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Sustainability behaviors. An application of the VBN theory in engineering students

Comportamientos de sustentabilidad. Una aplicación de la teoría VBN en estudiantes de ingeniería

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ABSTRACT

The theory of Values, Beliefs, and Norms (VBN) facilitates the understanding of how these aspects impact human behavior; understanding these influences triggers better prediction and explanation of behaviors. Values and beliefs can be internal, while norms refer to social and cultural expectations. The objective of this study is to analyze the values, beliefs, and norms of Computer Systems engineering students at the Tecnológico Nacional de México, Oaxaca campus, by contrasting the results with the study "Sustainability behaviors among college students: an application of the VBN theory." A descriptive quantitative methodology was developed; five sustainability behaviors were evaluated; it was applied to a total of 372 students, and three instruments were adapted. Results indicated that students who adhere to biospheric and altruistic values are more likely to engage in a variety of sustainability behaviors; conversely, those who adhere to selfish values are less likely to engage in most behaviors. Students who adhere to traditional values or are open to change showed mixed results.

Keywords: cultural behavior, social behavior, sustainable education, value judgment, social norm.

JEL Classification: C52; Q56; Q01

RESUMEN

La teoría de Valores, Creencias y Normas (VBN) facilitan la comprensión de cómo estos aspectos impactan en el comportamiento humano; entender estas influencias desencadena una mejor predicción y explicación de las conductas. Los valores y creencias pueden ser internos, mientras que las normas se refieren a expectativas sociales y culturales. El objetivo del presente estudio es analizar los valores, creencias y normas de estudiantes de ingeniería en Sistemas Computacionales en el Tecnológico Nacional de México, campus Oaxaca, mediante la contrastación de los resultados con el estudio "Sustainability behaviors among college students: an application of the VBN theory". Se desarrolló una metodología de tipo cuantitativa descriptiva; se evaluaron cinco comportamientos de sustentabilidad; se aplicó a un total de 372 estudiantes y se adecuaron tres instrumentos. Los resultados indicaron que los estudiantes que se adhieren a valores biosféricos y altruistas son más propensos a participar en una variedad de comportamientos de sustentabilidad; por el contrario, aquellos que se adhieren a valores egoístas son menos propensos a participar en la mayoría de los comportamientos. Los estudiantes que se adhieren a valores tradicionales o abiertos al cambio mostraron resultados mixtos.

Palabras clave: comportamiento cultural, comportamiento social, educación sostenible, juicio de valor, norma social.

Clasificación JEL: C52; Q56; Q01

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INTRODUCTION

Sustainability has become a global concern that requires the attention of all sectors of society (Guerrero et al., 2023; Jiang et al., 2023). In this sense, education is a key factor in fostering sustainable practices in the population (Salangka & Kameo, 2024; Shishakly et al., 2024; Uda, 2024), especially in young people who will be the leaders and decision-makers of the future (Pérez-Franco et al., 2022; Pérez et al., 2022; Sigüenza et al., 2022). Shuhaiber et al. (2023) state

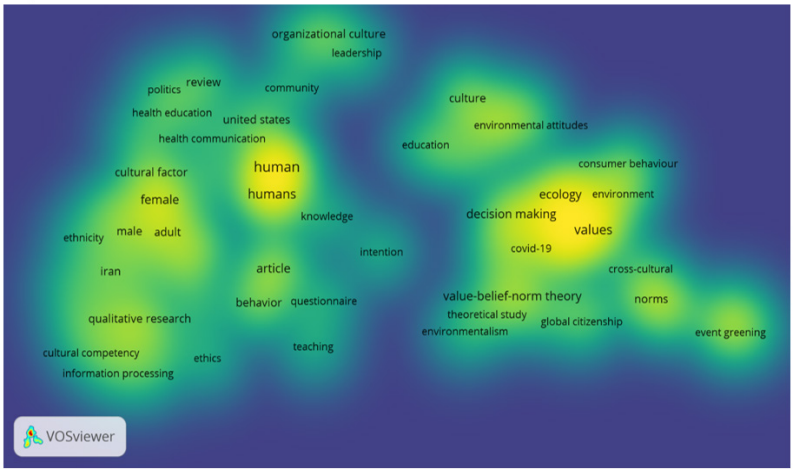
that young people have enormous potential to become present and future drivers of inclusive and sustainable development. However, to achieve effective environmental education, Heimlich and Ardoin (2008) point out that in order to encourage students to be more environmentally friendly, academics must understand what factors motivate behavior.

