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Measuring sustainable development knowledge, attitudes, and behaviors: evidence from university students in Mexico

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Abstract

Current trends such as imminent overpopulation and the take-make-waste economic model are largely responsible for the planet's dire situation. One of the main limitations identified in research on education for sustainable development is the lack of consensus regarding the measurement of sustainable development in both developed and developing countries. In this regard, several Latin American and Caribbean countries have shown their commitment to sustainable development through policies, strategies, or plans related to both education for sustainable development and environmental education. Taking this into account, the present study aimed to develop standardized measures for the levels of sustainable development knowledge, attitudes, and behaviors among university students in northwestern Mexico. Thus, the importance of this study lies in validating previous instruments and determining the degree to which knowledge and positive attitudes explain sustainable development behaviors. Based on the theory of planned behavior, the empirical evidence showed that in northwestern Mexico, university students presented a moderate degree of knowledge and attitudes regarding sustainability but that they scored at the low-moderate level on behavior. The results are consistent with previous studies, with knowledge ($\beta = .296$) and attitudes ($\beta = .183$) explaining behaviors favorable to sustainable development ($R^2 = .18$, $p < .001$). It is recommended that universities promote sustainable development by incorporating education on sustainable development into curricular requirements and extracurricular activities and that institutions of higher education become responsible for training future professionals in this area and evaluating the impact of public initiatives in generating sustainable behaviors among students.

Keywords Sustainable development · Knowledge · Attitudes · Behaviors · University students

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1 Introduction

Recent research warns about the dangers of underestimating the current environmental challenges and what doing so could mean for life on Earth as we know it if global leaders do not take urgent action (Bradshaw et al., 2021; Pacheco, 2020). For instance, issues such as rapid biodiversity loss and ecological disruption could have serious consequences for the social wellbeing of the population (e.g., environmental health-related issues) and economic implications (e.g., mass production and overconsumption of resources). Current trends such as imminent overpopulation and the *take-make-waste* economic model are largely responsible for the planet's dire situation. To tackle such global problems, 193 United Nations member states are currently committed to the 17 Sustainable Development Goals (SDGs) (United Nations Development Program [UNDP], 2021).

According to Porter (2013), only corporations have the capacity and resources required to confront large-scale social problems (e.g., poverty, gender inequality, and inequity), which have traditionally been resolved by governments. In general, these challenges and difficulties related to sustainable development (SD) are characteristic of Latin America and Mexico in particular. Such challenges in Mexico might include the percentage of the population living in poverty, at 43.6% (National Council for the Evaluation of Social Development Policy, 2016); the solid waste production, which was 99,104 tons/day in 2012 (Hoornweg & Bhada-Tata, 2012); the death rate due to adverse health conditions, which reached 10.4% in 2012 (World Health Organization [WHO], 2012); and deforestation, with more than 3.1 million cleared hectares in 2010 (Global Forest Watch, 2010).

Therefore, current leaders, administrators, and employees of organizations must develop knowledge, attitudes, and behaviors favorable to SD (UNECE, 2003; Freyling, 2015). Thus, it is essential that institutions of higher education (IHEs) become responsible for training future professionals in this area. It is also important to investigate whether education on SD should be included in the university training of students as preliminary preparation to face various current difficulties and challenges of organizations. The inclusion of such education was one of the main objectives of the Decade of Education for Sustainable Development (DESD) 2004–2015, promoted by the United Nations Educational Scientific and Cultural Organization (UNESCO, 2005). Thus, a change was encouraged in the behavior of students, teachers, and the community in general, promoting environmental integrity, economic feasibility, and a just society for both present and future generations.

One of the main limitations identified in research on education for sustainable development (ESD) is the lack of consensus regarding its measurement in both developed and developing countries (Glavič & Lukman, 2007; Tanguay et al., 2010), which, in turn, precludes its evaluation and, in fact, remains in a stage of consolidation (de Haan, 2006; Rode & Michelsen, 2008; Tilbury, 2007). This issue is crucial, given that it is necessary to know whether the ESD efforts and investments by governments and educational institutions have obtained positive results. The lack of agreement may be due to the inclusion of economic, social, and environmental components within the concept of SD, which adds to its complexity and leads to multiple approaches (Kopnina & Meijers, 2014).

Therefore, various scholars have suggested the development of standardized indices to measure the construct of SD (Carleton-Hug & Hug, 2010; Jacobson et al., 2006; Zint et al., 2011). Among the most recent studies that have proposed standardized measures are those of Michalos et al. (2011, 2012, 2015, 2017), which evaluated tenth grade students in the Canadian province of Manitoba on knowledge, attitudes, and behaviors concerning SD using the definition of the concept established by United Nations Educational Scientific

and Cultural Organization (UNESCO, 2005). The objective of these studies was to evaluate the impact of public initiatives in Manitoba in terms of generating sustainable behaviors among students.

In Mexico, as a response to the DESD, the government created and promoted an initiative known as the National Strategy of Environmental Education for Sustainability (with the acronym ENEAS in Spanish) in 2006 to encourage ESD at every education level. Thus, the present study aimed to develop standardized measures of the level of the SD knowledge, attitudes, and behaviors of university students in northwestern Mexico. In addition, the study aimed to determine the degree to which knowledge of and positive attitudes toward SD explained SD behaviors using the theory of planned behavior (TPB) (Ajzen et al., 2011). This study responded to the call by Kopnina and Meijers (2014) to develop standardized instruments to measure behaviors favorable to SD. Thus, the originality of this study lies in its measurement of university students' SD knowledge, attitudes, and behaviors in a developing country to contribute to validating previous instruments (Michalos et al., 2017).

