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Exploratory Factorial Model of Hydric Conservation in the COVID-19 era

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Abstract

Environmental education programs by assuming an intensive training of savings skills as the axis of solution to the scarcity of resources have focused on the optimization of public services. In this sense, the objective of the present work has been to observe the effects of an informative workshop in which the prevention and repair of leaks was promoted, as well as the saving of water through dosage and reuse. A quasi-experimental study was conducted with 316 intentionally selected intact subjects. The results show significant differences before and after the informative workshop. This is the case of the rainwater harvesting indicator, which was initially considered the indicator reflecting the factor, but after the workshop its value was reduced. In contrast, the maintenance of hydraulic installations revealed a domestic awareness of heritage conservation, although the segmentation of the informative workshop is recommended to corroborate latent relationships between water optimization and heritage conservation.

Keywords: Behavior; Vulnerability; Insertion; Environmental education

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Introduction

Two complementary objectives prevail on the international agenda. The Millennium Development Goals (MDG) and the Sustainable Development Goals (SDG). In terms of water resources and services, the MDGs refer to generalities related to vague requirements in national plans regarding sanitation. It is the SDGs that define lines of action that are binding on local programs such as universal and equitable access [1]. The differences between the MDGs and the SDGs are evident in the construction of an agenda based on the operational specification of concepts and their empirical testing.

The sixth SDG related to clean water and environmental sanitation stands out. It is a balance between the availability of water resources and the management of minimum health. It refers to the effects of contamination of water bodies on the hydration and cultivation of agricultural products. Specifically, technological development in desalination, reuse and recycling is proposed as a measure of sustainability [1] The generality of these proposals assumes an agenda of specification of topics for discussion.

Despite the fact that the availability of water resources is decreasing and access to quality service is limited, the agenda lists the problems of contamination and over-exploitation of water bodies, but the problems of drought are still intensifying in developed areas such as California, United States where plantations have been abandoned due to scarcity or shortages [2]. In other words, the SDGs can advance in terms of their specification based on regional scenarios or local situations.

Precisely, Education for Sustainability, understood as a process of changing attitudes and capacities based on the availability of resources, equitable access and desalination, treatment and reuse technology, is a diagnostic and intervention instrument for the achievement of the SDG -6. This is so because the promotion of equitable relationships, risk prevention and intervention through technology in the face of scarcity, shortages, unhealthiest and famine are attainable goals for SDG-6 [3].

In this section, the theoretical and conceptual matrix related to the SDG-6 in HEIs is exposed to clarify the differences between localities and institutions when observing a learning of the SDG-6 indicators. In this way, it is considered that the levels of explanation are consubstantial to the interventions (Little, 2014: p. 3). In the case of news programs, it is necessary to take into account some findings reported in the selected and consulted literature [4].

Given that education for sustainability (ES) refers to an awareness

of the effects of climate change on environmental public health, in the framework of Higher Education Institutions (IES) it refers to comprehensive training (Kumar, 2014: p.125). In other words, the SE as an area in which the SDG-6 are transferred reveals a knowledge management, production and transfer system. In other words, scarcity, drought, depletion, sanitation, potabilization, quality and floods are affordable, assailable and translatable data into optimization actions in institutional water consumption [5].

This is how the SDG-6 and the SE are intertwined at the institutional level of public universities by establishing awareness, saving and institutional reuse programs with the purpose of reducing the water footprint. It is a deliberate, planned and systematic process in which the SDG-6 is translated into the institutional mission and vision. Even the evaluation, accreditation and certification of the quality of processes and products already include this item of water sustainability [6].

However, the studies seem to focus their interest on the scarcity indicator more than on the other SDG-6. That is, at the institutional level, the SDG-6 are limited to a preponderant indicator that refers to the optimization of water resources through the service of drinking water, reuse and treatment.

In that vein, the SDG-6 they have been translated from an awareness and reactive action before the shortage to an anticipation of shortage. In this way, the diffusion of sanitation determined community health, a positive correlation between preventive measures with respect to the optimization of resources and school achievement [7].

The SDG-6 allude to a personal and collective awareness of resource scarcity, but reversible through the training of resource optimizers, care and water saving. In this sense, the evaluation of the effects of an informative workshop on the scarcity will allow you to specify your institutional analysis [8].

