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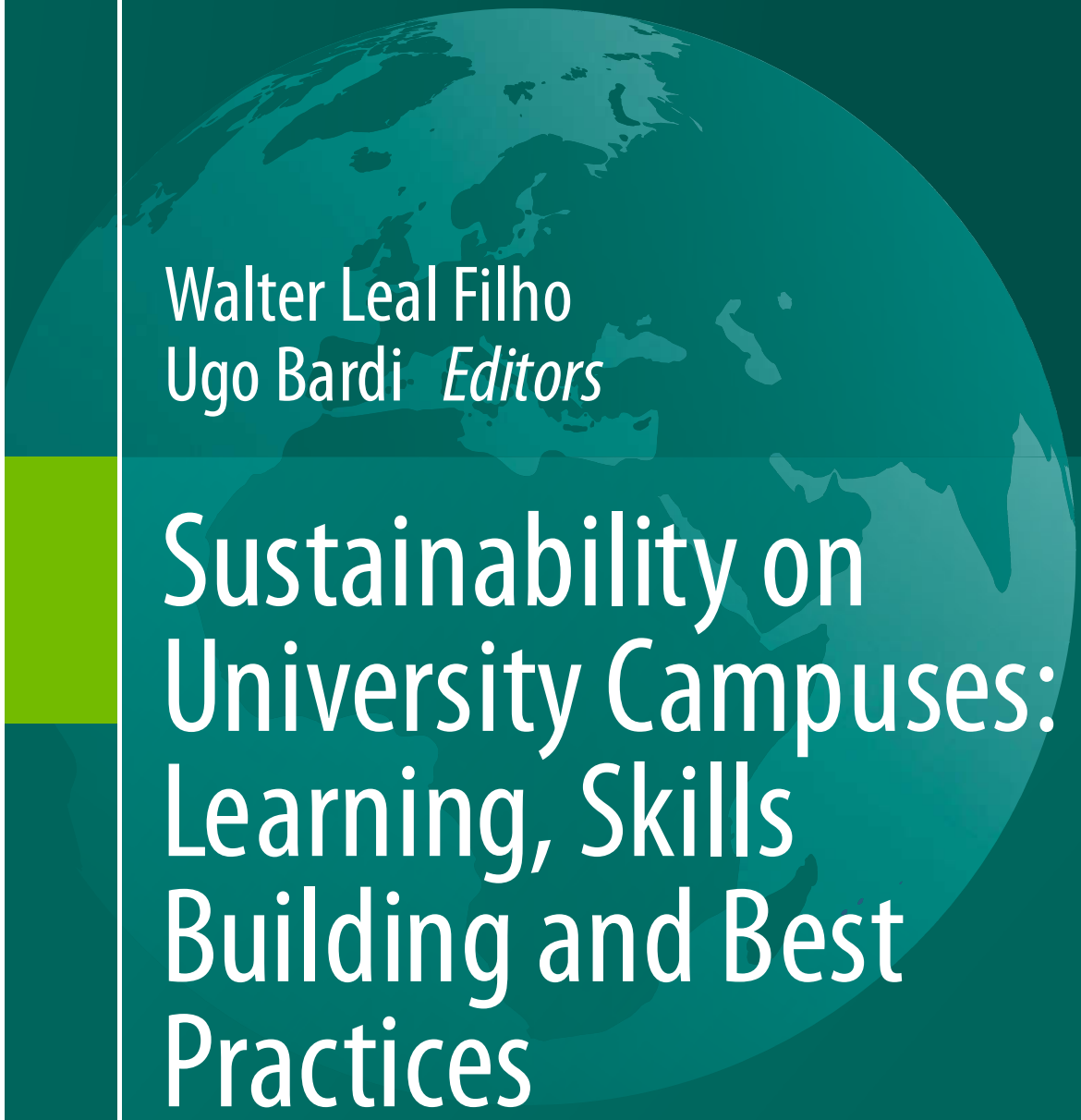

Walter Leal Filho
Ugo Bardi *Editors*

Sustainability on University Campuses: Learning, Skills Building and Best Practices