2 Literature review

This section presents the Latin American and Caribbean context, particularly the Mexican context, regarding the initiatives that have been developed to embed SD in education. Furthermore, the Theory of the Planned Behavior (TPB) is described, several empirical studies on sustainable behavior are presented, and research questions are proposed.

2.1 Education for sustainable development initiatives in Latin America

Since the establishment of the DESD in 2005, the United Nations has focused on the issue of ESD via the adoption and implementation of different intergovernmental initiatives. The Latin American and Caribbean regions proposed the strategy "Building Education for Sustainable Development" in 2006 at a conference organized in Costa Rica in collaboration with UNESCO and Earth Charter (Buckler & Creech, 2014). This strategy emerged as one of the actions to promote the DESD at the regional level to agree on a common vision and actions regarding this United Nations initiative. An objective of the strategy was to "create a strong educational community, capable of incorporating the principles of sustainability at every level of formal education, as well as within non-formal and informal education" (United Nations Educational Scientific and Cultural Organization [UNESCO], 2007a, p. 4).

Individually, several Latin American and Caribbean countries showed their commitment through policies, strategies, or plans related to both ESD and environmental education (EE).[1] Regarding this pledge in this region, the development of ESD is closely related to the results obtained in the addition of EE to curricula because some countries began to incorporate an ecological dimension and later added social and economic dimensions (United Nations Educational Scientific and Cultural Organization [UNESCO], 2007b),

[1] Salgado and Tréllez (2009) mentioned the following actions: the Policy on Education for Sustainable Development in Chile in 2009, the National Commitment to the Decade of Education for Sustainable Development adopted by Costa Rica in 2006, the Uruguayan Network on Environmental Education for Sustainable Human Development in 2005, and the 1998 National Action Plan of Environmental Education for Sustainable Development in Jamaica.

which could explain the increasing use of both ESD and EE in documents concerning public policy (Buckler & Creech, 2014; Salgado & Tréllez, 2009).

Concerning Mexico's initiatives in favor of embedding SD in education, in 2006, the National Strategy of Environmental Education for Sustainability was announced along with the country's Commitment with the Global Action Program on Education for Sustainable Development (United Nations Educational Scientific and Cultural Organization [UNESCO], 2015). Notably, in Mexico, the term *environmental education for sustainability* (EES) corresponds to the internationally used concept of ESD (i.e., economic, environmental, and social development). Thus, EES was adopted in the country's national strategy (Secretaría de Medio Ambiente y Recursos Naturales, 2006). The strategy is based on the diagnosis of the current EES status at every level of education as well as a SWOT analysis to generate initiatives along four strategic axes: (1) legislation and funding, (2) education and the development of human resources for EES, (3) institutional strengthening and cross-sector and interinstitutional coordination, and (4) consolidation of the EES knowledge base.

2.2 Theory of planned behavior and empirical studies on sustainable behavior

Multiple perspectives have been used to explain SD behaviors. For example, from the standpoint of culture and the context in which people live (Sharma & Jha, 2017), the value systems that people follow (Landon et al., 2018) and hypocritical attitudes are predictors of environmentally friendly behaviors (Focella & Stone, 2014). Even religion and beliefs have been considered possible explanations for sustainable behaviors (Minton et al., 2015). On the other hand, attempts have been made to use predictor variables such as feedback systems. For instance, Barreto et al. (2014) analyzed the technologies that families used to measure information regarding their energy consumption and found that this type of control and indicator helped generate greater awareness and promote more sustainable behaviors. From a marketing standpoint, sustainable consumer behaviors have also been studied, such as the use of digital marketing to sensitize consumers and encourage behaviors favorable to SD (i.e., Delacolette et al., 2011; Khan & Canny, 2008; Minton et al., 2012). Additionally, efforts to explain sustainable consumption include the use of different types of normative appeals, such as injunctive, descriptive and benefit appeals (White & Simpson, 2013).

However, these previous approaches have been used with groups such as consumers and families or people in general. In this paper, the aim is to explain the sustainable behavior of university students. Therefore, the use of a model that uses knowledge as a predictor variable is expected to be more appropriate because educational institutions are where knowledge is generated and transmitted to learners. Such knowledge seeks to produce student awareness to promote a change in attitudes toward SD, thus fostering positive behavior toward SD. Both knowledge and attitudes are considered in the TPB model.

The TPB has shown utility in predicting different types of behaviors among individuals (Ajzen, 1985, 1991). This theory asserts that individuals' perceived attitudes, subjective norms, and control are determining factors of their behavior. In addition, the TPB has been used to study general environmentally friendly behaviors (Kaiser et al., 1999; Oreg & Katz-Gerro, 2006) as well as specific behaviors such as the tendency to recycle (Oskamp et al., 1991) and manage waste (Desa et al., 2011; Gusti, 2016). Nevertheless, some authors have suggested that although the attitudes and perceptions of individuals are important, they are not the only factors that can explain individuals' behavior. Thus, different

Table 1 Empirical studies conducted to measure sustainable behaviors

Authors	Knowledge	Attitudes	Behaviors	Participants	Country
Al-Naqbi and Alshannag (2018)	×	×	×	University students	UAE[1]
Gusti (2016)•	×*	×*	×	Elementary students	Indonesia
Heeren et al. (2016)•	×	×*	×	University students	USA
Michalos et al. (2012, 2015)	×*	×*	×	High school students	Canada
Connell and Kozar (2012)	×		×	University students	USA
Davis et al. (2009)•		×	×	Nonacademic staff	Australia

×=the specified variable was measured, * = positive and significant impact on sustainable behaviors, • = empirical studies conducted using the TPB, [1] UAE: United Arab Emirates

predictive factors, such as knowledge and awareness of environmental issues, have been included (Heeren et al., 2016; Kollmuss & Agyeman, 2002). Nonetheless, scholars such as Bamberg and Möser (2007) highlighted that while knowledge is important, it is insufficient on its own to generate changes in environmentally friendly attitudes and habits. A recent study that used the TPB suggested the integration of other behavior-predicting variables such as organizational behavior, human decision processes and information accuracy (Ajzen et al., 2011). Furthermore, Hines et al. (1987) carried out a meta-analysis to identify predictive factors of environmentally friendly behaviors. The authors found, among other explanatory factors, that attitudes and knowledge regarding environmental issues are significantly related to these behaviors. Bamberg and Möser (2007, p. 22) agreed with these findings and concluded the following: "Our results underline the role of awareness of and knowledge about environmental problems as a second important indirect determinant of pro-environmental behavior".

