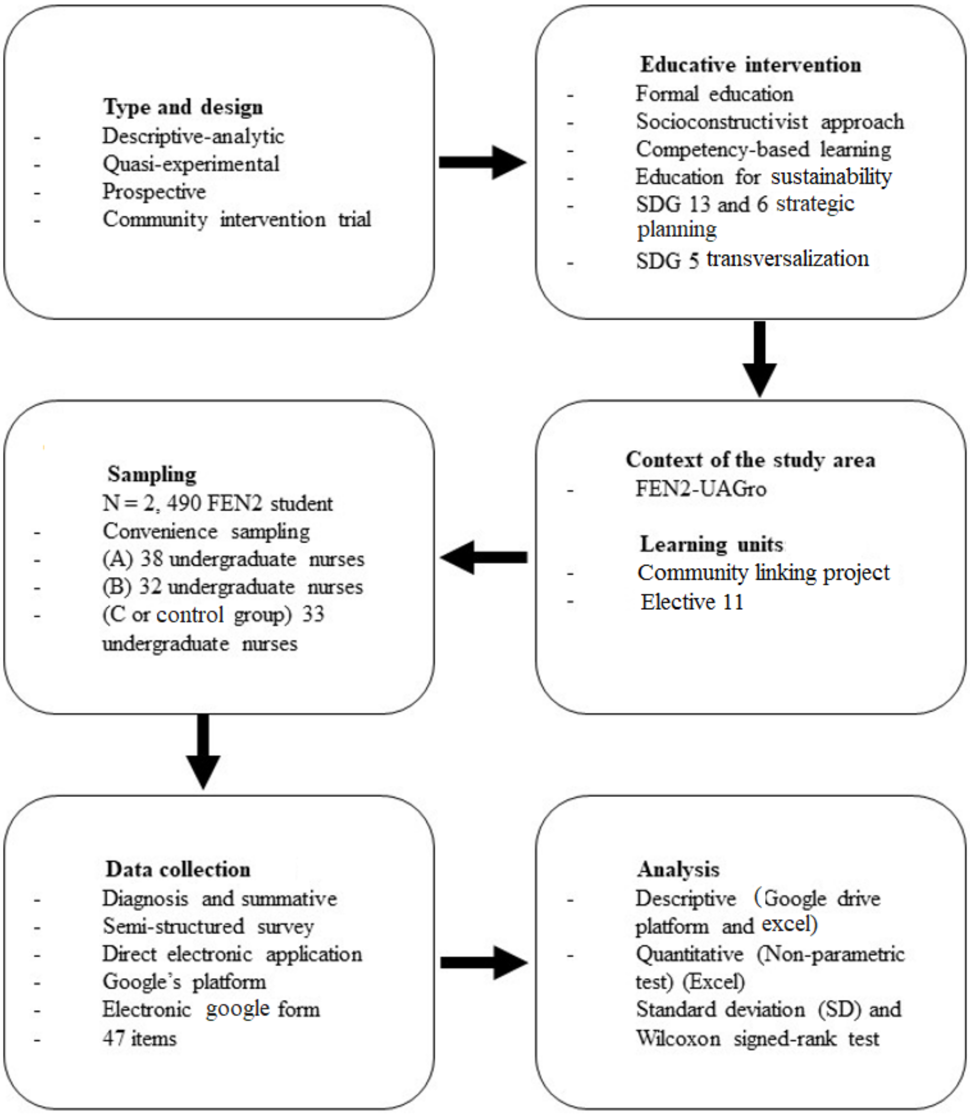

Figure 4. Methodology flowchart of the study.

Formative evaluations were performed in groups A and B during the final phase. Nonetheless, the program evaluation was performed with the KAPP diagnostic and KAPP summative survey results, building a baseline of knowledge, attitudes, perceptions, and practices (KAPP) about the NWC in all three study groups. Finally, the lecturer evaluation was completed to improve the teaching-learning technique continuously.

The questionnaire comprised 47 items and was distributed to the participants online in Google form. The questionnaire was designed to measure the KAPP variables and evaluate the program's influence on dimensions, such as water quality prevention, conservation, and efficient home use, using indicators throughout the educational strategy (Table 2).

Table 2. Education for sustainability: The new culture of water.

Didactic sequences			
Identification of the learning units			
Credit number	8		
Curricular weeks	16		
Hours number	**Hours with the facilitator**	**Independent working hours**	**Total hours**
Weekly	5	3	8
Semester	80	48	128
Learning unit competence	Train undergraduate nurses, through a formal program of education for sustainability on the new water culture, with a constructivist approach and competency-based learning, toward the deconstruction of knowledge, awareness of environmentally sustainable attitudes, prevention of water quality, conservation, and its efficient use in the home.		
Components			
Integrating axis 1	Knowledge	Ability	Attitudes and values
The social importance of water: interests and values at stake, conflicts and water management in Guerrero that force a new water culture	1. Analyses and understands the problem of water from the philosophical, social, ecological, and economic point of view to face from his/her level, the water environmental complexity and the climate crisis.	1. The student can talk about water pollution, access to water and water-saving measures, as well as increase the visibility of successful cases. 2. Counter-critical, de-ideologize, demythologize, local environmentalist thinking	1. It raises awareness of the environmental risk of the planet and biodiversity, thus jeopardizing the trophic chain and the human species derived from anthropogenic activities. 2. S/he commits to the values of the philosophy of liberation, the evolutionary ontology of biophilic culture, acknowledging the world ruled in a logical-causal geometric order towards the ecological event
Integrating axis 2	Knowledge	Ability	Attitudes and values
Water, sanitation and hygiene (WASH)	1. Analyses the WASH strategy to address the social determinants of health arising from it.	1. Recognizes that WASH interventions have broad public health benefits that enable multiple disease reductions and contribute to non-disease outcomes such as school attendance.	He/She is actively concerned about the quality of the water environment and its consequences, as well as its impact on the environmental health and families of the rural community.
Didactic sequence No. 1		Didactic sequences No. 2	
The social importance of water: Interests and values at stake, conflicts and local water management that force a new water culture.		Water sanitation and hygiene	