This section presents the axes, trajectories and relationships between the SDG-6 indicators with respect to HEIs and their behavior for sustainability. Scenarios of scarcity, shortages, healthiness and scarcity are proposed to which HEIs would react, but with nuances according to the capacities of the areas of knowledge such as the case of health sciences and administrative economic sciences.

Therefore, a Modeling is a mapping of the variables indicative of a behavior based on inclusion criteria such as the consensus of the literature regarding the SDG-6 and its observation in HEIs.

If HEIs filter information based on their needs, capabilities, expectations and resources, then they result in shortages, shortages, healthiness, recycling, sanitation, reuse and scarcity. These institutional indicators can be observed in the health and economy divisions, although with their accentuations. It is expected that the SDG-6 will be better known in the biological and health sciences than in the economic-administrative sciences.

Thus, verifiability frameworks prevail in the biological and health sciences. In other words, the dissemination of the SDG-6 encourages a willingness to verify its contents with different sources. In fact, a comparison between different sources observing the same phenomenon generates the veracity of a data [9].

In contrast, the economic-administrative sciences, distant from the SDG-6, develop logic of plausibility that consists of accepting an informative dissemination due to its content structure or data sequences rather than due to the consensus of various sources. This is how a note related to the scarcity of water is plausible if the recipients have been trained with this principle of water shortage in the institution and therefore their care.

Phenomena, verifiability and plausibility, coexist in the institutions that adopted the SDG-6 and disseminated them as scarcity, shortages, healthiness, sanitation, scarcity, recycling and reuse.

The study HEI, located in the Center of Mexico, a region of medium human development, per capita income below the average of 7,500.00 pesos per month, with a birth rate above the national average of 7% per year, density of 3 people per 20 square meters of construction, as well as low water availability with a tandem system two or three times a week for an average of three hours. Close to 20% of the family income is invested in the purchase of bottled water, although water-borne diseases cause the death of infants more than adults. The IES only covers a few disciplines that respond to the development needs of the region, as well as the projected labor demand [10].

Therefore, the objective of this work is to contribute with empirical evidence to the SDG indicators: scarcity, drought, depletion, sanitation, purification, quality and floods [11]. For this purpose, the effects of an information program are evaluated, considering these SDG indicators as part of a construct that the literature identifies as behavior for sustainability, which it defines as a deliberate, planned and systematic action to optimize resources and process innovation. in favor of the conservation of animal and plant species for future generations [11].

What are the effects of an informative program focused on the water indicators of the SDG-6, considering the Sustainability Orientation Scale and its factorial structure of eight dimensions concomitant with each other and reflecting a common factor in students of a public university?

The hypotheses that guide this work suggest: 1) confirmation of the structure of the Sustainability Orientation Scale, which includes eight dimensions related to austerity, altruism, pambientalismo, deliberation, affinity, indignation, self-presentation and normativity; 2) significant differences between the SDG-6 indicators with respect to their observable effects on the Sustainability Orientation Scale;

Given that the discussion lies in the institutional differences by area of knowledge, this paper includes a section dedicated to the Institutionalise Theory for sustainability in order to clarify the levels of intervention and the effects of information programs. Next, the modeling of the axes, trajectories and relationships between the indicators as part of the behavior for sustainability is exposed in order to explain the differences between disciplines. The methodological approach, the results and the discussion based on the theoretical assumptions of education and behavior for sustainability are included.

Method

The measurement of the SDG-6 in HEIs followed a quasi-experimental study with a cross-sectional variant of inter-subject comparison and a non-random assignment.

First phase. A non-probabilistic and intentional selection was made with 316 students (M = 23.2 SD = 2.1 age and M = 8'983.24 SD = 435.46 monthly income) from the UAEM of the degrees of Economics, Social Relations Public, Human Communication and Psychology. The reliability and validity of an instrument designed from the Corral et al (2008) Sustainability Orientation Scale was carried out. It includes nine relative dimensions: 1) austerity with six actions that limits the consumption and waste of resources, which reached an internal consistency alpha coefficient of 0.60 in the original version and 0.65 in the final version of this study, 2) altruism with ten statements about disinterested help and an alpha of 0.70 in the original version and 0.68 in the final version, 3) pro- mentalist with 11 reports of saving, reusing and recycling behavior with an alpha of 0.74 in the final version and 0.70 in the final version, 4) deliberation in the protection of species with 10 items and alpha of 0.78 in the original version and 0.70 in the final version, 5) affinity for diversity with 4 statements and alpha of 0.68 for the original version and 0.73 for the final version, 6) indignation at environmental deterioration with seven items and alpha of 0.79 in the original version and 0.66 in the final version of seven items, 7) self-presentation with eight items that measure stock valuation with alpha of 0.74 pa ra original version and alpha of 0.66 in final version; 8) normativity with five reagents and alpha of 0.90 for the original version and 0.86 for the final version. Validity was established with factorial weights between 0.342 and 0.561 between the indicators and the subscales, after adaptation and sphericity.