The relationship among knowledge, attitudes, and behaviors in ESD is congruent. Therefore, the curricula at IHEs must provide students with the necessary information and knowledge on sustainability and its economic, environmental, and social aspects. Thus, by promoting a greater awareness of SD issues through different disciplines and their perspectives, students are more likely to subsequently adopt pro-SD attitudes and behaviors. In this sense, various efforts to measure and explain pro-SD behavior using knowledge and attitudes in different areas and based on several theoretical foundations can be found in the ESD literature (e.g., Djeflat, 2010; Perrault & Clark, 2018; Tapia-Fonllem et al., 2013; Zeegers & Clark, 2014); among these studies, it is worth highlighting those conducted using the TPB due to their positive and significant evidence explaining sustainable behaviors. Table 1 presents empirical studies that have attempted to measure sustainable behaviors using predictors such as knowledge, attitudes, or both; that have included various types of participants; and that have been conducted in different settings, mostly in economically developed countries.

Based on the review of several empirical studies measuring SD in education, the need to identify measurement approaches that explain this construct, which are still in a maturation stage, is evident (de Haan, 2006; Rode & Michelsen, 2008; Tilbury, 2007). In this regard, efforts to develop standardized measures that evaluate ESD are needed, and such measures were suggested by authors such as Kopnina and Meijers (2014). On this issue, Michalos et al. (2012, 2015, 2017) agreed that there are currently few efforts to create standardized indices to evaluate government investments and initiatives for ESD. These authors stressed the need for a standardized measurement mechanism applicable not only to Canada but also to several countries worldwide to enable governments and education authorities

to verify progress and determine whether their ESD strategies have generated benefits and significant changes in students. This paper intends to measure sustainable behaviors in Mexican college students based on knowledge and attitudes related to SD. Thus, it is expected that since the National Strategy for Environmental Education for Sustainability was implemented in 2006, university students in Mexico have relatively moderate to high SD knowledge, attitudes, and behavior.

Concerning the predictive variables of university students' behaviors favorable to SD, the TPB claims that attitudes are a fundamental variable generating behaviors in individuals (Ajzen, 1985, 1991). According to (Allport, 1935, p. 810), "*an attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related.*" An attitude is thus considered a state of mind that causes a person to react. Such a reaction can be both favorable and unfavorable. An attitude could be described as a stance that a person has about something and that guides his or her personal response or behavior.

Furthermore, it can be argued that behavior is seen as a manifestation of an attitude about something. In this case, it is considered that an attitude favorable to SD will therefore lead to behavior aligned with economic, social, and environmental sustainability. In addition, there is empirical evidence that supports the relationship between attitudes and sustainable behaviors (Gusti, 2016; Heeren et al., 2016; Michalos et al., 2012, 2015).

As mentioned above, attitudes can be a possible predictive factor of intention in planned behavior (Ajzen, 1991). Nevertheless, authors such as Kollmuss and Agyeman (2002) argued that the behavior of individuals is complex, which makes the linear explanation of individual behavior based on just one factor impossible. Therefore, it is necessary to add another predictive component that reflects the degree of students' knowledge and awareness of sustainability. Knowledge of SD and the environment is an important component of the curriculum because it is unlikely that students will adopt sustainable behaviors if they are unaware of environmental issues (Heeren et al., 2016). Consequently, it is possible to assume that the level of students' SD knowledge is related to their attitudes and ways of thinking about this issue (Gusti, 2016; Michalos et al., 2015).

Considering the discussion above, the following research questions (RQs) are proposed:

RQ1 What are the levels of knowledge, attitudes, and behaviors favorable to SD among university students in northwestern Mexico?

RQ2 Do attitudes favorable to SD significantly explain sustainable behaviors among university students from northwestern Mexico?

RQ3 Does knowledge of SD significantly explain the sustainable behaviors of university students from northwestern Mexico?

Given the possibility that both attitudes and knowledge favorable to SD can impact SD, the following theoretical framework is proposed as the basis for the analysis in this study, in which attitudes and knowledge are independent variables to explain behavior related to SD (see Fig. 1).