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Sustainable Universities: A Comparison of the Ecological Footprint, Happiness and Academic Performance Among Students of Different Courses

M. J. Alves-Pinto Jr. and B. F. Giannetti

Abstract Universities are environments of significant influence in people's lives, where students are trained for training and become the future leaders of society. In this sense, this work develops a way of evaluating the sustainability of university students, comparing them in different courses. The sustainability assessment is based on the input-state-output framework for systems, using three different indicators: the ecological footprint, happiness and academic performance. The ecological footprint is measured by the consumption of meat, fish, vegetables, fruits, milk and dairy products, paper, electricity, mobility and built area. Happiness has its own questionnaire, drawn from others already consolidated by the literature such as the Gallup World Poll, Gross National Happiness Index Survey-Happiness Alliance and Santa Monica Wellbeing Survey. Academic performance is assessed by the average grade of students. The three indicators are represented in a cube, graphically presenting the result of the sustainability assessment. Within the cube are presented eight ways of expressing the students' sustainability, characterizing their course. This tool can facilitate decision making by university managers.

Keywords Sustainable universities · Ecological footprint · Happiness · Academic performance

1 Introduction

Chapter 36 of Agenda 21 (UN 1993) outlined an action plan on Education and Sustainable Development—ESD. However, progress towards ESD has been very slow, and the United Nations has declared the years between 2005 and 2014, such

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as the United Nations Decade for Education and Sustainable Development (UN 2002). Education can and should contribute to a new vision of sustainable global development (Unesco 2015).

Recently, the UN launched a publication for learning objectives for sustainable development goals, aiming at the application of local and national educational policies (Unesco 2017). One concept that can contribute to achieving the goals of sustainable development is that of a sustainable university. A sustainable university seeks academic excellence, as well as incorporate humanistic values into people's lives, promote and implement sustainability practices. In this way, a sustainable university can promote the minimization of negative effects within society, economy and the environment. Students' lifestyles, for example, can contribute to a sustainable transition (Velásquez et al. 2006), as well as transforming a more just society, spreading more sustainable practices (Nejati and Nejati 2013).

A sustainable university must address, involve and promote the minimization of adverse effects to environmental, economic, social and health impacts to its main functions, thus contributing to a society in transition to sustainable lifestyles (Velásquez et al. 2006).

In this paper, we present a review of the literature on the development of sustainable universities (Turan et al. 2016), perspectives and perceptions within the university (Sylvestre et al. 2014). As the main function of a university is to train its students to disseminate knowledge within society, the focus of university sustainability could be better directed at students. It was not evidenced in the literature, a way of evaluating students' sustainability in the context of a sustainable university. Human systems need ecosystem resources for their maintenance and promotion of services, such as culture, government and the economy. These services can generate an individual or social well-being for the population's lifestyle.

In this way, assessing the sustainability of university students can contribute to a more sustainable university, bringing benefits to society, economy and the environment. Environmental management initiatives in an academic community are fundamental to reduce the demands of energy and materials, contributing to decision making by its managers (Almeida et al. 2013).

This research aims to evaluate the sustainability of students, considering aspects of ecological footprint, happiness and academic performance. The evaluation of the students' sustainability can contribute to the better decision-making of university managers in their services provided.

2 Ecological Footprint

The ecological footprint is a measure of the burden imposed by a given population on nature. It represents the surface area of the Earth that is needed to sustain levels of resource consumption and waste discharge by this population (Wackernagel and Rees 1994; Wackernagel et al. 2002; Herva et al. 2008). Pereira et al. (2016) define

Table 1 Areas of biocapacity and their ideal use (Global Footprint Network 2016b)

Area	Utilization
Forests	Area of forests needed to provide wood and wood products and other non-wood products
Carbon	Area that we should reserve for the absorption of CO_2 that is released in excess
Crops	Area of agricultural land needed to meet the food needs of the population
Grazing	Area needed to raise cattle under certain conditions
Infrastructure	Required area for building construction
Fish	Area for fishing as a form of food need

how much land and water would be needed to sustain current generations, taking into account all the resources, materials and energy employed by a given population.