Second stage. A non-probabilistic and intentional selection was made with 100 students (M = 21.4 SD = 3.21 years old and M = 7,345.23 SD = 541.36 monthly income) in the same degrees of Economics, Public Relations, Human Communication and Psychology . The Education for Sustainability Workshop was implemented with the purpose of disseminating the SDG-6 in the university community, promoting practices in teachers and administrators. During the period from January 2018 to December 2019, in seven sessions, the SDG-6 indicators translated into dimensions of scarcity, shortages, healthiness, famine, reuse, recycling and sanitation were promoted. Each session lasted two hours with an introductory pedagogical sequence to the SDG-6, followed by a transfer of knowledge in role plays and with a question and answer session at the end. Each participant signed an informed consent letter in which they were notified that their participation would not be remunerated. Confidentiality, anonymity and non-involvement of the participants were guaranteed and the data of the institutions and researchers responsible for the project were provided. At the end of all the sessions, the scale based on orientation towards sustainability was applied; 1) austerity with alpha of 0.65 and 16% of the total variance explained, 2) altruism with alpha of 0.63 and 13% of the total variance explained, 3) general ecological behavior with alpha of 0.68 and 10% of the total variance explained, 4) deliberation with alpha of 0.70 and 7% of the total variance explained, 5) affinity with alpha of 0.78 and 5% of the total variance explained, 6) indignation with alpha of 0, 69 and 3% of the total variance explained, 7) self-presentation with alpha of 0.62 and 2% of the total variance explained, 8) normativity with alpha of 0.80 and 1% of the total variance explained Procedure The instrument was applied to students of the Autonomous University of the State of Morelos (UAEM) in the campuses that concentrate the largest number of students of this university: Chamilpa and Cuautla.

The questionnaire was adapted so that the students answered it voluntarily online without the presence of an interviewer, avoiding bias in their answers as much as possible. The data was grouped in the Google Forms platform from which they were downloaded to MS-Excel 2013 in order to perform their validation, as well as their debugging, discarding 11 questionnaires that presented inconsistencies. Subsequently, they were exported to IBM-SPSS-AMOS v.25 where the corresponding statistical analyzes were carried out. Considering that the UAEM has about 50 thousand students, this was taken as the universe, for which the sampling error is 5.6% with a reliability level of 95% in accordance with the formula n=(⟦(pq)⟧^(2) z^2)/e^2 . A normal distribution was performed considering the parameters of univariate and multivariate kurtosis, as well as bias analysis. Reliability was estimated with Cronbach's alpha parameter, which identifies the measurement error from a minimum of 250 subjects and the comparison between them (Merino, 2016, p. 587). Validity was established with a confirmatory factorial analysis of the structure reported in the Sustainability Orientation Scale in order to test the hypothesis of the number of factors and relationships both between the dimensions and with respect to a common second-order factor (Ferrando and Anguiano, 2010, p. 22). Structural equation models were contrasted, considering: 1) identification or exclusion of negative variances and equal or lesser number of relationships with respect to observable variables; 2) estimation or test of the hypothesis that the population variance and covariance matrix is equal to the variance and covariance matrix of the theoretical model, considering the maximum likelihood; 3) adjustment or empirical test of the sample variance and covariance matrix with respect to the one identified in the model parameters [12].

Results

This section presents the findings related to the reliability and validity of the Sustainability Orientation Scale, as well as its differences once a sample of students has been intervened through an informative workshop on the SDG-6. The null hypothesis was rejected that there are no significant differences before and after the informative workshop was implemented.