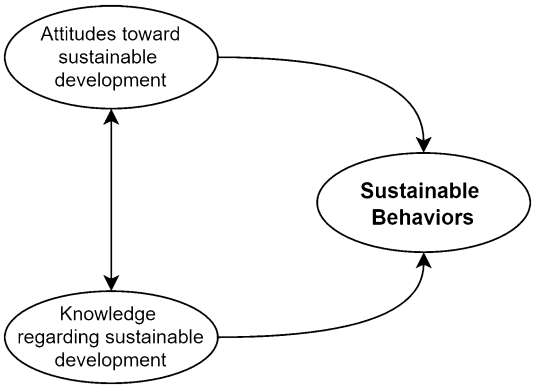

Fig. 1 Proposed theoretical framework based on the TPB by Ajzen (1991) and Ajzen et al. (2011)

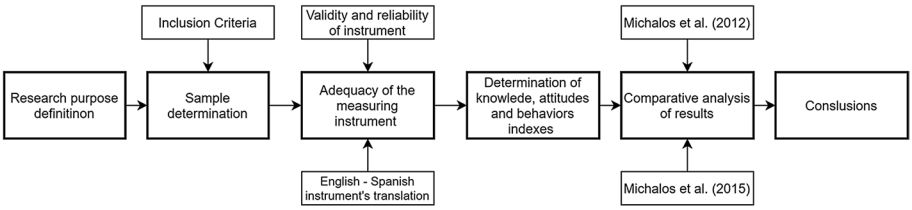

Fig. 2 Proposed research framework

3 Materials and methods

To carry out this study, a research framework was developed (see Fig. 2) in which a quantitative methodology, a nonexperimental design, and a descriptive-explanatory scope were employed. A sample of 350 students at *Instituto Tecnológico de* Sonora, a public university in a state in northwestern Mexico, was obtained through nonprobability convenience sampling. The sample was required to represent the characteristics of the study population.

All students in the sample were pursuing management degrees and were in their first through eighth semesters. The average age of the students ($\bar{x}$) was 21.3 years old, with a standard deviation (*SD*) of 1.93 years, and the age range was 10 years (18–28 years old). In addition, the students' average score was 8.7 out of a maximum of 10 points; the average monthly income of the participants was MXN 4,095 (≈ USD 218.5). Table 2 shows the remaining characteristics of the participants.

To fulfill the research purpose, a questionnaire proposed and developed by Michalos et al. (2015) was used to measure the students' SD knowledge, attitudes, and behaviors. The instrument used for this study was composed of four sections: (1) sociodemographic data, wherein the participants were asked their age, gender, education level, monthly income, school semester, and general academic average; (2) an SD knowledge index, including 24 items measuring the consistency between the participants' knowledge and selected issues considered necessary or essential for SD; (3) an index of attitudes favorable to SD, comprising 18 items measuring the level of attitudinal support for SD; and finally, (4) an index of behaviors favorable to SD, with 17 items measuring the level of behavioral support for SD.

Table 2 Characteristics of the participating university students ($n = 350$)

Characteristics	*f*	%
Gender		
Men	178	50.9
Women	172	49.1
Current semester		
First	20	5.7
Second	12	3.4
Third	28	8
Fourth	62	17.7
Fifth	38	10.9
Sixth	19	5.4
Seventh	85	24.3
Eighth	86	24.6

The response format used in the instruments was a Likert-type scale, with five response options ranging from 1 ("Strongly disagree") to 5 ("Strongly agree"); a higher score indicated a higher level of agreement with each of the statements. In addition, the options "I don't know" and "I don't understand" were included in the response options for each item to provide the participants with the opportunity to indicate any lack of understanding regarding any question in the instruments and thereby identify difficulties that could be improved in future studies (see Appendix 1–3). These options were also needed for comparative analysis on the understanding of the items in the discussion section. Importantly, six questions were negatively worded to identify any lack of commitment and avoid unusable responses by the participants, and these data were discarded from the analysis if necessary; for the corresponding statistical analyses, the scoring of these questions was reversed to correspond to the remaining items.

The instrument was translated into Spanish by professionals, ensuring that the clarity of the corresponding instructions, words, and statements in the context of its application was maintained at all times. Subsequently, the instrument was back-translated into English to verify that the original meaning of each question was maintained. To respond to the first research question in this study, a scale based on the general average of the indices was developed to categorize the levels of the SD knowledge, attitudes, and behaviors of the participants. In this sense, it was possible to establish ranges to label different levels of average progress for the participants based on the indices. The levels were as follows: high ($\bar{x}$= 4.5–5), moderate-high ($\bar{x}$= 4–4.5), moderate ($\bar{x}$= 3.5–4), low-moderate ($\bar{x}$= 3–3.5), and low ($\bar{x} \leq$ 3). Concerning the second and third research questions, the correlation between the three indices and the regression of knowledge and attitudes on sustainable behaviors are described in Sect. 4.4.

The study aimed to establish the validity of the instrument by soliciting the opinions of three SD experts (content validity) who participated in the revision and evaluation of each item to identify any ambiguity or lack of clarity in the sentences or words used based on the corresponding context. In addition, congruency was required for each of the three indices (knowledge, attitudes, and behaviors).

The results demonstrated a great level of consistency among the experts in the evaluation of the questions for each index. Nevertheless, the following recommendations were made: (1) to eliminate four items (items 15, 21, 23, and 24) from the original index

Table 3 Descriptors of the reliability of each index in the study

Knowledge index		Attitude index		Behavior index	
N	210	N	281	N	255
Alpha (α)	.955	Alpha (α)	.809	Alpha (α)	.833
Mean	3.93	Mean	3.79	Mean	3.51
SD	0.72	SD	0.58	SD	0.56
Item number	Item-total correlation	Item number	Item-total correlation	Item number	Item-total correlation
A1	.653	B1	.674	C1	.581
A2	.735	B2	.695	C2	.500
A3	.714	B3	.505	C3	.517
A4	.643	B4*	−.105	C4	.537
A5	.664	B5*	.257	C5	.627
A6	.739	B6	.634	C6	.613
A7	.785	B7	.290	C7	.567
A8	.648	B8*	.226	C8*	−.211
A9	.603	B9	.439	C9*	−.298
A10	.701	B10	.604	C10	.486
A11	.619	B11	.593	C11	.639
A12	.700	B12	.671	C12	.573
A13	.788	B13	.727	C13	.556
A14	.767	B14*	.154	C14	.599
A15	.711	B15	.569	C15	.613
A16	.769			C16	.549
A17	.650				
A18	.694				
A19	.748				
A20	.669				