SD	Sessions	DS	HF	HI	Total hours	SD	Sessions	DS	HF	HI	Total hours
16 Weeks	20	2	40	20	60	16 Weeks	20	2	40	28	68
• Integration technique						• Nature-based solutions					
• Introduction to the course						• Landscape and climate change					
• Registration and management of the Edmodo virtual platform						• Water insecurity, climate change and NTD					
• Electronic diagnostic questionnaire instructions						• People populations and citizenship					
• Presentation of the research project						• Water cycle and urban water cycle					
• SDG agenda-2030						• Water quality and preservation					
• SDG 13, 6 and 5						• WASH					
• Why study the environment?						• Water and gender justice					
• Biogeochemical cycles						• Food and water					
• The basin and ecosystems						• Waste output					
• Environmental services						• Efficient energy consumption					
• Ecologic footprint						• Global greenhouse gas (GHGs) emissions and nationally determined contribution of México (Climate Action Tracker, 2020)					
• Water footprint and uses						• Healthy environments					
• Virtual water and agriculture						• Circular economy and bio economy					
• Integrated water resources management (IWRM) in Mexico						• Water for development					
• Water governance crisis						• Drinking water and sanitation in the new rurality					
• The social importance of water: Interests and values at stake						• Water technologies					
• The value of water						• Construction of ASH medium-scale eco technics and efficient irrigation systems agricultural sector					
• The new culture of water						• Medical botanical garden					
• Current challenges						Project presentation; new water culture, gender, and health (Extinction-linking community)					

• Evolutionary ontological theory of culture	Training of application of data collection diagnostic tool
• Existence-reality dissociation	Application of diagnostic survey in the community
• The being-in-the-world	
• The world ruled in a logical-causal order	
• Intermediate Monism of res cogitans – res extensa (Mind and body are essentially the same thing from different perspectives, therefore our thoughts determine our personal actions)	
• Analectic method (Philosophy of liberation)	
• Crisis of colonialism and exclusionary globalization	
• Criticism of the current order: the people as a collective actor and negative critical normative principles	
• Diachronic constellations	
• The material will examine life of the people and political-ecological problem.	
• The ecological event	
• Mexican *ingenium*	
• Culture deconstruction of local Latin American environmentalist thought	
• Other ways of thinking life	
• Ways to build other forms of habitability of the world	
• Abolitionist environmental legislation	
• Policy and public policies since the creative critical moment	

Notes: SD - session weeks per semester, DS - session duration, HF- hours with facilitator, HI - independent hours learning teaching techniques.
Oral presentation of focus groups, research workshops, analectic, countercriticism, deliberative dialogs, reflection, challenges, and perspectives of each topic.
Source: Araya-Ramírez (2014); Bedolla-Solano et al. (2017); Chatagner, Cabañas, and Lucas (2016); Dussel (2009); IPCC (2018); Powell-Neil (2012); Šmajs (2019); Spinoza (2018); UNESCO (2017) & UNESCO (2020).

Table 3. Data collection instrument variables.

Objective	**Assess the influence of EfS formal program[x] on factors for preventing water quality, conservation, and efficient use in the household**	
Variables [y]	**Dimension**	**Indicator**
Knowledge	Prevention of water quality	• Environmental knowledge • Water demography • Water resources • Water quality, sanitation, and hygiene • Factors that affect water quality
Attitude	Conservation	• Attitudes towards water conservation • Water-efficient appliances
Perception	Conservation	• General perceptions of various water use • Water quality, sanitation, and hygiene • Protection and governance • Environmental issues • Water supply and demand • Sources of information
Activity	Efficient use	• Water uses • Water management (Availability and satisfaction) • Water conservation practices • Visions and environmental actions • Purchase water-efficient appliances

Finally, the study performed the descriptive analysis (mean) of the separate KAPP data using Excel. Next, the impact of KAPP intervention on the EfS Program was completed using mean, standard deviation (SD) and Wilcoxon signed-rank test. The before and after intervention data for each group were compared. The analysis of mean is a measure of the average score used to depict the differences among groups (Pallant, 2011). Meanwhile, the SD measures the dispersion of a dataset relative to its mean. The higher the SD, the more spread out the data is. Finally, the Wilcoxon signed-rank test is a non-parametric test that compares two sets of data equivalent to the repeated measures t-test analysis.

3. RESULTS AND DISCUSSION

3.1. Knowledge Competence

The mean evaluation of knowledge competence in Figure 5 shows that initially, group A has the highest positive mean value (28.3%), and group C has the lowest positive mean value (25.5%). After the intervention, groups A and B demonstrate an increase in mean values, with group A remaining at the highest (29.4%). Group C also shows a positive mean increase (27.4%). Contrarily, all groups had decreased negative mean values after the intervention, including group C (without intervention).

The results in Table 4 demonstrate that most participants from all groups initially believe that the main sources of water pollution are pathogenic contaminants: bacteria, viruses, and germs affect the quality of water bodies (A = 53%, B = 59%, C = 37%). Nonetheless, after the intervention, most participants in group A believe that the main source of water pollution is pathogenic contaminants: bacteria, viruses, and germs (44%) and fertilizer/nitrate contaminants (47%). Nevertheless, most participants from group B still believe that pathogenic contaminants: bacteria, viruses, germs affect the quality of water bodies (59%) are the main sources of water pollution. Furthermore, most participants in group C believe that fertilizer/nitrate contaminants (47%) are the main water pollutants after the intervention.