Stern and Dietz (1994), Al Zaidi et al. (2023), and Chi et al. (2023) explained that people's pro-environmental behavior is guided not only by personal norms based on altruistic values toward other humans but also by norms based on self-interest and altruism toward other non-human species (Awan & Khan, 2021; Rameezdeen et al., 2019). They also claimed that selfish and biospheric personal norms are activated in the same way as altruistic personal norms within norm activation theory (Stern & Dietz, 1994). Subsequently, Stern et al. (1999) extended this idea of three value orientations describing environmental action and proposed a more elaborate theory: the value-belief-norm (VBN) theory. This theory generalizes norm activation theory to incorporate, in addition to altruistic values, egoistic and biospheric value orientations in personal norms (Chan et al., 2023; Mikuletič et al., 2024).

Consistent with the purpose of the manuscript, a bibliometric analysis was conducted in the SCOPUS database (https://www.scopus.com/), following the patterns described by Laita et al. (2024) and Xia et al. (2024), with the aim of exploring research addressing value-belief-norm theory (Figure 1). Among the major words, people, values, sustainability, decision-making, and value-belief-norm theory stand out for their level of co-occurrence.

Figure 1.

Keyword co-occurrence network



Source: own elaboration

De Groot and Steg (2008) define altruistic values as those that focus on the well-being of others and the promotion of social justice; selfish values, those that focus on the pursuit of personal well-being and the maximization of individual benefits; biospheric values refer to concern for the protection and preservation of the environment and biodiversity; values of openness to change refer to openness and willingness to explore new ideas, experiences and changes; and, finally, traditional values refer to the importance given to the preservation of existing cultural norms and customs.

According to Garcia (2018), "sustainable behavior is defined as a set of specific dispositions and actions in the face of local problematics, which are deliberate, planned, systematic, equitable and optimizing of natural resources" (p. 75). It should be noted that, although there are antecedents of research in Mexico, its main connection with our paper lies in the application of the VBN theory in the context of sustainability, but not applied to young Mexican university students.

The Tecnológico Nacional de México, Oaxaca campus, which is located in southern Mexico (latitude 17.077566 and longitude 96.744461), offers a total of 11 bachelor's degrees, including industrial engineering, mechanical, chemical, electronic, electrical, business management, civil, computer systems, administration, and public accountant. It also offers several master's degrees, such as teaching, administration, construction, engineering sciences, regional and technological development, and a doctorate in the latter. The student population of this institution comes from the city of Oaxaca de Juárez and its surrounding municipalities and other regions of the state, with a wide diversity of economic levels and social strata. For the February-June 2023 semester, this population was estimated at 5808 students.

A useful tool to test the theory of beliefs, norms, and values is the SEM (Structural Equation Modeling) model (Aunyawong et al., 2024; Tariq et al., 2024; Toni & Theng, 2024). In this regard, Pacheco (2019) explains that this model allows the analysis of the relationship between observed and latent variables. According to the author, observed variables are those that are directly measured by means of questionnaires, while latent variables are not directly measured, but their presence can be inferred from the observed variables. That is why such a model is ideal for measuring the constructs that make up the theory of beliefs, norms, and values (Alam et al., 2024; Rabaa'i et al., 2024). Through the SEM model, it is possible to perform an empirical evaluation of the theory, providing accurate and reliable results (Jalo & Pirkkalainen, 2024).

The objective is to evaluate the influence of students' values, beliefs, and norms on their behavior towards sustainability at the Tecnológico Nacional de México, Oaxaca campus, based on the paper conducted at Michigan State University in 2016; "Sustainability behaviors among college students: an application of the VBN theory", by Cameron T. Whitley, Bruno Takahashi, Adam Zwickle, John C. Besley and Alisa P., by replicating the study and adapting its terms, methodology, and questionnaire (Whitley et al., 2018).

