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ENVIRONMENTAL AWARENESS IN UNIVERSITY STUDENTS: STUDY CASE FOR VIRTUAL COURSES[*]

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Abstract

University social responsibility in achieving Environmental Goals has been considered as one of the main challenges in the current era. The development of new technologies has raised the need in Higher Education Institutions to articulate the way in order to survive. Among this articulation is the importance of generating environmental awareness within the framework of the professional competences of students. This article sets out the practical results and implications of identifying factors associated with the concept of environmental awareness in the data obtained from the application of a previously validated questionnaire to a sample of 121 students of Industrial Engineering and Systems Engineering programs in virtual courses. The results that have been obtained from a factorial analysis of main axes with direct oblimin rotation in delta 0, present the existence of seven factors containing categories of knowledge, beliefs, conative aspects and action by the environment. Descriptions of the factors obtained under the Environmental Goals are generated. In conclusion, practical implications are presented for the identification of these factors in terms of curricular management for sustainability education.

Keywords: environmental awareness, Environmental Goals, factor analysis, university students, University Social Responsibility

1. Introduction

The development of education policies is highly influenced by the phenomena that occur in global environments. One of the recent governmental and global challenges relates to the conception of the Environmental Goals as an international policy aimed at achieving 17 goals with an approach defined by global problem solving. In this sense, the Environmental Goals are conceived as "a universal call to end poverty, protect the planet and ensure that all

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people enjoy peace and prosperity by 2030." (United Nations, 2018). It is important to consider that all the objectives have an interrelationship in the sense that progress in one of them leads to the development of others, education is also recognized as a major component for knowledge and subsequent compliance with them, in fact education for environmental goals is proposed as a fundamental aspect for a quality education "betting on environmental goals and favoring people to change their thinking towards sustainability" (de la Rosa Ruíz et al., 2019). Education is a fundamental reference for the generation of cultural changes and from there it is possible to extend the concept of sustainability in all human actions.

It is necessary to consider the importance of addressing the concept of environmental awareness in the curriculum as a way of propensing for greater university social responsibility, which is considered as "a new philosophy of university management that aims to renew the social commitment of the University while facilitating innovative solutions to the challenges facing higher education in the context of a globalized but unsustainable world in its development patterns" (Vallaeys, 2014). University social responsibility proposes to institutions of higher education the need to configure new forms of interaction with social problems considering sustainability aspects.

Based on the above, the development of policies for the development of environmental awareness in university students, is proposed as a strategy that, in addition to promoting a greater culture for social responsibility, potentially enables progress in several Environmental Goals, among which are: health and well-being (number 3), quality education (number 4), responsible production and consumption (number 12) and climate action (number 13). This text presents factors that make up the concept of environmental awareness in university students, for this it proposes at first a contextualization regarding the concept of environmental awareness and the characteristics of the instrument used to identify the factors related to this particular concept. A second time presents the methodological aspects of research. A third time describes the results obtained and finally draws conclusions in relation to the factors identified and their relationship to the Environmental Goals and University Social Responsibility (USR) as well as their practical implications in the framework of curriculum management.

Improvement of Environment, save the Planet and solving current environmental and climate problems is not only engineering or economical task, but social development is needed as well. Since Education is main part of the human development, changes in the educational process must be applied to meet modern challenges in that area. It is in this sense that the motivation of this research is to identify the level of mental development of the concept of environmental awareness in students of virtual courses.

The main objective of the research consisted in determining the main factors related to environmental consciousness focusing on students of virtual engineering courses. To carry out this objective, as a first task, the questionnaire proposed by (Martínez et al., 2012) was adjusted, as a second task, the sample under study was identified and as a final task factorial analysis was applied in the SPSS software in order to identify the relationships between the variables. The identification and interpretation of the factors was carried out through the proposed theory and the socio-economic conditions of the Institution of Higher Education under study.