SD = Standard deviation; *A* = Items on knowledge; *B* = Items on favorable attitudes; *C* = Items on favorable behaviors; * = Reverse-scored items

measuring knowledge; (2) to eliminate items 13, 15, and 18 from the original index measuring attitudes; and finally, (3) to eliminate question 9 from the original index measuring behavior. The reason for these recommendations was that certain questions were considered to be not specific to the context in which the instrument would be applied (i.e., item 15: "Is it useful to estimate the dollar value of the services provided by the ecosystem?" [attitude index]). The final version of the instrument was submitted to pilot testing with a group of 30 students from the same university (*Instituto Tecnológico de* Sonora); the students completed the measurement instrument without indicating any problems understanding the questions.

Regarding the reliability of each of the three indices measuring knowledge, attitudes, and behaviors favorable to SD, the Cronbach's alpha coefficient (α) was calculated based on the number of participants who provided valid responses to all the items. In general, alpha coefficients with values equal to or greater than 0.70 are considered desirable and acceptable (Nunnally & Bernstein, 1994). Table 3 shows each index with the number of

valid responses, alpha coefficient, statistical mean, standard deviation, and the correlation of each item with the totality of the other items.

To administer the questionnaire to the participants, the consent of the authorities at the educational institution was necessary. Students who expressed interest in participating in the study were invited to participate voluntarily and provided with information on the study, with an explicit guarantee of the confidentiality of their data and personal information. In addition, for the bivariate and multivariate statistical analysis of the data, it was necessary to create a database using SPSS statistical software (version 22).

4 Results

This section presents the participants responses and level of agreement for each item of the three indices as well as an analysis of the questions that presented difficulties with regard to their understanding. Next, the results of the statistical analysis that shows knowledge and attitudes as predictive factors of behaviors favorable to SD are shown.

4.1 Knowledge index

The following tables show the participants' mean scores for each item in descending order. Michalos et al. (2012, p. 219) proposed the following for the analysis of the results:

> Because rank order scores are ordinal numbers, strictly speaking, the mathematical functions of addition and so on are not applicable. So, one might prefer to rank order the support indicated for each sentence by the percentage of respondents strongly agreeing (or disagreeing for negatively worded sentences) or perhaps the total percentage of favorable responses (i.e., percent strongly agreeing plus percent agreeing or disagreeing for negatively worded sentences).

The results in Table 4 show that the item with the greatest level of agreement was item 2, which states that environmental protection is necessary for SD, followed by item 13, which restates the environmental aspect, and item 19, which discusses people's quality of life. The university students showed the lowest level of agreement with items 8 and 9, regarding gender equity and the fight against poverty, respectively.

Concerning the first research question, the average level of knowledge ranged from moderate ($\overline{x} = 3.5$) to high ($\overline{x} = 5$). The overall mean score of the knowledge index was 3.93 points, which indicates a moderate level of participant knowledge regarding SD. The environment was the predominant area of knowledge among the students who participated in the study. Regarding the items that the participants did not understand or did not know (see Appendix 1), the following items stood out on the knowledge index: item 17, regarding knowledge of the United Nations' SDGs; item 16, on the issue of changing natural resources; and item 12, on the conservation of drinking water.

4.2 Attitude index

The findings in Table 5 indicate that the item with the greatest level of agreement was item 2, regarding commitment and responsibility to future generations, followed by item 6, which restates the poverty reduction issue, and item 13, which refers to gender equity. These findings contrast with those presented in Table 4 because the items related to

Table 4 Summary of the mean scores of the knowledge index items, listed in descending order

Items (statements)	*M*	% Strongly agree/disagree	% Strongly agree and agree/ plus negatively worded items	*N* valid entries
5. Human actions are contributing to atmosphere and climate change	4.14	49.3	79.0	337
13. 'Maintaining biodiversity' means maintaining the number and variety of living organisms. This is necessary for SD	4.12	42.9	80.9	329
2. The protection of the environment is necessary for SD	4.08	43.2	83.8	347
6. SD requires that individuals reduce all types of waste	4.07	38.0	80.2	329
19. SD requires that individuals reflect on what it means to improve quality of life	4.07	37.9	80.5	338
7. Good citizenship is necessary for SD	4.06	37.9	78.7	338
12. The conservation of drinking water is necessary for SD	4.04	40.4	75.9	324
16. SD requires a change in the use of renewable resources as much as possible	3.97	34	75.4	324
15. SD requires respect for human rights	3.97	34.4	75.4	334
14. Respect for cultural diversity (variety of cultures) is necessary for SD	3.96	32.2	75.1	329
10. SD requires access to quality education for everyone	3.91	30.9	74.4	340
11. SD demands that companies behave responsibly with employees, clients, and suppliers	3.89	31.9	69.8	335
3. Economic development is necessary for SD	3.89	29.1	75.0	344
1. Improving the opportunities of individuals for a long and healthy life contributes to SD	3.87	28.9	75.2	339
18. SD requires that individuals learn new things throughout their lives	3.84	31.7	69.8	328
17. SD requires the achievement of the Millennium Development Goals of the United Nations	3.81	28.7	66.8	286
20. SD requires that people understand how the economy Works	3.80	27.5	68.3	331
4. A culture of peace where individuals solve conflicts through dialogue is necessary for SD	3.76	29.2	66.7	339
9. Eliminating poverty is necessary for SD	3.73	25.6	64.3	336
8. Gender equity is important for SD	3.66	25.9	62.1	340

Table 5 Summary of the mean scores of the attitudes index items, listed in descending order