Two measures are required for calculation, ecological footprint and biocapacity, both expressed in global hectares (gha), hectares of land or water standardized to have the average world production of all organic productive land and water in a given period (Wackernagel and Rees 1994). The ecological footprint as a demand that humans place on bioproductive areas and biocapacity, the availability of nature to provide ecosystem sources and services that are consumed annually by humans (Monfreda et al. 2004).

The biocapacity supply represents the planet's biologically productive land areas (Global Footprint Network 2016a), presented in Table 1.

The ecological footprint indicator provides data with which students can make responsible decisions and can set goals to reduce their impact on the biosphere with their lifestyle (Monfreda et al. 2004).

Several studies relate the ecological footprint to happiness or well-being (Jess 2010; Sikka et al. 2013; Jorgenson and Dietz 2015; Knight and Rosa 2011; Dietz et al. 2009; Rice 2008). Happiness is dealt with in the next section.

3 Happiness

The concept of happiness is used in a variety of ways, which can mean general positive humor, an overall assessment of life satisfaction, living a good life, or the causes that make people happy (Diener 2006). Some concepts that can be related in the literature are well-being, quality of life, flowering and contentment (Graham and Nikolova 2015).

One country that has developed a concept of happiness with society is Bhutan, with Gross National Happiness (GNH). For the country, its Happiness Index, managed by the Bhutan Studies Center, is a coherent way to develop the economy. In this way, the proposed ideals of the index to the country attracted political interests from various

countries and communities but was also refined by scientific studies incorporated in a variety of contexts. For the calculation of GNH, as a unique number, the methodology of Alkire and Foster (2007, 2011) was used, a robust multidimensional method.

Another index of happiness is the Gross National Happiness Index Survey-Happiness Alliance, which is directly inspired by GNH and was first published as the fifth set of Sustainable Seattle Sustainability Indicators in 2010 for use by communities, cities, campuses, and businesses around the world. The world. In 2012, we started from Seattle Sustainable and emerged as people and non-profit groups, from communes to teams, with tools and resources, including the Gross National Happiness Index.

Gallup Word Pull is an index widely used by many scientific organizations and communities. It researches with representation in more than 160 countries and more than 140 languages (Gallup 2016). This measure of happiness is chosen for the experiment of this work through its extensive application in large projects and for being a well-developed measure.

The Santa Monica Wellbeing Index is another way to measure people's happiness or well-being. This idea was the result of participation in the Bloomberg Philanthropies' Mayors Challenge in 2013, where he was champion. The main purpose of the index is to obtain information about the well-being of people dynamically, providing solutions by decision-makers within the governmental sphere. Also, this can be replicable to other communities.

Six dimensions make up the Santa Monica Wellbeing Index, defined through research and relevance to the local community: community, local, learning, health, opportunity, and perspectives.

Applasamy et al. (2014) argue that happy teachers alone would not constitute an ideal learning environment, necessitating students as well. Students who are happy are more willing to participate and perform difficult tasks, thinking deeply about problems and developing new solutions such as happiness, an important emotional approach to learning. Graham (2009) and De Neve and Oswald (2012) complement that happy people can be healthier and more productive.

In this context, research on the measurement of general happiness in an educational institution is an important component of school management (Applasamy et al. 2014).

O'Brien (2005) promotes a concept of "sustainable happiness", merging principles of sustainability with results of studies of happiness. The author defines sustainable happiness as a concept that can be used by individuals, communities, and nations to guide their actions and decisions daily. Actions that should genuinely consider social, environmental, and economic indicators so that group happiness is sustainable (O'Brien 2005).

4 Academic Performance

The world economy is driven to increase the new levels of productivity through technological and organizational advancement; is still relentlessly destructive of the natural environment (Helliwell et al. 2012). Every approach that is uniquely produc-

tive does not consider the destruction of the environment and the happiness of the people who participate.