METHODOLOGY

Design and adaptations

A descriptive quantitative type methodology was developed (Gyan et al., 2023; Rhomadhoni et al., 2023). For data collection, the questionnaire used in the research "Sustainability behaviors among college students: an application of the VBN theory" (Whitley et al., 2018) was reviewed. Subsequently, the necessary adaptations were made in terms of language and instructions to apply it at the Tecnológico Nacional de México, Oaxaca campus. In this process, demographic data and the gender of the participants were excluded because they were not relevant for the analysis and obtaining significant results while keeping anonymity and for the students to answer with greater confidence (Chad, 2020). Once adapted, it was implemented through an online form (Gatt et al., 2024; Nichols et al., 2024); also, a pilot test was conducted to evaluate its readability and comprehension, corresponding adjustments were made, and the link was provided so that students could respond.

At the end of the data collection process, in the first cut, 450 questionnaires were answered; subsequently, they were cleaned, and 78 questionnaires were discarded for having inconsistencies in the answers, leaving a total of 372. Finally, the statistical analysis was performed using the R programming language (Koren et al., 2024; Reddy et al., 2024), and then the findings obtained were discussed. For processing, reliability and validity values were calculated. Cronbach's alpha estimates how reliable the answers given to a set of items are by indicating the degree of consistency of the answers (stability) with respect to the psychological domain measured (Frías-Navarro, 2022).

Before submitting the data to structural equation modeling (SEM), the data were validated by calculating Cronbach's alpha to assess the internal consistency of the questions and the reliability of the participants' responses (Jesus & Balsanelli, 2023; Riato et al., 2023). The measures of the constructs assessed in the study demonstrated high reliability through Cronbach's alpha coefficients. In particular, a coefficient above 0.72 was obtained for the values, indicating good internal consistency. On the other hand, beliefs, and norms also presented a high degree of reliability, with Cronbach's alpha coefficients ranging between 0.85 and 0.94 for beliefs and between 0.79 and 0.92 for norms, depending on the behavior in question.

Criteria variables

By criterion variables, Whitley et al. (2018) refers to the five key behaviors among students:

- Choosing modes of transportation with the least environmental impact.
- Recycling waste paper, plastics, and metals.
- Turning off lights and other electronic devices when leaving a room
- Choosing food to help the environment whenever possible
- Support political candidates with environmental proposals.

Predictor variables

Predictor variables are those that are used to predict or explain variation in student behaviors. For this study, the following were considered as predictor variables: values, beliefs, and norms regarding sustainability, as indicated by the VBN theory.

- **Values**

Students were asked using a 5-point Likert scale ranging from "Not at all important" to "Extremely important" to express the importance they give to each value as a guiding principle in their lives.

- **Beliefs**

Regarding the construction of the belief scales, students were required to indicate their degree of agreement or disagreement with a series of statements. For this purpose, a 7-point Likert scale ranging from "Strongly disagree" to "Strongly agree" was used. Each belief scale was made up of three questions related to a behavioral category.

- **Norms**

Four items were used to construct the normative scales. As with the belief scales, participants were asked to express their level of agreement or disagreement with a series of statements on a 7-point Likert scale ranging from "Strongly disagree" to "Strongly agree".

Instruments

Scale of values

5-point scale from "Not at all important" to "Extremely important".

Altruistic values

- Social justice, correction of injustices, care for the environment.
- Equality, equal opportunities for all
- A world of peace, free of war and conflict.

Biospheric values

- Respect for the earth, harmony with other species.
- Protecting the environment, preserving nature
- Unity with nature, adaptation to nature.

Selfish values

- Social power, control over others, dominance.
- Authority, the right to lead or command.
- Wealth, material possessions, money.

Traditional values

- Honoring parents and elders, showing respect
- Family security, security for loved ones
- Self-discipline, self-control, resistance to temptations.

Opening values

- Constantly seeking a varied life, full of challenges and changes
- Constantly seek exciting and stimulating experiences
- Maintain a curious and interested attitude in everything around us, seeking to explore and discover new knowledge and experiences.

Belief scale

7-point scale from "Strongly Disagree" to "Strongly Agree"

- This action is a good idea
- This action can make a difference
- I have thought a lot about this action

Scale of personal standards

7-point scale from "Strongly Disagree" to "Strongly Agree".