Items (statements)	*M*	% Strongly agree/disagree	% Strongly agree and agree/plus negatively worded items	*N* valid entries
13. Men and women should have equal access to all types of education and jobs	4.24	50.7	82.9	345
12. People who pollute the land, air, or water should pay for the damages caused to communities and the environment	4.20	46.5	82.8	342
6. It is important to find ways of reducing poverty	4.18	43.1	84.4	339
1. Everyone should receive an education that includes the necessary knowledge, values, and skills for the sustainable life of a community	4.17	46.6	82.8	348
2. The current generation should ensure that the next generation can live in communities that are at least as healthy as those that exist today	4.17	43.4	84.7	346
15. Tasks at home should be equally shared among the members of the family, regardless of their gender	4.08	42.7	76.0	342
10. Governments should adopt SD as a national priority	4.07	36.0	80.5	339
3. Manufacturers should discourage the use of disposable materials	4.03	41.1	74.5	338
11. Citizens should be well informed and participate actively in democratic processes, such as voting	4.00	34.3	76.2	341
9. The use of fuel-efficient vehicles should be promoted by governments	3.92	35.4	74.9	339
7. SD will not be possible until the richest countries stop the exploitation of workers from the poorest countries	3.66	25.5	62.7	325
14. It is ok to use as much water as desired, as long as it is available.*	3.23	27.7	50.4	343
5. We do not need more strict laws and regulations to protect the environment.*	3.22	24.6	51.6	341
8. Understanding and addressing the problems of climate change is not important.*	3.10	27.4	43.7	343
4. As long as the resources are available, using more than what is needed currently does not threaten the health and wellbeing of future generations.*	2.59	9.9	26.9	335

* = Reverse-scored items

knowledge on these subjects had lower percentages of agreement. Notably, the reverse-scored items (items 14, 5, 8, and 4), all of which were related to natural resource management issues, were those that obtained a lower percentage of agreement among the participants.

Regarding the first research question, the attitude index ranged between 3.5 and 5. The overall average of the attitude index was 3.79 points, indicating that the participants presented a moderate level of attitudes favorable to SD. This figure was slightly lower than the average of the knowledge index. The items that were least understood or most unknown were item 7, concerning the equal distribution of wealth among nations, and item 4, concerning the excessive use of natural resources (see Appendix 2). Notably, both items were negatively worded, which could explain the levels of lack of understanding and comprehension.

4.3 Behavior index

Finally, Table 6 presents the results from the index of behaviors favorable to SD. Item 16, which deals with equity among men, women, and children, showed the highest level of agreement. In contrast, item 8, regarding awareness of damage to the environment, and item 9, which discusses composting, received the least amount of agreement from the participants. This finding suggests that participants do not consider that their daily activities could be damaging the environment; in addition, they show a lack of knowledge on composting organic matter.

Finally, regarding the first research question, the behavior index ranged from a medium ($\bar{x} = 3.5$) to high ($\bar{x} = 5$) level, but the overall average of the behavior index was 3.49 points, which indicates that the participating students showed a low-moderate level of behaviors favorable to SD, making the behavior index the lowest scoring index. Items 9 and 10 concerning composting and the purchase of goods from companies that are involved in labor and environmental controversies, respectively, were the items that were least understood or least certain (see Appendix 3). The participating students again indicated a lack of knowledge of the item on composting, which could be explained by the sociodemographic characteristics of the participants.

4.4 Statistical analysis of the indices of the study

To respond to the second and third research questions regarding knowledge and attitudes significantly explaining SD behavior, a linear regression model was used; the model met the assumptions of linearity, homoscedasticity, independence of error terms (Durbin-Watson, $d = 1.88$), normality of the error distribution and multicollinearity (VIF = 1.57 and tolerance = 0.63) (Field, 2009; Ho, 2014). As part of the statistical analysis, Table 7 shows the correlations obtained between each index. The strongest correlation was between the knowledge and attitude indices (0.60), followed by that between the knowledge and behavior indices (0.40), and finally by that between the behavior and attitude indices (0.36). This finding suggests that knowledge had an increasingly positive relationship with the other indices.

The findings in Table 7 show that a significant relationship existed among the predictor variables and the students' SD behaviors. Nevertheless, in the comparison of the coefficients obtained for each of these variables, knowledge (0.29) had a greater impact than attitudes (0.18) in terms of explaining the SD behaviors of university students in northwestern

Table 6 Summary of the means scores of the behavior index items, listed in descending order

Statements (affirmations)	*M*	% Strongly agree/disagree	% Strongly agree and agree/plus negatively worded items	*N* valid entries
16. I respect men, women, boys, and girls equally	4.28	52.9	84.3	344
4. When I use the computer or the telephone for social media or gaming, I always treat everyone respectfully as I would in person	3.99	35.9	76.1	348
5. I always make life choices that are good for my health	3.83	29.5	68.2	346
14. Generally, I analyze problems from different perspectives	3.77	24.0	66.7	342
15. I have thought a lot about how to live in a sustainable way	3.76	26.8	65.6	343
6. I try to help people who live in poverty	3.70	22.4	62.9	343
7. I pick up trash when I see it in the park or a natural área	3.54	19.5	53.6	343
2. I never waste water	3.53	17.4	53.3	345
1. I choose to walk or bike to places instead of using a motor vehicle	3.48	20.6	51.0	345
3. I recycle as much as I can at home	3.42	17.5	48.0	348
11. I have changed my personal lifestyle to reduce waste	3.37	16.2	45.9	340
10. I try to avoid buying goods from companies with insufficient care for their workers or the environment	3.34	13.5	44.9	318
13. I volunteer with local charity organizations or groups that look after the environment	3.16	16.4	40.7	341
12. I participate in democratic activities concerning student life in my school/university	3.15	12.6	38.7	341
8. I do not think about how I could be damaging the environment.*	2.85	12.8	31.8	343
9. Even when I have the option, I do not always compost.*	2.73	8.6	23.5	302