Besides, all groups initially thought that water, sanitation, and hygiene (WASH) decreases the morbidity and mortality load, an indicator of development, and affordable human rights (A = 47%, B = 50%, C = 64%). Nonetheless, only group A reported a high percentage of knowledge on WASH reduces the burden of morbidity and mortality (42%) after the intervention. Meanwhile, groups B and C maintained their initial thoughts on WASH (B = 47%, C = 56%).

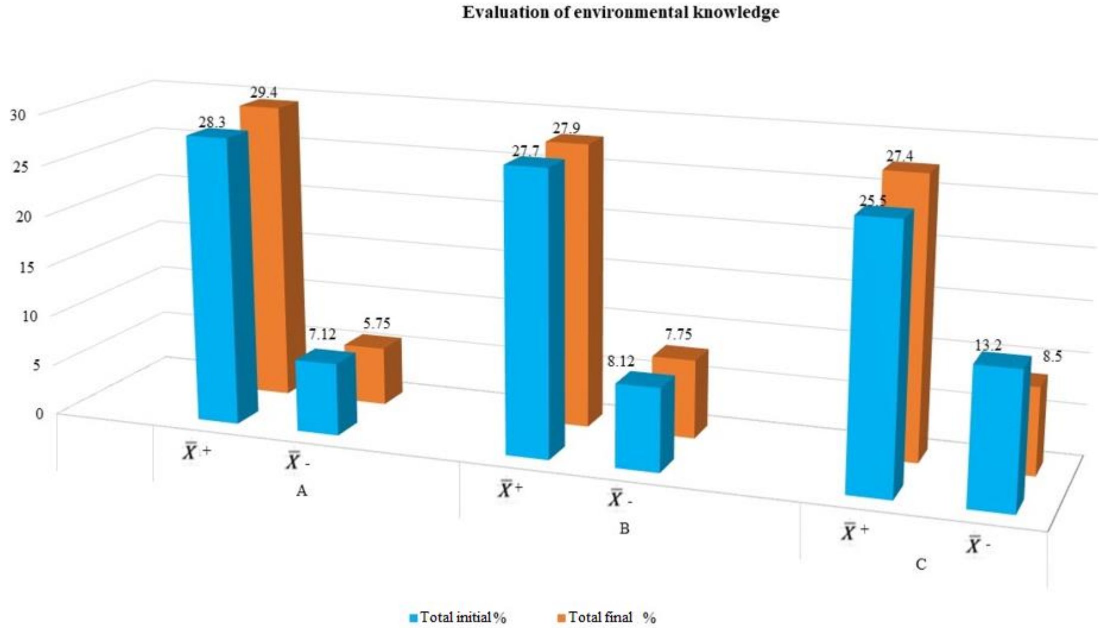

Figure 5. Mean of positive and negative summative evaluation of environmental knowledge before and after intervention.

The increased positive mean knowledge competency values in all groups, including the non-intervention group after the intervention, could be due to the existing integrating water culture among the community members (Mvulirwenande, Alaerts, & Wehn de Montalvo, 2013). Integration is a crucial step to be taken before the knowledge and capacity development intervention. The intervention process is the next step to increase the individual's knowledge competency after successful integration. The intervention could influence the individual's knowledge (Trickett et al., 2011) and the community's supports and resources positively or negatively. Social learning that highlights the dependence on knowledge for an integrated and adaptive natural resources management can manage the complexity of natural resources (Pahl-Wostl et al., 2007). Besides, ongoing learning allows the natural resources managers to develop their capacity and trust to collaborate with all social levels.

The second result is consistent with the UN (2019) that includes pathogens, nutrients, heavy metals, and organic chemicals from point (domestic, industrial, or sewage pipeline discharges, septic tank leaks), and/or non-point sources (storm water runoff in areas of intensive agricultural use and urbanization) as the main water pollutants. Notably, water pollutants also include human-produced wastes (Owa, 2013).

The long-term exposure to water pollution may expose the community to 'slow-scale' environmental disasters (Sullivan & Young, 2020). Furthermore, environmental disasters due to water pollution may contribute to approximately 14,000 mortalities daily in India, reducing environmental function and productivity and risk to human health (Owa, 2013). Halder and Islam (2015) found evidence of the impacts of water pollution on human health, whereby the high water pollution rate in Bangladesh has created severe health problems, such as skin problems, diarrhea, respiratory problems, dengue, and cholera for locals.

Table 4. Evaluation of environmental knowledge.

Groups	Pathogenic contaminants: Bacteria, viruses, germs affect the quality of water bodies					Fertilizer/Nitrate contaminants affect water body quality					Fertilizer/Phosphate contaminants affect water quality					Importance of WASH				
		Before		After			Before		After			Before		After			Before		After	
		F	%	F	%		F	%		%		F	%	F	%		F	%	F	%
(A) before: 38 after: 45	M	20	53	20	44	M	16	42	16	44	M	18	47	17	38	mm	15	34	19	42
	P	14	37	16	37	P	15	39	14	37	P	39	39	22	49	D	2	5	4	9
	I	3	8	7	15	I	5	13	6	15	I	4	10	5	11	DHA	6	13	6	13
	P	1	3	1	2	P	1	3	1	2	P	1	2	0	-	TA	22	47	16	36
	N	0	0	1	2	N	1	3	1	2	N	0	0	1	2					
(B) 32	M	19	59	19	59	M	13	41	16	50	M	10	31	15	47	mm	7	22	12	37
	P	8	25	11	34	P	11	34	8	25	P	12	37	9	28	DSL	3	9	4	12
	I	4	12	2	6	I	6	19	5	16	I	8	25	6	18	DHA	6	19	1	3
	P	1	3	0	0	P	1	3	3	9	P	1	3	2	6	TA	16	50	15	47
	N	0	0	0	0	N	1	3	0	0	N	1	3	0	0					
(C) 33	M	12	37	12	37	M	5	15	15	47	M	4	12	10	31	mm	9	27	10	31
	P	9	27	15	47	P	16	48	12	37	P	18	54	13	41	D	2	6	2	6
	I	9	27	4	12	I	9	27	4	12	I	8	24	7	22	DHA	1	3	2	6
	P	2	6	1	3	P	3	9	0	0	P	2	6	0	0	TA	21	64	18	56
	N	1	3	0	0	N	0	0	1	3	N	1	3	2	6					

Note: M= Very likely; P= Probably; I= Undecided; P= Unlikely; N= Not likely.
Mm= Decreases the morbidity and mortality load; D= Indicator of development; DHA= Affordable human right; TA= All previous.