2. Material and Methods

2.1. Contextualization

The concept of environmental awareness has meanings that will depend on aspects related to belief systems, social environment, knowledge of problems, politics among others. The concept of environmental awareness is multidimensional and has greater or lesser implications depending on the sociohistorical context in which it is considered. Table 1 presents dimensions associated with the concept of environmental awareness.

Table 1. Some dimensions related to the concept of environmental awareness.
Adapted from (Sharma and Bansal, 2013)

| Dimension	Concept	Keywords
Social belief system (Zelezny and Schultz, 2000)	Specific psychological factors related to the propensity of individuals to initiate pro-environmental behaviors. It's part of the social conscience.	Psychological factor Behaviors Social awareness
Social orientation (Kang and James, 2007)	It occurs in the context of organizations and considers the degree to which an organization produces by favoring the environment by minimizing negative impacts on it	Production factor Organizations Impact minimization Social responsibility
Individual Belief System (Schlegelmilch et al., 1996)	Multidimensional concept consisting of cognitive, attitudinal and behavioral components. Recognition of the implications of individual actions on the environment	Cognitive factor Attitudinal factor Behavioral factor Runout Recognition of responsibility
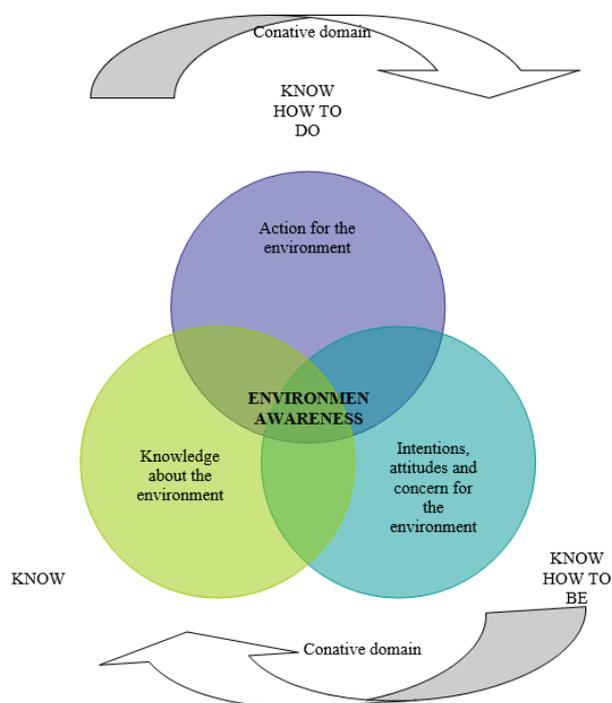
Fig. 1. Relationships between Knowledge know how to be and Know how to do with the concept of environmental awareness

From the information presented in Table 1 can be identified different components that vary depending on the processes, individuals or organizations in which its possible to analyze the concept of environmental awareness. The level of environmental awareness in

general is identified with the level of relationship between knowledge about the environment, intentions, attitudes or concern for the environment and the behavior or level of action for the environment. In this order of ideas, it is possible to relate environmental awareness from its components with the three knowledges oriented to training in competences: knowledge (cognitive field), know-to be (emotions) and know-how (application). The aspects mentioned are interrelated through a conative domain which is characterized by the effort and motivation to achieve something. The conation is defined as "the mental process that activates and/or directs behavior and action. Various terms used to represent some aspect of conation include intrinsic motivation, goal orientation, volition, will, self-direction, and self-regulation" (Huitt and Cain, 2005).

The above concepts are considered in the instrument used in this research which can be seen in (Martínez et al., 2012). The questionnaire presents cognitive, affective, conative and active dimensions that in turn are broken down into variables. The description of the dimensions is as follows:

- Cognitive dimension: encompasses everything related to information and environmental knowledge in the university including all its members and the institution itself.
- Affective dimension: consider beliefs, values and feelings of concern on the environmental issue in local and global environments.
- Conative dimension: willingness and motivation to act to solve environmental problems, including the responsibility of the human being in them.

With the above and the results derived from the article in the sense of the understanding of the needs at the level of environmental awareness and university social responsibility by virtual course students it is possible to aim and enable the positioning a better promise of value of the University Institution.