The statistical properties of the instrument that measured the eight factors of pro-environmental behavior related to water conservation. It is possible to observe that the skewness and kurtosis values allow inferring the normal distribution of the responses to the inventory, although the value that determines the normal distribution is the multivariate kurtosis, which reached a value just above the minimum of 15.00. These results justify the analyses of reliability and validity. The normal distribution of the responses to the items suggests that the SDG-6, being represented by the Sustainability Orientation Scale, are known

by the students before the informative workshop on this subject (**Table 1**).

R = Reactive, MN = Minimum, MX = Maximum, S = Bias, CU = Univariate Kurtosis, CM = Multivariate Kurtosis

Once the normal distribution of the pro-environmental behavior factors was established, their correlations and covariance's were estimated in order to measure the incidence of other factors associated with the water conservation construct (see Tables 2 and 3). These findings reveal the structure of relationships between the dimensions of orientation towards sustainability. It then means that it is a structure consistent with the theory reported in the literature regarding the factors of the Sustainability Orientation Scale (**Table 2**).

Condition number = 5,255; Eigenvalues: 2.345 1.606 .938 .895 .703 .560 .507 .446

The correlations show a prevalence of positive associations between the factors, although in some cases this relationship was spurious and negative, a condition for assuming that the factors are associated with a common construct. This is so because the orientation towards sustainability, being a common factor, affects the eight dimensions reported in the literature and observed in the present work. Therefore, the SDG-6 are identifiable in this structure of relationships where this sustainability orientation construct explains up to 57% of the total variance (**Table 3**).

Condition number = 6,347; Eigenvalues: 2.555 1.636 1.043 .887 .715 .620 .465 .403; Determinant of sample covariance matrix = .321

In the case of covariance's, the values show that other factors could be included in the water conservation factor, but its value close to zero assumes its convergence in the factor and the non-incidence of other factors. In other words, the structure

Table 1. Statistical Properties of the Instrument Prior To the Workshop.

	MN	MX	S	K
F1	1,000	5,000	0.61	-0.54
F2	1,000	5,000	-0.202	-0.837
F3	1,000	5,000	1,748	2,821
F4	1,000	5,000	-0.389	-0.785
F5	1,000	4,000	1,317	0.851
F6	1,000	5,000	-0.19	-0.589
F7 _	2,000	5,000	-0.702	-0.226
F8	1,000	5,000	1,423	0.711
CM				15,088

Table 2. Correlations between factors.

	F8	F7	F6	F5	F4	F3	F2	F1
F8	1,000							
F7	0.111	1,000						
F6	0.438	0.072	1,000					
F5	0.035	0.311	0.082	1,000				
F4	0.42	0.052	0.316	-0.073	1,000			
F3	0.124	0.323	0.19	0.35	0.201	1,000		
F2	-0.046	0.279	0.082	0.143	-0.086	0.149	1,000	
F1	0.354	0.228	0.434	0.22	0.165	0.117	0.041	1,000

Table 3. Covariance's between factors.

	F8	F7	F6	F5	F4	F3	F2	F1
F8	1,039							
F7	0.128	1,273						
F6	0.382	0.07	0.733					
F5	0.037	0.367	0.073	1,092				
F4	0.386	0.053	0.244	-0.069	0.813			
F3	0.132	0.382	0.17	0.383	0.19	1,096		
F2	-0.043	0.289	0.064	0.137	-0.071	0.143	0.842	
F1	0.433	0.309	0.445	0.276	0.178	0.147	0.045	1,435

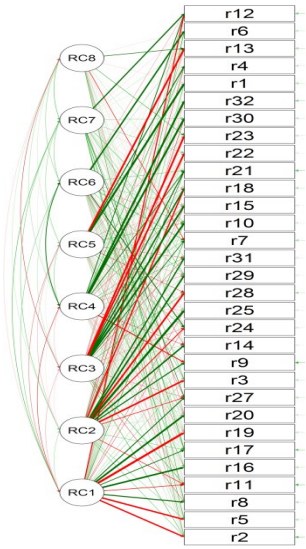

Figure 1 Exploratory factorial model of conservation hydric in the COVID-19 era.

of the SDG-6 measured through the Sustainability Orientation Scale is homogeneous. In different contexts and samples, these relationships between factors do not vary significantly. Therefore, the observation of a construct reflected by eight dimensions can be observed after an informative workshop (**Figure 1**).