The high percentage of knowledge on WASH for all groups, before or after the intervention, is consistent with the WHO World Health Organization (2015) stating that WASH programs are crucial in preventing all NTDs, an indicator of poverty, unsatisfied basic needs, and other disadvantages contributing to deprived human development (WWAP UNESCO, 2019). Additionally, knowledge plays a vital role in determining the success of water management (Brown & Farrelly, 2009). Hence, an advanced program emphasizing the social capital, professional development, and shared information system is needed to integrate and coordinate sustainable water management.

3.2. Attitude Competence

The results of environmental attitude Figure 6 illustrates that initially, group B had the highest positive mean value (27.9%), and group C had the lowest positive mean value (23%). After the intervention, all groups had increased positive mean values, including group C (without intervention). The highest positive mean value after the intervention was group A (29.1%). All groups also decreased in negative mean values after the intervention.

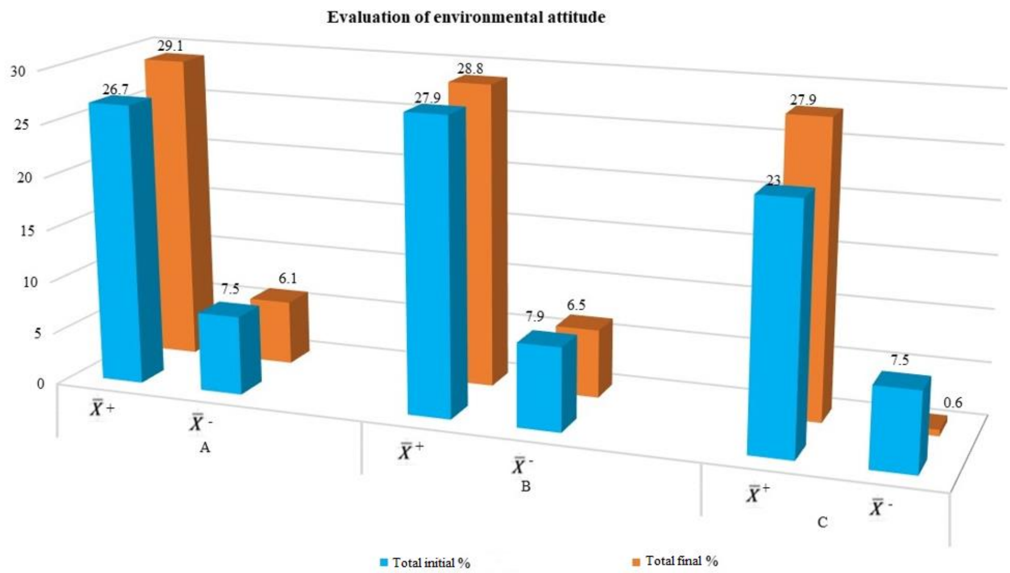

Figure 6. Mean of positive summative evaluation of environmental attitude before and after intervention.

The attitude competence results in Table 5 demonstrate that initially, all groups thought that buying appliances low in water consumption was a crucial attitude (A = 82%, B = 87%, C = 79%). Nevertheless, after the intervention, groups A and B still believed that buying appliances low in water consumption was a vital attitude (A = 91%, B = 97%). The majority of group A also believed that buying water optimizing showerheads were equally important (91%). Meanwhile, group C believed that the rural community's participation in water management was very important (100%).

Despite the differences, all groups agreed on optimizing water use for conservation, protecting the environment, and reducing its rates before and after the intervention. Attitude is defined as an evaluation of an object or behavior, including norms, beliefs and values (López-Bonilla, Reyes-Rodríguez, & López-Bonilla, 2020). Past studies proposed that attitude could change an individual's behavior. The WASH program intervention in Kenya was also effective in installing good attitudes among the local communities (Wasonga, Olang'o, & Kioli, 2014). Despite the low knowledge level, the study reported that more than 10% of the students have a positive attitude towards water treatment, latrine use, handwashing, and water storage.

Table 5. Evaluation of environmental attitude.