2.2. Methodology

The research development methodology was mixed-type with a cross-cutting experimental design. The instrument applied has been previously validated and presented in (Martínez et al., 2012). It is intended to identify factors related to cognitive, affective, conative and active dimensions by applying an exploratory factor analysis with main axis extraction method and direct oblimin rotation with zero kappa value. The development of the research is in order to identify factors related to the concept of environmental awareness in order to define a working path for the eventual generation of a Structural Equation Model to be carried out in subsequent work.

With regard to the sample, reviewing studies carried out on factor analysis, according to (Lloret-Segura et al., 2014) it is possible to consider a sample greater than or equal to 100 provided that the communes obtained were greater than 0.8. Therefore, the sample consisted of 121 students who study virtual courses from the Systems Engineering and Industrial Engineering programs in the Higher Education Institution "Corporación Universitaria Americana" and performing the previously mentioned test obtained the necessary communality proposed in the theory. The data analysis was performed in the SPSS software (IBM Corp., 2015).

Finally, conclusions are proposed regarding the variables obtained for each factor, the practical implications of research and future lines of work. The instrument applied can be seen in Table 2, this is an adaptation to the Colombian context of the questionnaire proposed in (Martínez et al., 2012) and adapted for a Lickert type scale. The validation of the items was performed using the cronbach alpha index and the evaluation of content validity and apparent validity carried out by experts. Because it was working with a validated instrument, the changes were mainly shape-shifting and context-changing.

Table 2. Relationship between descriptors and question identification number.
Adapted from (Martínez et al., 2012)

DESCRIPTOR	I.D.
1. I regularly receive information about the environment	K.A.1.1
2. I consider myself informed about environmental matters at the University	K.B.2.2
3. I know the area of the university dedicated to the protection of the environment	K.B.3.3
4. I know the environmental policy of the university	K.B.4.4
5. I am concerned about the environment	B.D.8.5
6. I believe that my daily activity negatively affects the environment	C.G.12.6
7. I use double-sided sheets when taking notes, printing or making photocopies	A.I.14.7
8. I prefer to use recycled paper	A.I.15.8
9. I consider it interesting to receive environmental training / information at the university	C.F.11.9
10. I would participate in possible environmental campaigns that could be organized	A.H.13.10
11. I think the university has improved from an environmental point of view	B.E.10.11
12. I would introduce some environmental improvement in the university	B.E.10.12
13. Human witness will ensure that we make the earth a habitable place	B.C.6.13
14. We are approaching the limit on the number of people the earth can hold	B.D.7.14
15. Despite our special abilities, human beings are still subject to the laws of nature	B.C.5.15
16. Plants and animals have as much right as human beings to exist	B.C.5.16
17. Human beings have the right to modify the environment to suit their needs	B.C.6.17
18. In time, human beings will learn enough about the way nature works to be able to control it.	B.C.6.18
19. The earth has abundant natural resources, we just have to learn to exploit them	B.C.7.19
20. If things continue as they are, we will soon experience a great ecological catastrophe	B.D.7.20
21. The balance of nature is very delicate and easily altered	B.C.5.21
22. The idea that humanity will face a global ecological crisis has been greatly exaggerated	B.C.6.22
23. Humans are seriously abusing the environment	B.C.5.23
24. Nature's balance is strong enough to cope with the impact of industrialized countries on it.	B.C.6.24
25. To achieve sustainable development, a balanced economic situation is necessary in which industrial growth is controlled.	B.D.7.25
26. Earth is like a spaceship, with limited resources and space	B.D.7.26
27. When humans interfere with nature, the consequences are often disastrous	B.D.7.27
28. Humans were created to dominate the rest of nature	B.C.6.28

Questions have an identifier that depends on the dimension to which it contributes, the variable to which the question number in the questionnaire is related, the indicator to which they contribute, and the number of the question. For example, K.A.1.1 corresponds to question 1.1 of knowledge dimension (K) of Information variable (A). Table 3 provides the relationships between dimensions, variables and indicators, as well as the number of questions they provide.