- My friends carry out this action
- Computer Systems Engineering students, in general, carry out this action.
- My friends support this action
- Computer Systems Engineering students, in general, support this action.

Behavior

7-point scale from "Never" to "Always".

Support for politicians: I support political candidates who propose to strengthen environmental policies.
Recycling: I recycle paper, plastic or metal waste.
Energy conservation: I turn off lights and other electronic devices when I leave a room.
Food selection: I choose my food to help the environment. For example, I consume less meat, local foods, less pesticides, whenever possible.
Transportation choices: I choose means of transportation with less environmental impact whenever possible (e.g., bus, bicycle, walking), to help the environment.

RESULTS

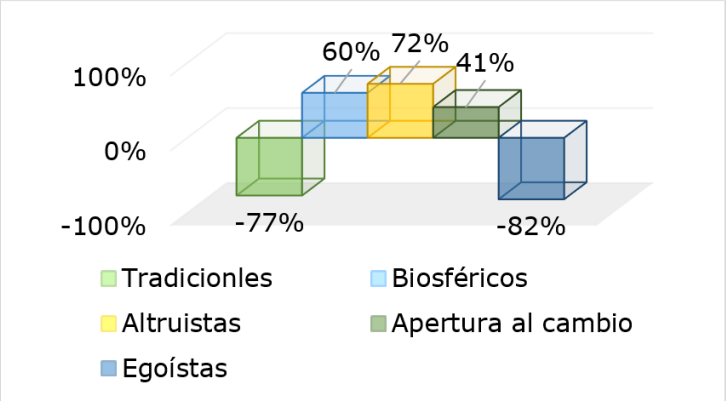
The results presented in Table 1 highlight that students who are more altruistic (correlation coefficient = 0.72) and have a biospheric perspective (correlation coefficient = 0.60) are more likely to support political candidates with environmental proposals.

Table 1.
Correlation coefficients of the values with respect to support for environmental candidates (political support)

Variables	Beliefs	Standards	Support for political candidates
Traditional values	0.74	0.78	-0.77
Biospheric values	0.80	0.87	0.60
Altruistic values	0.76	0.48	0.72
Values of openness to change	-0.80	-0.72	0.41
Selfish values	-0.63	-0.58	-0.82
Beliefs		0.60	0.05
Standards			0.54
Remarks	76	76	76

Source: own elaboration

Figure 2.
Correlation between values and support for environmental candidates



Source: own elaboration
Note: the figure appears in its original language

According to table 1, there are significant correlations between several factors, suggesting that there is a complex interaction between them, which may influence the probability of adopting the evaluated behavior (Figure 2).

The data reflect that students who are more inclined toward selfish values are less likely to support these political candidates. Similarly, those students who adhere to the traditionalist construct are less inclined to support them. These tendencies may be the result of several factors, which could include a lack of adequate environmental education and the influence of cultural biases that do not encourage environmental stewardship as a social priority.

Recycling

The correlations in table 2 show that traditional, altruistic, and openness to change values have a weak or practically null relationship with recycling behavior.

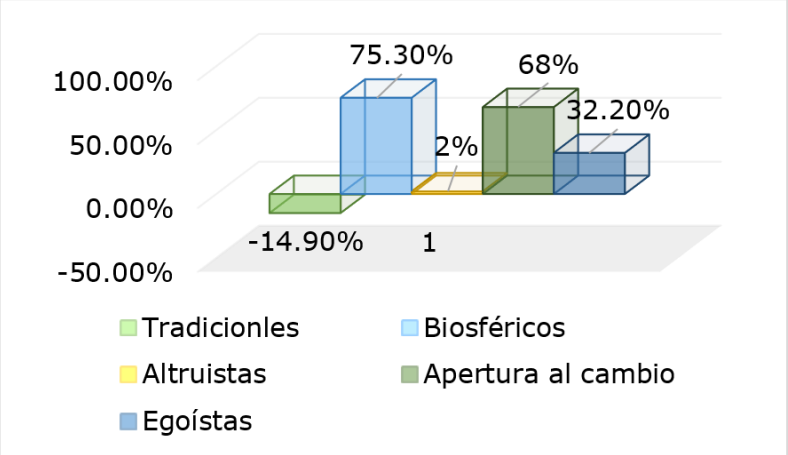
Tabla 2.
Correlation coefficients of the values with respect to recycling behavior