Jenny Martin, a professor at the University of Queensland in Brisbane, Australia, criticizes the way universities are currently assessed, often imposing performance metrics on research and academic impact, not measuring happiness in any way (Woolston 2016).

For example, Times Higher Education evaluates universities around the world through its students, and ranks them by providing a ranking, where for 2015 and 2016 five areas were used to propose performance indicators (Times Higher Education 2016); being: teaching, research, citations, perspective and work.

5 Method

For sustainability assessment, it is important to consider the life of the system, the essential physical inputs from the environment, the current state capacity properties, and the results that can be generated. An evaluation framework that has this systemic characterization, where the components interact, is the Input-State-Output model (Pulselli et al. 2011, 2015; Coscieme et al. 2013, 2014). This model can be used to describe ecosystems in a socio-ecological context (Pulselli et al. 2011).

For this work, the Input-State-Output model is used to evaluate student sustainability, represented in Fig. 1. For each component of the model, an indicator related to the system is assigned. The input was considered the ecological footprint, the happiness state and the output its academic performance with the average grade of the student in the course.

Data were collected through questionnaires. Own questionnaires were developed to evaluate the three indicators chosen. The ecological footprint questionnaire has 11 questions, evaluating the six areas of the methodology of Wackernagel and Rees (1994), Monfreda et al. (2004). The questionnaire on happiness was elaborated based on other questionnaires recognized for this type of evaluation, being Gallup World Poll, Gross National Happiness Index Survey-Happiness Alliance and Santa Monica Wellbeing Survey. The questions that were related to the researched public and their environment were extracted from these three questionnaires. Once these questions were identified in the questionnaires, direct questions were asked to the surveyed public, in the case of students. The questionnaire to identify academic performance is asked by a question, "On a scale from 0 (zero) to 10 (ten), what number represents your average grade in the general course?" This question and others to evaluate

Fig. 1 Input-State-Output student sustainability assessment model

research variables, such as age, gender and if students work, were collected through a paper. The complete unified questionnaire is presented in Appendix 1.

A case study was conducted at a school in April 2018 to apply the evaluation. The estimated time between data collection and analysis was about one month. This school is located in the interior of São Paulo, Brazil. It has a population of seven hundred students, where two hundred and ninety-nine students were randomly assigned to the sample, about 43% of the population.

The questions of the ecological footprint and happiness were collected through the ZipGrade mobile application. Students have received templates to answer questions that are projected in a table by data show. These cards are standardized and made available on the application provider's website. With the data collected, a spreadsheet was prepared in Microsoft Excel for data processing. ZipGrade has a web platform that imports the answers collected by the cell phone in real time if connected to the internet. In the platform, it is possible to export the answers in CSV mode worksheet, which manually suits the spreadsheet already elaborated in XLS mode.

The ecological footprint that will represent the input in the model is the fraction of the average of the ecological footprint in gha (global hectare) by the biocapacity of a person. This quotient will have unity of planets needed to supply a lifestyle.

The method used to analyze the happiness data is Alkire and Foster (2007, 2011). The algebra of the Alkire and Foster method (2007, 2011) for the Happiness Index that will represent the state is:

$$\mathrm{HI} = 1 - (\mathrm{A} \times \mathrm{N}), \quad \text{thus :}$$

HI Happiness Index
A is the intensity of the still not happy. It is the fraction of average dissatisfaction for each person not yet happy;
N is the intensity of people not yet happy. A fraction of the variables still not met by the total of existing variables, considering only people not yet happy.

For academic performance, it is represented by the average grade of each student in the course. The average of these grades will represent the output of the model for the group of students in the respective course.

With the result of the ecological footprint, happiness and academic performance of each student, it is possible to represent them graphically in a cube, facilitating the interpretation of the results. It is possible that there are eight types of scenarios that students can characterize, taking into account their results and goals for each indicator. These scenarios are presented in Appendix 2. For each scenario it is presented where the dispersion would be represented in the cube. Also, to detail the service of each indicator, it is represented by green or red traffic light if the indicator is within the goals. If green, the result meets the goal if red is out of the scope of the indicator. It is the red aspects that the decision maker will need to take action.