* = Reverse-scored items

Table 7 Descriptors and correlations between the three indices ($n = 350$)

Indices	*M*	*SD*	Attitudes	Behaviors
Knowledge	3.93	0.7203	.604***	.406***
Attitudes	3.79	0.5795	–	.361***
Behaviors	3.51	0.5629		–

***$p < .001$ (linear)

Table 8 Regression analysis of knowledge and attitudes on sustainable behaviors

N	350
% of explained variance	18.1
Predictors	Betas
Knowledge	.296***
Attitudes	.183**

**$p < .01$. ***$p < .001$

Mexico. The percentage of total variance explained according to the model was 18%, with acceptable significance levels (see Table 8).

5 Discussion

According to the scale based on the overall average of the indices, the empirical evidence suggests that the participants showed a moderate level of knowledge ($\bar{x} = 3.93$) and attitudes ($\bar{x} = 3.79$) concerning SD. However, the average of the index of sustainable behaviors of university students in northwestern Mexico was low-moderate ($\bar{x} = 3.49$). The findings of this study indicate that the participants demonstrated a higher level of knowledge regarding the environmental components of SD (Zeegers & Clark, 2014) than the social aspects, such as poverty and gender equity, or even the SDGs of the United Nations. Regarding positive behaviors, the highest scoring were equal labor opportunities and access to education, compensation for damages to communities and the environment, and poverty reduction. In addition, the index of behaviors favorable to SD had higher values for equity among men, women, and children. Nevertheless, interestingly, the issues that were the least valued by the university students were the behaviors related to volunteer work and participation in democratic activities within the university.

This study's findings suggest that EE is maintained and promoted in Mexico through subjects such as ecology and environmental studies. Practically, this promotion could be reflected by indicators such as PET plastic recycling in the country. According to data from the environmental nongovernmental organization ECOCE (www.ecoce.mx), Mexico is a world leader in recycling this material (ECOCE A.C. 2018). To maintain this trend and results, it is necessary for IHEs in Mexico to continue to offer comprehensive courses on SD to help students become equally involved with the environmental, social, and economic aspects of SD from both international and local perspectives. Similarly, it is important that universities promote SD by incorporating ESD into curricular requirements and extracurricular activities. According to Michalos et al. (2015), the continuous promotion of SD is essential to generate sustainable behaviors in students.

In the comparison of the results of this study with those of Michalos et al. (2012, 2015), several similarities and differences can be observed (see Table 9). For example, the knowledge index showed that environmental issues were the most valued by the participants of both studies. Likewise, the item concerning the United Nations' Millennium Development Goals was one of the least understood or most unknown in all the studies.

Ajzen et al. (2011) mention that there must be a distinction between knowledge regarding a topic and the quantity of information. It is possible that the information provided on SD to university students in the classroom could be repeated in multiple courses, impacting knowledge index values. Notably, despite the cultural and contextual differences between Mexico and Canada, the results of this study are comparable to those obtained in reference studies (Michalos et al., 2012, 2015), which may be explained by the fact that both country's governments prioritize ESD in their public policies (Council of Ministers of Education, 1997; Secretaría de Medio Ambiente y Recursos Naturales, 2006). Regarding the index correlations, the strongest correlation in previous studies was between knowledge and attitudes, followed by knowledge and behaviors. Despite the correlation levels ($r = 0.35$–0.66) and the explained variance ($R^2 = 0.18$–0.25) in both studies, the results suggest that knowledge is significant and has value as a predictive variable in student behavior.

Considering the second research question, the results of this study show that attitudes ($\beta = 0.183$) significantly explained SD behaviors. These findings suggest that the TPB may help explain SD behaviors among Mexican university students (Gusti, 2016; Oreg & Katz-Gerro, 2006). Concerning the third research question, the findings indicate that knowledge ($\beta = 0.296$) explains favorable behaviors to a greater degree than attitudes, in contrast to the study carried out by Ajzen et al. (2011), which found that attitudes had greater explanatory power than behavior. Notably, the current study had the following limitations: the study used a nonprobability convenience sample, so caution is required when generalizing from the results; furthermore, it is necessary to highlight the lack of information and available studies on ESD in Mexico.

6 Policy and managerial implications

Regarding the main policy and managerial implications based on the present study results, first, as the world's businesses move toward more sustainable practices, it is imperative that universities and business schools embed multidisciplinary sustainability topics, equally addressing environmental, social, and economic dimensions, in the professional formation of students. Thus, governments, via education ministries, should include sustainability issues in all career curricula so that students are sensitized on these topics and consider the triple bottom line implications of their decisions once they are practitioners. Second, universities should emphasize that SD involves much more than just recycling solid waste or being more socially inclusive, which is a common misconception in young learners. SD involves various topics, such as the direct and indirect economic impacts of business operations, the ethical implications of managers' decisions, the anti-corruption practices and corporate governance policies of organizations, and the sustainable management of supply chain associates. Therefore, it is advised that IHEs address the aforementioned topics in multiple business administration subjects so that students can grasp management concepts through an integral SD approach. Last, the results show that some elements of SD were not clearly understood at the university level, so governments should maintain their efforts to strengthen ESD at previous educational levels.