Variables	Beliefs	Standards	Recycling
Traditional values	0.09	0.57	-0.15
Biospheric values	0.90	-0.54	0.75
Altruistic values	0.47	-0.35	0.02
Values of openness to change	0.12	-0.14	0.07
Selfish values	-0.98	0.57	0.32
Beliefs		-0.93	0.16
Standards			-0.33
Remarks	73	73	73

Source: own elaboration

A strong relationship between biospheric value and recycling behavior can be observed, evidenced by a positive standardized loading of 0.75. This indicates that students who value environmental protection more highly and have a greater concern for the conservation of the planet are more likely to recycle. In contrast, the relationship between the construct norms (correlation coefficient = -0.33) and the behavior in question is negative. This implies that students who see recycling as a mere obligation due to society or do not perceive positive social expectations in this regard tend to recycle less (Figure 3).

Figure 3.
Correlation between values and recycling



Source: own elaboration
Note: the figure appears in its original language

In addition, there is evidence of a remarkable and positive correlation between recycling behavior with the selfish construct (correlation coefficient = 0.32), which contradicts expectations according to VBN theory. Interestingly,

students adopt recycling practices even when it goes against their personal beliefs (correlation coefficient = -0.98). This suggests that, in this aspect, they are more influenced by norms than by their own convictions.

Electricity

The model analysis indicates that altruism, biospheric values, traditional values, and beliefs are positively linked to energy-saving behavior, while selfishness shows a negative correlation (Table 3). On the other hand, no significant relationship is observed between openness and norms variables with respect to this behavior.

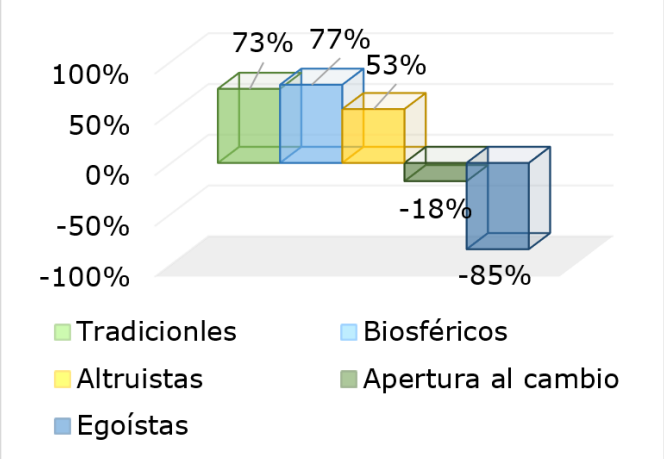
Table 3.
Correlation coefficients of the values with respect to energy saving behavior (electricity)

Variables	Beliefs	Standards	Electricity
Traditional values	0.94	0.82	0.73
Biospheric values	0.96	0.57	0.77
Altruistic values	0.91	0.86	0.53
Values of openness to change	0.58	0.90	-0.18
Selfish values	-0.60	-0.97	-0.65
Beliefs		0.60	0.63
Standards			-0.12
Remarks	72	72	72

Source: own elaboration

Students who strongly commit to traditional and environmental values, such as environmental protection and conservation of natural resources influenced by society, are likelier to adopt behaviors that promote energy saving (Figure 4). In contrast, students who are more inclined to the selfish, self-interested construct are less likely to adopt energy-saving behaviors.

Figure 4.
Correlation between values and electricity savings



Source: own elaboration
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Feeding

In the food theme, the biospheric values variable reveals a positive and moderately significant relationship with food selection behavior to help the environment (Table 4). As environmental awareness increases, the probability of selecting food considering the impact of its production and consumption increases.