In Table 3 one can see how the original questionnaire raises the vast majority of questions regarding beliefs. Based on factor analysis, it is intended to further explore this type of distribution for a sample of engineering students in Colombia.

Table 3. Dimensions, variables and their description. Adapted from (Martínez et al., 2012)

Dimension	Variable	Description	Question number
Knowledge (K)	A. Information	Higher values indicate	1

		perception of having more information or various sources of information.	
	B. Specific knowledge	Higher values imply higher specific knowledge.	2, 3, 4
Beliefs (B)	C. Adherence to environmental beliefs	Higher values imply awareness of the limits of the biosphere (ecocentrism), lower values represent unconsciousness of the limits of the biosphere (anthropocenrism)	13, 15, 16, 17, 18, 19, 21, 22, 23, 24, 28
	D. Environmental assessment (global and local)	Higher values represent global and local environmental assessment.	5, 14, 20, 25, 26, 27
	E. Perception of Environmental Problems at the Local Level	Higher values represent a critical perception of environmental problems.	11, 12
Conativo (C)	F. Willingness to bear costs (training and participation)	Higher values represent greater willingness to receive training and environmental information	9
	G. Feeling of individual environmental responsibility	Higher values represent greater awareness of the impact of individual actions and activities on the environment.	6
Action (A)	H. Intent of conduct and manifest conduct for collective action	Higher values represent more motivation for direct participation in environmental activities.	10
	I. Intent of conduct and manifest conduct for individual action	Higher values manifest more responsible consumer behaviors	7, 8

3. Results and discussion

Performing the reliability analysis for a sample of 121 students and a total of 28 questions, has been obtained a Cronbach Alpha of 0.894, which is considered as good and reveals a strong relationship between the items of the questionnaire of (Bojórquez Molina et al., 2013). Subsequently, and performing the proposed factor analysis, the results presented in Table 4 are obtained as a result of the Kaiser-Meyer-Olkin (KMO) Measurement test which indicates the applicability of the factorial analysis to the sample, values greater than 0.6 are considered acceptable and greater than 0.8 are considered very good parameter (Kaiser and Rice, 1974). Bartlett's Sphericity Test presents the level of significance of the results. The Gis value represents a p-value that in this case is less than 0.05.

By analyzing Table 4 its possible to identify that the sample data is properly matched and gives the possibility of considering that the data obtained is reliable. With regard to grouping factors, the results of Table 5 are obtained.

Table 4. KMO and Bartlett test for the questionnaire, the result had a p-value of less than 0.05.

KMO and Bartlett test		
Kaiser-Meyer-Olkin sampling adequacy measurement		0.804
Bartlett's Sphericity Test	Approx. Chi-square	1942.247
	Gl	378
	Gis.	0.000

Table 5. Number of Factors obtained according to the total variance explained and self-values greater than 1, taking into account the Kaiser method

							Sums of loads squared of the rotation
Total variance explained							
	Initial self-values			Sums of loads squared from the extraction			
Factor	Total	% of variance	Accumulated %	Total	% of variance	Accumulated %	Total
1	7.524	26.873	26.873	7.142	25.509	25.509	4.284
2	4.582	16.366	43.239	4.221	15.075	40.584	4.485
3	2.349	8.388	51.626	1.961	7.002	47.586	4.878
4	1.551	5.538	57.164	1.149	4.104	51.690	3.397
5	1.231	4.398	61.561	0.886	3.164	54.854	2.412
6	1.170	4.180	65.741	0.799	2.854	57.708	1.429
7	1.034	3.691	69.432	0.659	2.355	60.063	3.256
8	0.845	3.016	72.449				

Extraction method: main axis factorization.

a. When factors are correlated, the sums of the squared loads cannot be added to obtain a total variance.

A total of seven factors are then identified in which questions can be grouped factor number 8 is excluded because in the initial self-values it obtains a total value of less than 1.0 (see 0.845 value in column 2). This number of factors, in addition to being analyzed based on the Kaiser method, were compared using parallel analysis.