Groups	Importance of nature					Knowledge of people in the rural community for water preservation and quality					Participation of the rural community in the issue of management of the water					Optimized appliances					Buy appliances, low in water consumption					Buying water optimizing shower heads					Water storage in drought				
		Before		After			Before		After			Before		After			Before		After			Before		After			Before		After			Before		After	
		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%
(A) before: 38 after: 45	MI	21	55	20	44	MI	19	51	28	62	MI	10	26	12	31	MI	24	63	25	57	Yes	31	82	41	91	Yes	16	42	41	91	S	15	39	18	40
	I	10	27	20	45	I	18	49	17	37	I	0	0	1	2	I	7	18	15	33	No	7	18	4	9	No	22	58	4	9	M	6	16	16	36
	N	2	5	0	-	N		-	0	-	m	0	0	0	0	N	6	16	5	11			-		-			-		-	N	11	29	7	15
	PI	0	0	2	4	PI		-	0	-	PI	8	21	3	9	PI	1	2	0	-			-		-			-		-	A	3	8	4	9
	NI	5	13	3	7	NI		-	0	-	NI	20	53	22	57	NI	0	-	0	-			-		-			-		-	N	3	8	0	0
(B) 32	MI	18	56	22	69	MI	21	66	26	81	MI	5	16	10	31	MI	13	41	19	60	Yes	28	87	31	97	Yes	16	50	15	47	S	7	22	14	44
	I	1	35	6	19	I	11	34	6	19	I	1	3	0	0	I	10	31	8	25	No	4	12	1	3	No	16	50	17	53	M	11	34	11	34
	N	3	9	1	3	N		-		-	m	0	0	0	0	N	7	22	3	9											N	6	19	4	12
	PI	0	-	2	3	PI		-		-	PI	11	34	3	9	PI	1	3	2	6											A	4	12	3	9
	NI	0	-	1	6	NI		-		-	NI	15	47	19	59	NI	1	3	0	0											N	4	12	0	0
(C) 33	MI	13	64	19	60	MI	18	54	18	56	MI	1	3	32	100	MI	9	27	11	34	Yes	26	79	25	78	Yes	18	54	14	44	S	10	30	8	25
	I	18	24	7	22	I	15	45	14	44	I	0	0	0	0	I	15	45	8	25	No	7	21	7	22	No	15	45	18	56	M	0	0	1	3
	N	1	3	4	12	N		-		-	m	0	0	0	0	N	7	21	12	37											N	2	6	3	9
	PI	0	-	0	0	PI		-		-	PI	0	0	0	0	PI	2	6	1	3											A	7	21	6	19
	NI	1	3	2	6	NI		-		-	NI	32	97	0	0	NI	0	0	0	0											N	14	42	15	44

Note: MI= Most important; I= Important; N= Neutral; PI= Little important' NI= Not important
S= Always; M= Most of the time; N= Neutral; A= Sometimes; N= Never.

The intention to save water is affected by attitudes, norms, demographics, environmental attitudes, and climate change knowledge (Ehret et al., 2021). Lapinski, Rimal, DeVries, and Lee (2007) mentioned that the region of origin influences the water conservation attitude in the Midwestern universities. Observably, African students had more positive attitudes on water conservation than students from other regions such as the United States, Malaysia/Singapore, China/Hong Kong, Nigeria, Ethiopia, and Ghana, which is highly correlated with the different cultures. Jacobs and Buijs (2011) examined the stakeholders' attitudes towards water management intervention in the Netherlands, denoting that their attitude is rooted in five factors: attraction, functionality, affection, biodiversity, and threat. These factors determine the positive and negative attitudes towards the water management system.

3.3. Perception Competence

The assessment of the perception of domestic water uses in Figure 7 demonstrates that initially, all groups had high positive mean values, with group C being the highest (29.1%). After the intervention, all groups (including group C without intervention) showed increased mean positive values, with group B being the highest (31.8%). Contrastingly, the negative mean values decreased after the intervention for all groups.

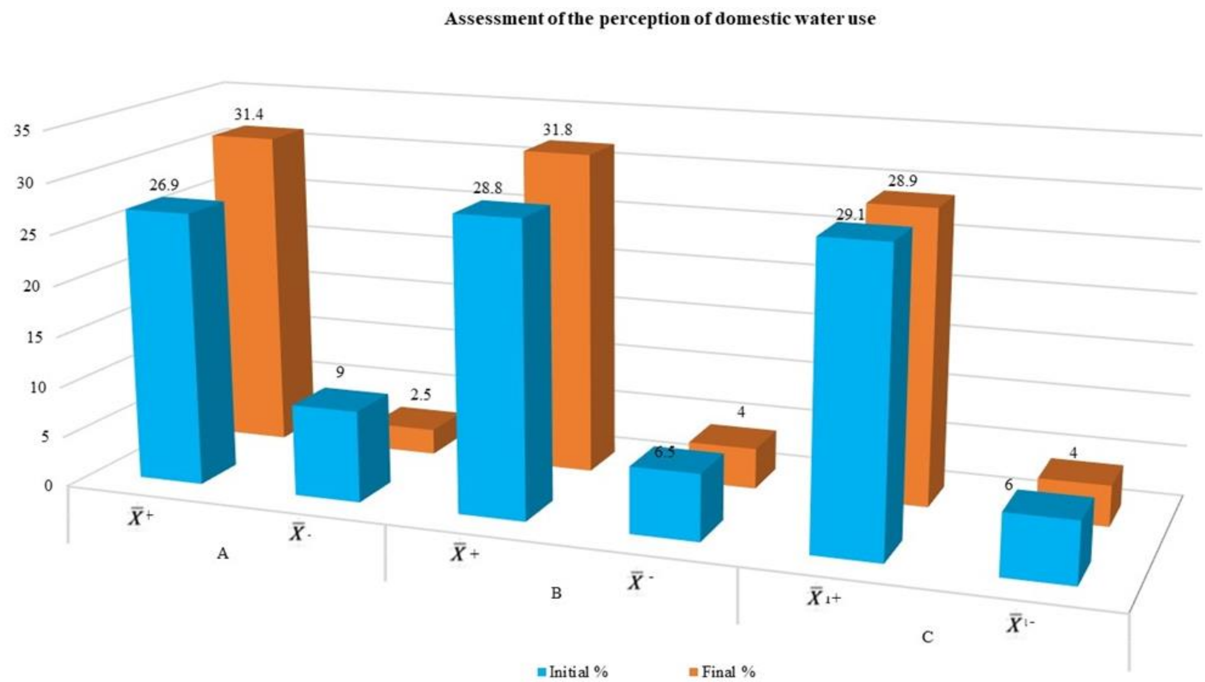

Figure 7. Mean of positive and negative summative evaluation of the perception of domestic water use before and after intervention.

The results of participant's perception of the economic value of water (Table 6) proved that most participants in Group A felt that water had moderate economic value before the intervention (29%) and very high economic value (42%) after the intervention. Conversely, most participants in group B felt that water had moderate economic value before and after the intervention (Before = 44%, After = 34%). Meanwhile, group C initially felt that water had a very high economic value (100%) and later felt that water had moderate economic value (50%).