The structural model of reflective trajectories shows that rainwater harvesting is the main indicator that reflects water conservation. In other words, the sample surveyed seems to show a propensity to adopt rainwater harvesting technology more than other actions recorded in the inventory. Such a finding allows us to observe the SDG-6 in a residential setting as part of an orientation towards sustainability in the sample surveyed. That is, the students acquire Behaviors related to the SDG-6 in terms of austerity [13].

Fitting parameters ⌈X 2 = 345.24 (23 µl) p = 0.005; CFI = 0.990; GFI = 0.995; RMSEA = 0.006⌋ suggest the acceptance of the null hypothesis regarding the non - significant differences between the model specification with respect to the structure of the relationships between the construct and the factors. This is so because the orientation towards sustainability in the north of the country where the scale was generated is different.

Once the first diagnosis was established, a second study was carried out after the intervention focused on a workshop to

Table 4. Correlations between the factors.

	F8	F7	F6	F5	F4	F3	F2	F1
F8	1,000							
F7	0.62	1,000						
F6	0.628	0.594	1,000					
F5	0.429	0.511	0.63	1,000				
F4	-0.542	-0.399	-0.31	-0.174	1,000			
F3	0.373	0.325	0.277	0.207	-0.456	1,000		
F2	-0.46	-0.393	-0.297	-0.079	0.554	-0.358	1,000	
F1	0.574	0.456	0.526	0.31	-0.545	0.336	-0.32	1,000

promote water saving, considering eight factors: 1) rainwater harvesting (austerity), 2) planned storage (altruism), 3) resource optimization (pro -environmentalism), 4) consumption dosage (deliberation), 5) water reuse (affinity 6) leak detection (indignation 7) leak repair (self-presentation 8) Hydraulic maintenance (regulations).

It is possible to observe that the factors maintain a normal distribution, although the multivariable kurtosis shot up from 15,088 in the first diagnosis to 58,030 in the second diagnosis (see Tables 4 and 5). This was the first indication of significant differences before and after the informational workshop. Such a finding suggests the improvement of the SDG-6, considering the measurement of some traits in the Sustainability Orientation Scale (**Table 4**).

Condition number = 15,750; Eigenvalues: 3.983 1.272 .695 .638 .417 .398 .345 .253

In the case of the correlations between the factors, an increase in their negative values is observed, which suggests the possible relationship of these factors with another factor, but the low covariance's between these factors denote that the conservation factor would only be observed and inferred by these eight factors. Such results reveal a structure of relationships between variables that explain the incidence of the informative workshop in the factors of the scale. This consistency of results before and after the informative workshop suggests that the sample surveyed had already assimilated the SDG-6 and the workshop came to increase their orientation towards sustainability.

However, the most significant difference regarding the effects of the workshop can be observed in the first indicator, which went from being the main one with a value of .55 to fourth place with .47, showing that rainwater harvesting no longer reflected the conservation of the Water.

In contrast, the last indicator related to the maintenance of hydraulic installations, located in second place in importance with .52, became the first reflective indicator with .57 after the workshop was carried out.

Both findings, the reduction in rainwater harvesting and the increase in maintenance of hydraulic facilities, suggest that the SDG-6 reflect a social evolution in terms of caring for resources that can be intensified by the informative workshop.

Finally, the adjustment parameters ⌈X 2 = 345.25 (34df) p = 0.005; GFI = 0.990; CFI = 0.995; RMSEA = 0.008⌋ suggest the rejection of the null hypothesis regarding no differences before and after the informative workshop.

Therefore, the informative workshop had a positive impact on the normative and institutional factor of repairing hydraulic installations, although negatively on the observable austerity in rainwater harvesting.

Discussion

The present work has shown significant differences before and after implementing an informative workshop on water resources and services, considering eight dimensions oriented towards sustainability, although the research design limits these findings to the research sample, suggesting the extension of the work. to other scenarios and samples.

By virtue of the contrast parameters found, the hypotheses related to 1) the confirmation of the factorial structure with an orientation towards sustainability prevail, although the eight dimensions alluding to austerity, altruism, pro-environmentalism, deliberation, affinity, indignation, self-presentation and normativity prevail. ; 2) Differences between the SDG-6 indicators reported in the literature with respect to those observed in this study.