In Table 6, one can see the results of the organization of the questions in the factors in descending order according to their factorial load input and based on the pattern matrix obtained from the direct oblimin rotation with zero kappa.

By analyzing Table 4 its possible to identify that the sample data is properly matched and gives the possibility of considering that the data obtained is reliable. With regard to grouping factors, the results of Table 5 are obtained.

According to Table 7, factors related to the dimensions of knowledge, belief and action are identified. You can see that the dimension (questions 6 and 9) is not clearly

identified in one of the factors, but is among the factors that contribute to beliefs and action. It also identifies groups of questions that have an interpretation that represent aspects that are directed towards one of the Environmental Goals, the objectives identified were: life of terrestrial ecosystems, quality education and action for the environment. It is important to note that the three factors identified are related to beliefs, but depending on the point of view of the systemic relationship between the human being and the ecosystem in which it develops, directing these beliefs from formation, enables an improvement of curricular management, within the framework of an education for sustainability.

Table 6. Pattern matrix obtained from direct oblimin rotation. Questions that contribute to the seven previously identified factors

Question item	1	2	3	4	5	6	7
				Factor			
20	0.796						
21	0.726						
23	0.571						
27	0.531						
25	0.509						
26	0.421				0.407	-0.366	
16	0.395					0.348	0.327
24		0.746					
19		0.712					
17		0.699					
22		0.680					
28		0.639					
18		0.636					
6		0.295					
3			-0.938				
2			-0.855				
4			-0.850				
1			-0.817				
11			-0.456				
10				0.828			
9	0.347			0.589			
12				0.434			
5				0.353			
14					0.754		
15					0.508	0.519	
13		0.312				0.452	
7							0.794
8				0.436			0.526

Extraction method: main axis factorization.

Rotation method: oblimin with Kaiser standardization.

a. Rotation has converged on 18 iterations.

Table 7. Question list by factor obtained and their respective interpretation. The questions have been written in descending order according to their respective factorial load. SDG stands for Sustainable Development Goals in the framework of Environmental Goals

Factor/Dimension	*Questions*	*Interpretation*	*Denomination*
1/Beliefs	20, 21, 23, 27, 25, 26, 16	Belief in the terrestrial ecosystem must be in balance with human actions to achieve habitability by systemic balance	Habitability as balance with the environment (systemic balance) – life of terrestrial ecosystems (SDG 15).
2/Beliefs	24, 19, 17, 22, 28, 18, 6	Belief in human beings as a modifying agent of the terrestrial ecosystem to achieve habitability by predation.	Ecosystem-independent habitability (anthropocentrism) – life of terrestrial ecosystems (SDG 15)
3/Action	3,2,4,1,11	Concern abouts aspects related to the way the environmental issue is treated at university	Education for Sustainable Development – Quality Education (SDGs 4)
4/Action	10, 9, 12, 5	Interest in learning about the environment and generating actions for its improvement in community	Social responsibility – climate action (in community) (SDG s 13)
5/Knowledge	14	Concern about the sustainability of the planet in population terms	Overpopulation – sustainable cities and communities (SDG 11)
6/Beliefs	15, 13	Belief in the terrestrial ecosystem as a human changing space to achieve survival habitability	Planet-dependent habitat (ecocentrism) – life of terrestrial ecosystems (SDG 15)
7/Action	7, 8	Intent of conduct and manifest conduct for individual action	Responsible Consumption – Climate Action (Individual) (SDGs 12 and 13)

4. Conclusions

The factors obtained allow for a better evaluation of the dimensions of environmental awareness in order to carry out curricular management that make it possible to improve education for environmental awareness in university programs, especially in virtual courses. It is through the evaluation and determination of the dimensions of knowledge, action, beliefs or through the conative that it is possible to develop profiles that allow studying in greater depth the characteristics of the student population in an Institution of Higher Education, in this way there are inputs for virtual courses.