Table 6. Assessment of the perception of domestic water use.

Groups	Economical value of water					The human right to water must be charged					Aquatic habitats and fishing					Origin of water					Environmental impact of water on the economic issue				
		Before		After			Before		After			Before		After			Before		After			Before		After	
		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%
(A) before: 38 after: 45	MA	9	24	19	42	TD	2	5	15	33	MI	27	71	35	78	CA	8	21	4	10	MI	17	45	20	44
	A	5	5	9	20	D	6	16	12	27	I	8	21	9	20	Cu	22	58	25	66	I	14	37	24	53
	m	11	29	13	29	N	13	34	11	24	m	2	5	1	2	N	8	21	9	24	m	5	13	0	-
	P	5	13	3	7	ED	9	24	6	13	PI	1	3		-						PI	0	-	0	-
	N	11	29	1	2	Td	8	21	1	2	N		-		-						NI	2	N	1	2
(B) 32	MA	6	19	8	25	TD	3	9	5	16	MI	25	78	22	69	CA	21	66	7	22	MI	11	34	18	56
	A	2	6	9	28	D	5	16	12	37	I	5	16	9	28	Cu	8	25	18	58	I	17	53	12	37
	m	14	44	11	34	N	13	41	7	22	M	2	6	0	-	N	3	9	7	21	m	4	12	2	6
	P	7	22	2	6	ED	4	12	6	19	PI		-	1	3						PI		-	0	0
	N	3	9	2	6	Td	7	22	2	6	N		-	0	-						NI		N	0	0
(C) 33	MA	33	100	14	44	TD	5	15	9	9	MI	20	61	22	69	CA	10	31	10	31	MI	17	51	16	50
	A	0	0	13	41	D	4	12	2	6	I	11	33	5	16	Cu	15	47	16	50	I	13	39	16	50
	m	0	0	5	16	N	8	24	16	50	M	2	6	5	16	N	5	15	4	12	m	1	3	0	0
	P	0	0	0	0	ED	13	39	8	25	PI	0	0	0	0	NK	2	6	2	6	PI	1	3	0	0
	N	0	0	0	0	Td	3	9	3	9	N	0	0	0	0						NI	1	3	0	0

Note: MA= Very high economic value; A= High economic value; m= Moderate economic value; P= Low economic value; N= No economic value.
TA Totally agree; D= Agree; N= Neutral; ED= Disagree; TD= Strongly disagree.
MI= Very important; I= Important; m= Meanly important; PI= Unimportant; N= Not important.
CA= CAPAMA; Cu= Bodies of water; N= Nature; NK=I do not know.

Most participants in groups A and B felt neutral on the human right that water must be charged (A = 34%, B = 41%) before the intervention, while most participants in group C disagreed (39%). After the intervention, group A completely agreed (33%), and group B agreed (37%) that the human right to water must be charged. Nonetheless, group C felt neutral (50%) on the issue.

Besides, all groups felt that the domestic water use for aquatic habitats and fishing is very important (A = 71% (before), 78% (after), B = 78% (before), 69% (after), C = 61% (before), 69% (after)) before and after the intervention. Furthermore, most participants from groups A and C believed that their domestic water came from the natural bodies of water before the intervention (A = 58%, C = 47%). Meanwhile, group B believed their domestic water comes from the local authority CAPAMA (66%). After the intervention, all groups believed that their domestic water comes from the natural bodies of water (A = 66%, B = 58%, C = 50%).

Finally, most participants in groups A and C believed that the environmental impact of water on the economy was significant before the intervention (A = 45%, C = 51%). Group B only felt that the environmental impact of water on the economic issue is important (53%). Nevertheless, after the intervention, group A felt that it was important (53%), and group B felt that it was very important (56%). Group C also felt divided between the very important and important environmental impact of water on the economic issue.

The difference in perceptions can result from the individual's ideology. The ideology and worldview of individuals have shaped their perceptions of political issues and the dominant economic vision (Ehret et al., 2021). The ideology also emphasized their beliefs in human beings' dominance over nature. Morales et al. (2020) also showed the difference in ideology on water safety. Although the health authorities deemed that the water sources of the locals in Patagonia, Argentina is of poor quality concerning chemical and microbiological contents for human consumption, the locals believed otherwise. The locals considered the water source fresh, delicious, and transparent, although the water's physical characteristics, such as odor and color, are of poor quality.

Tarannum, Kansal, and Sharma (2018) also showed that participant's perception of the source of water pollution in India originated from their experiences. The main source of water pollution is deemed from anthropogenic activities directly linked to their dependency on the rivers. A person's ideology also may or may not necessarily be from their culture or nativity, according to Javidi and Pierce (2018). Observably, most African Americans perceived negatively the cleanliness of tap water, followed by the Hispanics. Nonetheless, the negative perception may stem from three potential sources: health-related contamination, non-health-related contamination, or pure misperception.

3.4. Practices Competence

Figure 8 illustrates the evaluation of water management practices with the highest mean positive value before (32.20%) and after (37.20%) the intervention in group A. All three groups showed an increase in positive mean values and a decrease in negative mean values after the intervention labeled as the final intervention (including group C with no intervention). The practices competence result in Table 7 demonstrates that groups A and C initially think that always closing the water tap is the best water management practice (A = 82%, C = 61%). Meanwhile, group B felt that closing the water (69%) and fixing the leaks (69%) are the best practices. After the intervention, groups A and B felt that always closing the water tap was the best water management practice (A = 96%, B = 84%). Conversely, most participants from group C felt that fixing the leaks was the best practice (72%).

The increasing practices competency in all groups after the intervention indicates that when people are informed about a problem, motivated to act, and have the skills for it, they tend to change their behavior (Ehret et al., 2021). Therefore, receiving information about water resources through active learning increases the probability of adopting water conservation practices (Adams et al., 2013). Similarly, Cincera and Krajhanzl (2013) found that the student's action competencies are higher when involved in the decision-making process. Involvement in the decision-making process provides opportunities to develop practice competency.