Yazici (2020) implemented a hydrography course to observe the awareness of students which was concomitant with their beliefs regarding the effectiveness of their actions on the impact of climate change and its effects on the distribution of terrestrial systems and biodiversity, as well as such as recycling, highlighting the attribution to the State as rector of policies against climate change and its effects.

In the present work, it has been observed that the water problems, measured in eight indicators, are oriented towards a symbolic construct of sustainability, but the configuration of its factorial structure is different with respect to the scenario and the sample of the original study. This is so because the SDG-6 seem to be assimilated indistinctly in the regions and localities, considering their degree of orientation towards sustainability.

Maletic, Maletic, Dahlgaard, Dahlgaard -Park & Gomiscek (2016) showed that quality and innovation oriented towards sustainability lead to benefits, profits and profits translated into economic and financial improvements for organizations that adopt these social responsibilities.

In the present study it has been shown that, although eight dimensions are oriented towards sustainability and configure a factorial structure according to that reported in the literature, differences prevail in terms of the relationships between the variables. Such questions reflect the differences between localities and their representation of SDG-6. This same detail can be observed in proposals for orientation towards sustainability in both organizations and institutions. In other words, the global guidelines of the SDG-6 are disseminated according to the available water resources and services, but also according to capacities; skills, knowledge and knowledge of groups or sectors, induced or not by informative workshops to guide their behavior towards water conservation.

The institutionalism theory oriented towards sustainability warns the assimilation of the SDG-6 on the members of HEIs such as teachers and students. Through the institutional mission and

vision, the theory indicates that the SDG-6 are disseminated by identifying problems and protocols aimed at reducing the impact or water footprint, as well as maximizing the conservation of water resources and services.

In the present work, the observation of this institutional orientation towards sustainability consists of eight dimensions which are represented asymmetrically before and after a workshop, suggesting that these differences extend to the local or regional level.

Regarding the specification of the model for the study of the orientation towards sustainability where differences are assumed between the parties involved before and after an informative workshop, the present work has shown that such asymmetries are due to the exposure of eight factors, but the research design limits this finding to the sample, suggesting an experimental redesign for the control and manipulation of variables that allow revealing the effect of the informative workshop.

Conclusion

The objective of the present work has been to establish the effects of an informative program on the importance of preventing and repairing residential leaks, as well as the conservation of water from savings, considering an ecological conscience.

However, the type of quasi-experimental study limits the results to the sample of participants, although the contrast of models in which the maintenance of hydraulic installations is observed as the main indicator of water conservation is especially important.

The type of study with intact subjects limits the results to the sample of participants, although the indicator that finally reflected water conservation seems to show a propensity to take care of household facilities more than awareness of saving water for future generations.

This would imply the design of a more effective workshop since the promotion of the prevention and repair of leaks seems to be more oriented to the conservation of heritage. Consequently, the optimization of resources would be linked to the awareness of preserving water for future generations.

It is necessary to segment the workshop and orient it according to these findings in order to innovate the maintenance processes of the hydraulic installations from the conservation of the residential heritage, at the same time, promote the optimization of water resources based on an awareness savings for future generations.

New questions emerge from this work; why are the SDG-6 spread asymmetrically between scenarios and sectors? Do such differences refer to the instrument with which the SDG-6 indicators are measured? Is awareness and behavior oriented towards sustainability a reflection of these differences?

Based on these questions, priority lines of research will be concerned with the reliability and validity of instruments that measure the dissemination of the SDG-6 in different sectors and scenarios, as well as the empirical evidence of differences before and after workshops oriented towards the sustainability of municipal and residential water resources and services.

Based on these inquiries, it will be necessary to observe the differences and similarities of the assimilation of the SDG-6 in public institutions as well as in private organizations in order to anticipate the endemic problems of scarcity, shortages, unhealthiness and famine.

Pedagogical sequences related to orientation towards sustainability in the classroom, as well as outside it, will allow reducing the impact of water problems and maximizing the SDG-6 in the academic, professional and labor training of the parties involved such as teachers and students.

In this sense, the design of teaching practices, performance evaluation, didactic planning and content management should be configured from the orientation towards sustainability, incorporating each of the eight factors established in this work.

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