Table 9 Results of Michalos et al. (2012, 2015) in Manitoba, Canada vs. results obtained in Mexico

	Michalos et al. (2012)/results from this study	Michalos et al. (2015)/results from this study
Knowledge	*Items* Items 2, 5, and 13, concerning the environment, were the highest valued in both studies. On the other hand, item 8 (negatively worded), concerning gender equity, was the lowest rated *Problematic questions* Item 17, which discusses the United Nations Millennium Development Goals, was the least understood and least known in both studies	*Items* Item 2, concerning the protection of the environment, and item 5, which discussed harm to the environment, were the highest rated in both studies. On the other hand, item 20, on understanding the economy, was the lowest rated *Problematic questions* Item 17, regarding the United Nations Millennium Development Goals, was the least understood and most unknown
Attitudes	*Items* The highest-valued items were item 1, which refers to ESD; item 2, which discusses the safeguarding of resources for future generations; and item 6, on the issue of poverty. On the other hand, item 5, on the protection of the environment, and item 7, about the exploitation of workers in the poorest countries, were the lowest rated *Problematic questions* The most unknown item in both studies was item 7, which concerns the exploitation of workers in the poorest countries	*Items* The highest-rated items in both studies were item 13, concerning gender equity in education and employment; item 6, which discusses poverty reduction; item 1, regarding ESD; and item 2, on safeguarding for future generations. The lowest-scored items were item 4, on the excessive use of resources; item 8, concerning climate change; item 5, which discusses the need for laws and regulations; and item 14, regarding the excessive use of water *Problematic questions* The most unknown items were item 7, concerning the exploitation of workers in the poorest countries, and item 3, which discusses the reduction in disposables
Behaviors	*Items* Item 16, on gender equity, and item 14, describing the analysis of problems from different perspectives, were the highest rated. On the other hand, item 9, which concerns composting, and 13, on the participation in democratic activities, were the lowest scored *Problematic questions* Item 9, on composting, and item 10, which discusses purchasing products from socially irresponsible companies, were the least understood and known	*Items* The highest valued items were item 16, on gender equality; item 4, which discusses respecting others; and item 14, on analyzing problems from different perspectives. On the other hand, the least favored items were items 9, concerning composting, and 13, on volunteering *Problematic questions* The most unknown item was number 10, which discusses purchasing goods from irresponsible companies. On the other hand, the least understood items were item 9, concerning composting; item 12, describing participation in the democratic activities of the university; and item 10, regarding purchasing from irresponsible companies

7 Conclusion

This study contributes to knowledge on SD and suggests the greater promotion and inclusion of this subject within academic curricula and extracurricular activities at the university level because it appears that knowledge has the strongest impact on individuals' behavior. The study confirms the importance that students attribute to issues related to the environment, equal respect, and gender equity in labor and education opportunities.

A suggestion for future research is to evaluate the SD knowledge, attitudes, and behaviors of students pursuing different academic degrees and/or study at educational levels in Mexico to obtain different and more accurate perspectives of each of these indices. Furthermore, it is recommended that different regions of the country be studied with greater sample sizes since SD is context specific.

The information provided by this study will hopefully be used by individuals to develop greater awareness and behaviors that are favorable to SD. It appears that in Mexico, there is still a lack of knowledge regarding various international SD initiatives. It is important that IHEs promote and include these initiatives as part of professional training. It is expected that SD will become more relevant and be studied to a greater extent in the future, which could enable greater development and better quality of life for each individual in Mexico and the world through comprehensive education that includes ESD.

Appendix 1

See Table 10.

Table 10 Summary of the problems presented in the knowledge index

Level of agreement rank	Item number	Don't Know (%)	Item number	Don't understand (%)
1	17	14.0	17	4.3
2	16	6.6	14	1.7
3	12	6.0	15	1.7
4	6	5.4	12	1.4
5	18	5.1	10	1.1
6	20	5.1	13	1.1
7	13	4.9	18	1.1
8	14	4.3	19	1.1
9	9	3.7	1	0.9
10	11	3.7	16	0.9
11	5	3.4	6	0.6
12	7	3.1	8	0.6
13	4	2.9	11	0.6
14	15	2.9	2	0.3
15	1	2.3	3	0.3
16	8	2.3	4	0.3
17	19	2.3	5	0.3
18	10	1.7	7	0.3
19	3	1.4	9	0.3
20	2	0.6	20	0.3

Appendix 2

See Table 11.

Table 11 Summary of the problems presented in the index of favorable attitudes toward SD

Level of agreement rank	Item number	Don't Know (%)	Item number	Don't understand (%)
1	7	6.9	8	0.9
2	4	3.7	9	0.9
3	3	2.9	14	0.9
4	6	2.9	15	0.9
5	10	2.6	2	0.6
6	9	2.3	3	0.6
7	11	2.3	4	0.6
8	5	2.0	5	0.6
9	12	2.0	10	0.6
10	15	1.4	13	0.6
11	8	1.1	1	0.3
12	14	1.1	6	0.3
13	13	0.9	7	0.3
14	2	0.6	11	0.3
15	1	0.3	12	0.3

Appendix 3

See Table 12.

Table 12 Summary of the problems presented in the index of favorable behaviors toward SD

Level of agreement rank	Item number	Don't Know (%)	Item number	Don't understand (%)
1	10	6.0	9	8.0
2	9	5.7	10	3.1
3	11	2.3	12	0.9
4	14	2.0	13	0.9
5	12	1.7	1	0.6
6	13	1.7	2	0.6
7	16	1.7	6	0.6
8	7	1.4	7	0.6
9	6	1.4	8	0.6
10	15	1.4	11	0.6
11	5	1.1	15	0.6
12	8	1.1	14	0.3
13	1	0.9	3	0.0
14	2	0.9	4	0.0
15	3	0.6	5	0.0
16	4	0.6	16	0.0

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