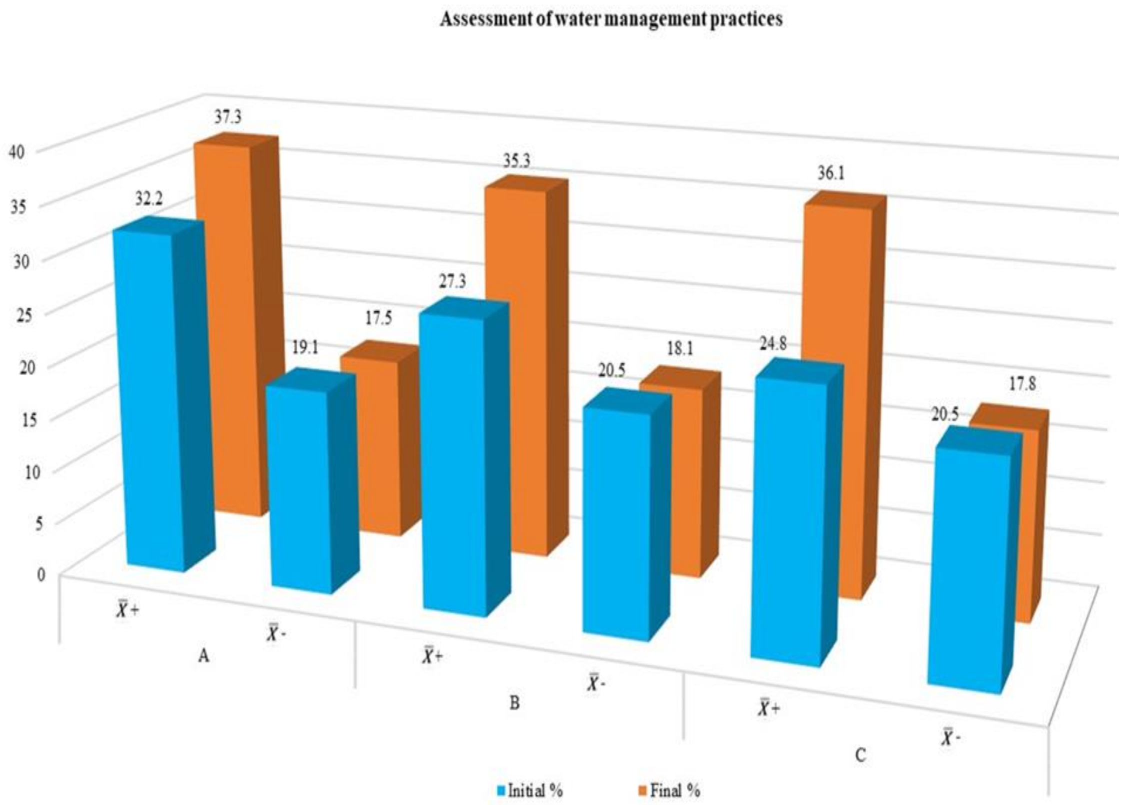

Figure 8. Mean of positive and negative summative evaluation water management practices before and after intervention.

Mosler (2012) also listed five main factors of positive behavioral change: risk, attitude, norm, ability, and self-regulation, which are the critical factors of the RANAS Model of behavior change. The successive interventions towards these factors influence an individual's behavior, intention, use, and habit. The model is practical in describing and altering different health behaviors in the past. The effect of cultural differences on practices competence on water activity was also mentioned in Abercromby et al. (2021). Notably, the major happenings, peer-attendance, and public acceptability influenced the younger generations' decisions to participate in water activity.

3.5. Impact of KAPP on EfS Program

The analysis of the mean shows that only the mean score of group A increased after the intervention (Figure 9). The SD also shows that the SD in group A increased more after the intervention. Nonetheless, the mean score of groups B and C decreased after the intervention and the SD of groups B and C were lower than group A, indicating that the intervention had a significant result in changing the students' environmental sustainability competencies. The results are further supported by the Wilcoxon signed-rank test result (Table 8). Observably, KAPP competencies of EfS on NCW elicited a statistically significant change in students from group A ($Z = -2.18$, $p = 0.03$). Hence, the null hypothesis is rejected. Notably, a difference in participants' KAPP competencies on NCW exists between before and after the intervention.

The results showed that the KAPP model used in the study relate cognitive, affective, and behavioral elements subject to intervention from communicative actions that increase the level of knowledge, change attitudes, and improve practices. Knowledge refers to cognitive elements linked to mental actions, such as perception, memory, learning, and prediction during information processing.

Table 7. Assessment of water management practices.