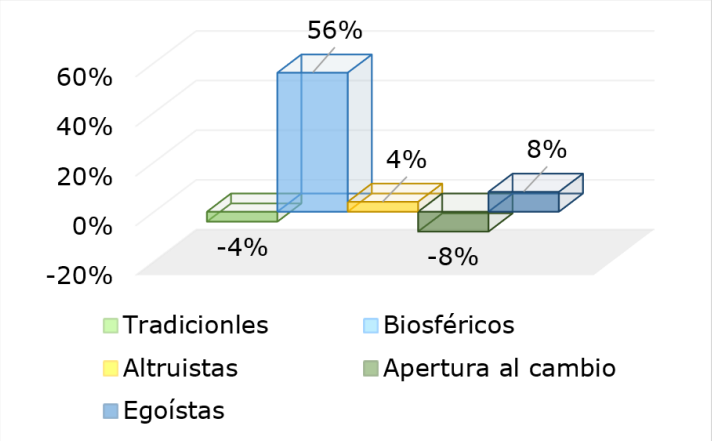
Table 4.
Correlation coefficients of the values with respect to food selection behavior

Variables	Beliefs	Standards	Foods
Traditional values	-0.87	-0.60	-0.04
Biospheric values	0.77	0.88	0.56
Altruistic values	0.85	0.85	0.04
Values of openness to change	0.95	0.56	-0.08
Selfish values	0.01	-0.02	0.08
Beliefs		0.85	0.02
Standards			0.30
Remarks	75	75	75

Source: own elaboration

Something that needs to be considered is that the low correlation between the variables suggests that other factors may influence the adoption of food selection behavior to help the environment (Figure 5). These factors could include a lack of available options, as well as a lack of knowledge or information to make informed choices.

Figure 5.
Correlation between values and food choices to care for the environment



Source: own elaboration
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Transportation

In transportation, altruism has a significant positive relationship (Table 5). This points to the fact that students with higher levels of altruism are more likely to choose transportation with less environmental impact. The biospheric value, which is the value that refers to concern for nature, has a non-significant positive relationship.

Table 5.
Correlation coefficients of the values with respect to the behavior of choice of means of transportation

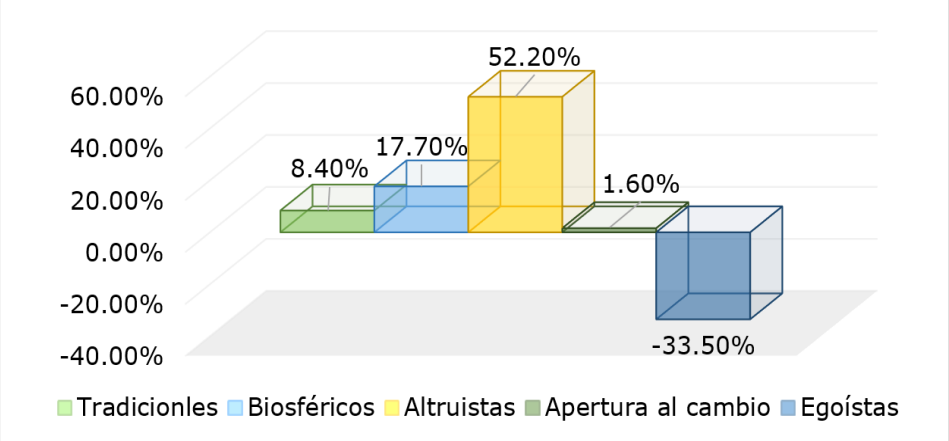
Variables	Beliefs	Standards	Transportation
Traditional values	0.10	0.09	0.08
Biospheric values	0.89	0.54	0.18
Altruistic values	0.77	0.53	0.52
Values of openness to change	0.13	0.23	0.02
Selfish values	-0.89	-0.86	-0.34
Beliefs		0.85	0.13
Standards			-0.18
Remarks	76.00	76.00	76.00

Source: Own elaboration

After examining in detail the data presented in the table, it is possible to observe that biospheric values have a strong connection with respect to beliefs related to the choice of means of transportation (Figure 6). However, this strong correlation does not translate proportionally into concrete behavior; something that points to the possible existence of obstacles between beliefs and practical actions.

Figure 6.