Environmental education is geared towards education for the achievement of the Environmental Goals, which should guide diagnostic, advocacy, intervention, evaluation and continuous improvement efforts. The application of this type of questionnaires to characterize the population, allow a better understanding of how the educational community conceives the concept of environmental awareness.

Higher Education Institutions are committed to strengthening an education for environmental awareness, progress in this area is conceived as a high priority issue for continuous improvement that makes good practices in the field of University Social Responsibility. With the development of this research, a process of building structural equations and characterizing student populations with respect to the concept of environmental awareness is initiated to eventually consider an environmental awareness index in Higher Education Institutions that help to direct training, learning and education processes in the field of professional competences related to environmental care.

In summary, education for a better environmental awareness must be based on the recontextualization and reconceptualization of the belief system, in knowledge about how to act, how to know and how to be.

Acknowledgment

References

Bojórquez Molina J.A., López Aranda L., Hernández Flores M.E., Jiménez López E., (2013), *Use of Cronbach's alpha to validate the reliability of an instrument for measuring student satisfaction in the use of Minitab software*, (in Spanish), Proceedings of the 11th Latin American and Caribbean Conference for Engineering and Technology, Boca Raton: Latin American and Caribbean Consortium for Engineering Institutions, Cancun, Mexico, #65, On line at: http://www.laccei.org/LACCEI2013-Cancun/RP065.html.
Huitt W.G., Cain S.C., (2005), *An overview of the conative domain*, In *Educational Psychology Interactive*, Valdosta State University, Valdosta, GA, 20, On line at: http://www.edpsycinteractive.org/papers/conative.pdf.
IBM Corp., (2015), *IBM SPSS Statistics for Windows*, IBM Corpopration, Armonk, NY.
Kaiser H.F., Rice J., (1974), Little Jiffy, Mark IV, *Educational and Psychological Measurement*, **34**, 111-117. DOI: 10.1177/001316447403400115.
Kang G.-D., James J., (2007), Revisiting the Concept of a Societal Orientation: Conceptualization and Delineation, *Journal of Business Ethics*, **73**, 301-318. DOI: 10.1007/s10551-006-9208-0.
Lloret-Segura S., Ferreres-Traver A., Hernández-Baeza A., Tomás-Marco I., (2014), The exploratory factor analysis of the items: a practical guide, revised and updated., (in Spanish), *Anales de Psicología*, **30**, 1151-1169. DOI: 10.6018/analesps.30.3.199361.
Martínez A.G., de la Torre F.V., Vaquero Abellán M., (2012), Measurement and categorization of environmental awareness of university students: contribution of the University to its strengthening, (in Spanish), *Profesorado. Revista de currículum y formación del profesorado*, **16**, 193-212.
de la Rosa Ruíz D., Armentia P.G., de la Calle Maldonado C., (2019), Education for sustainable development: The role of the university in the 2030 agenda transformation and design of new learning environments, (in Spanish), *Prisma Social*, 179-202.
Schlegelmilch B.B., Bohlen G.M., Diamantopoulos A., (1996), The link between green purchasing decisions and measures of environmental consciousness, *European Journal of Marketing*, **30**, 35-55.
Sharma K., Bansal M., (2013), Environmental consciousness, its antecedents and behavioural outcomes, *Journal of Indian Business Research*, **5**, 198-214. DOI: 10.1108/JIBR-10-2012-0080.
United Nations, (2018), *The 2030 Agenda and the Sustainable Development Goals an opportunity for Latin America and the Caribbean*, United Nations, Santiago de Chile, On line at: https://repositorio.cepal.org/bitstream/handle/11362/40156/25/S1801140_en.pdf.
Vallaeys F., (2014), University social responsibility: a new university model against commodification, (in Spanish), *Revista Iberoamericana de Educación Superior*, **5**, 105-117. DOI: 10.1016/S2007-2872(14)71945-6.
Zelezny L.C., Schultz P.W., (2000), Psychology of Promoting Environmentalism: Promoting Environmentalism, *Journal of Social Issues*, **56**, 365-371. DOI: 10.1111/0022-4537.00172.