Groups	Obtaining water in times of scarcity					Close the water tap					Reuse the grey water					Fix leaks					Clean yard and car with hose					Tooth-brushing under the continuous water jet of the sink					Shower under continuous water jet					Shower in short time				
		Before		After			Before		After			Before		After			Before		After			Before		After			Before		After			Before		After			Before		After	
		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%		F	%	F	%
(A) before: 38 after: 45	C	12	32	16	35	S	31	82	43	96	S	15	39	18	40	S	26	68	33	73	S	0	0	2	4	S	0	0	0	0	S	1	3	0	0	S	13	34	23	51
	AP	4	10	3	7	M	7	18	1	2	M	6	16	16	36	M	9	24	10	22	M	9	2	6	13	M	1	3	4	9	M	2	5	5	11	M	15	39	13	29
	P	22	58	26	58	A		-	1	2	A	11	29	7	15	A	3	8	2	4	A	8	24	3	7	A	6	16	2	4	A	8	21	7	16	A	9	24	5	11
						AN		-		-	AN	3	8	4	9	AN		-		-	AN	20	21	4	9	AN	10	26	6	13	AN	11	29	9	20	AN	1	0	2	4
						N		-		-	N	3	8		-	N		-		-	N		53	30	67	N	21	55	33	73	N	16	42	24	53	N		3	2	4
(B) 32	C	6	19	11	34	S	22	69	22	84	S	7	22	14	44	S	22	69	27	72	S	1	3	2	6	S	2	6	1	3	S	2	6	2	6	S	8	25	11	34
	AP	3	9	0	0	M	9	28	4	12	M	11	34	11	34	M	10	31	4	25	M	3	9	1	3	M	0	0	1	3	M	0	0	0	0	M	13	41	14	44
	P	23	72	21	66	A	1	3	1	3	A	6	19	4	12	A		-	1	3	A	5	16	1	3	A	4	12	2	6	A	10	31	2	6	A	11	34	6	19
						AN		-	0	0	AN	4	12	3	9	AN		-	0	0	AN	10	31	8	25	AN	7	22	5	16	AN	4	12	5	16	AN		-	1	3
						N		-	0	0	N	4	12	0	0	N		-	0	0	N	13	41	20	62	N	19	59	23	72	N	16	50	23	72	N		-	0	0
(C) 33	C	12	36	14	44	S	20	61	21	66	S	9	27	8	25	S	11	33	23	72	S	2	6	4	12	S	2	6	1	3	S	5	15	1	3	S	8	15	1	3
	AP	8	24	1	56	M	11	33	9	28	M	9	27	6	19	M	16	48	5	16	M	4	12	2	6	M	3	9	3	9	M	3	9	3	9	M	8	9	3	9
	P	13	39	17	3	A	2	6	1	3	A	9	27	5	16	A	3	9	4	12	A	10	30	5	16	A	4	12	4	12	A	11	33	10	31	A	14	33	10	31
						AN		-	1	3	AN	2	6	8	25	AN	2	6	0	0	AN	9	27	6	19	AN	7	21	6	19	AN	4	12	7	22	AN	1	12	7	22
						N		-	0	0	N	4	12	5	16	N	1	3	0	0	N	8	24	15	47	N	17	51	18	56	N	10	30	11	34	N	2	30	11	34

Note: C= Rainwater uptake; AP= Drinking water; P= Underground water well or counter water
S= Always; M= Most of the time; A= Sometimes; AN= Sometimes not; N= Never

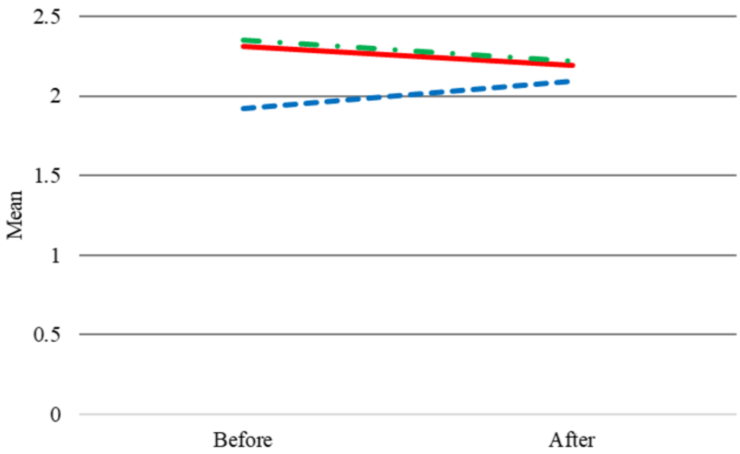

Figure 9. Mean and standard deviation of before and after KAPP intervention.

Table 8. Wilcoxon signed-ranks test of KAPP competencies on EfS program.

Comparison	A (Before) – A (After)	B (Before) – B (After)	C (Before) – C (After)
Z	-2.18	-1.69	-0.18
Sig. (P-value)	0.03	0.09	0.86

In this logic, participants' knowledge of sustainability was heterogeneous (Salas-Zapata, Ríos-Osorio, & Cardona-Arias, 2018). Furthermore, the summary assessment of water management practices coincides with Salas-Zapata et al. (2018). Although, low adherence to sustainability practices, low understanding and awareness of sustainability have been identified among university students, there is a need to involve them more in community activities to create a more sustainable society. Besides, building a baseline of KAPP enables gaining knowledge on water resources, governance, information sources, and demographics in water prevention and conservation practices consistent with Mahler et al. (2013). The KAPP intervention should begin with understanding the stakeholders and their opinions (Figueroa & Kincaid, 2010). Thus, studies should identify the factors that are particularly important for water conservation.

The gap between the management plan, claims, and reality poses other challenges for the water management system, as explained in Medema, McIntosh, and Jeffrey (2008). The evidence from two past water resources management systems: Integrated Water Resources Management (IWRM) and Adaptive Management Approaches (AMA), failed to present the main objectives due to an unpractical scientific approach. The examples also prove that managing natural resources (in this case, water) is a complex process, and hence, knowledge production must be managed more practically.

4. CONCLUSIONS

The results show that KAPP intervention has a significant impact on the EfS program for NCW. Hence, implementing formal and informal EfS as the basis for all HEIs is crucial. Relevant parties should also promote and reinforce action research in the corresponding learning units to implement no formal education programs derived from the formal program of this study. The results also prove that students should be intervened at earlier stages, as the period was not enough to deconstruct unsustainable competencies.

In addition, hydric sensitivity must implement measurable strategies and innovative, collaborative–participatory interventions geared towards climatic mitigation and adaptation, ethics, financing, climate transparency, and social responsibility. The joint and multilateral work of the Academy-Community-State has a direct and indirect impact on educational and ethical development models, linkages and extensions, and democratic governance concerning the implementation and certification of integrated institutional management systems eradicating all forms of climate nihilism and institutional orphan hood. In order to achieve peace, changing the orientation of the cultural system and current information in the educational system is necessary.

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