Correlation between values and the choice of means of transport with lower environmental impact



Source: own elaboration

Note: the figure appears in its original language

In contrast, selfish values reveal an inverse and significant correlation with beliefs and norms around transportation choice. In addition, beliefs are found to maintain a high correlation with norms; however, this close connection is not reflected to the same degree within the behavior in question. This finding suggests the existence of additional factors involved in practical decisions. Finally, after analyzing the influence of the factors with the five behaviors evaluated, the choice of means of transportation presents the weakest correlation.

DISCUSSION

Comparing our results with the findings of the Whitley et al. (2018) study reveals remarkable similarities in relation to the variables that influence sustainable behaviors. For example, at both Michigan State University and Tecnológico Nacional de México, Oaxaca campus, the biospheric value, focused on the protection and conservation of ecosystems and biodiversity, emerges as a strong predictor for all behaviors assessed; however, each variable had different influences within them.

Based on support for political candidates with environmental proposals, it was observed that negative values and beliefs exert an unexpectedly high positive influence. This phenomenon occurs when people are aware of their values or beliefs but nevertheless choose to take actions that contradict their own convictions due to other considerations. On the other hand, students who embrace traditional and selfish values tend to show less inclination to endorse such behavior. This pattern remains constant in both studies, demonstrating its consistency across different contexts.

In recycling, altruism has an indirect influence through beliefs, as positive attitudes are reflected in people's behavior; even though some people may not believe in the importance of recycling, they tend to follow norms about it. In the Michigan context, when beliefs were negative, this translated into negative behavior; however, in Oaxaca, negative beliefs did not always correlate with behavior, as norms positively influenced recycling. The influential variables identified were norms, selfishness, and biospheric values; additionally, it was found that the name or label associated with recycling was more likely to influence behavior than mere belief in its importance.

In the area of electrical energy savings, beliefs are important as a determining factor. Contrary to what was observed in Michigan, here beliefs are an important predictor of behavior; these beliefs are closely correlated with values. This indicates that when students strongly believe in the importance of energy conservation and in their personal responsibility to contribute to this cause, they are more likely to adopt more efficient consumption habits; this connection between beliefs and behavior suggests that strategies to promote energy conservation may be more effective by focusing on positive attitude formation and education about the benefits at both the personal and community levels.

Regarding food choices to help the environment, it continued to be observed that biospheric values remained a very strong predictor of behavior. Contrary to expectations, in the students of the Instituto Tecnológico de Oaxaca, the traditional value is not one of the two most influential values, but, on the contrary, has a negative correlation; an aspect that reinforces the need to effectively address traditional perceptions and attitudes that could be hindering the adoption of more environmentally friendly behaviors in the food arena.

Finally, in relation to the choice of means of transportation, this was the aspect that yielded the most contrasting results since, unlike what was observed in Michigan, here the biospheric values fail to manifest themselves in the adoption of the behavior; moreover, openness to change does not demonstrate a significant correlation either. All this suggests the existence of other factors that could influence students, such as limited transportation alternatives, due to different socioeconomic circumstances and different levels of local development than those present in the context of the students in the first study.

CONCLUSIONS

The results obtained through this research are of great value, as they support the efficacy of the Values, Norms, and Beliefs (VBN) theory as a fundamental tool for formulating strategies to promote environmental care in student communities. These findings allow the establishment of strategic approaches that differ from traditional methods by placing an emphasis on cultivating values intrinsically related to desired behaviors.

This study can also be applied in settings with different levels of development. For example, strategies can be adjusted to address the particularities of institutions located in both highly urbanized and more marginalized cities. This allows a focus on promoting sustainable behaviors that are specific and relevant to each institution, taking into account the particular conditions of its environment and the socioeconomic and cultural level of the students.

The effectiveness of the strategies formulated through applying the VBN (Values, Beliefs, and Norms) theory, compared to the traditional ones, focuses on discovering a more contextual and adaptable approach. Unlike the traditional practice of copying successful strategies from one setting and applying them directly in another - which often fails due to fundamental differences in the values, beliefs, and norms embedded in each community - the results obtained in this research, by applying a similar methodology in different contexts, reveals considerable and important changes in the study population. Therefore, a successful strategy in one place should not be directly transferable due to cultural and social variability since it is necessary to adapt and contextualize it in order to obtain more solid results consistent with local realities.

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