Also in Appendix 2, the utopian scenario would be the "D", where all indicators are within the goals. This would be the most sustainable scenario. The dystopia would be the "G" scenario, where the three indicators are red, out of meeting the goals. This would be the least sustainable scenario.

6 Results

With some questions of the questionnaire, it was possible to know some aspects of the students, presented in Figs. 2, 3 and 4.

Among these aspects of the students interviewed, there is little gender difference. Twenty-three students of the masculine gender surpassed the number of female students. Expressive is the number of students who are not working among students. Of the total interviewed, seventy-seven students answered that they are working.

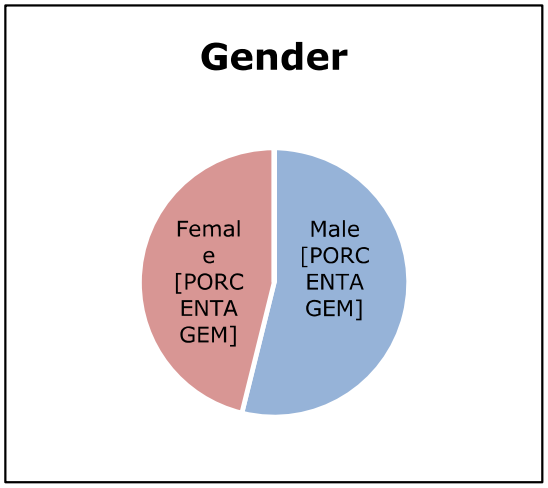

Fig. 2 Distribution of students by gender

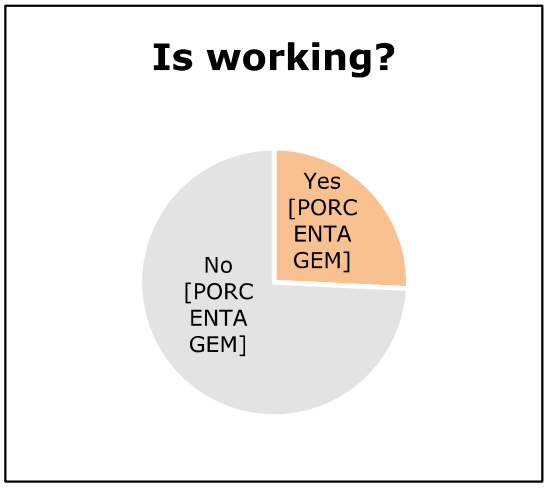

Fig. 3 Distribution of students if they work

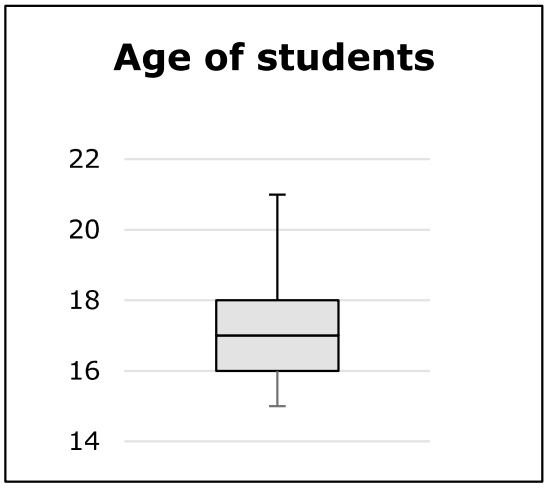

Fig. 4 Boxplot of the students' age

There is also, a significant distance from the age of students, ranging from fifteen to twenty-one years. The median age of the students is seventeen years, close to their average.

The ecological footprint is calculated on planets, with biocapacity being one planet. In this case, the goal for the students is to have an indicator of ecological footprint up to 1 planet. The Happiness Index should be higher than 0.78, considering the happy group. And, academic performance has an indicator goal that is greater than 0.75, that is, a fraction of student scores greater than seven by the number of students should exceed this expectation.

Table 2 presents the indicators for each course evaluated and also evaluated in a general way. When observed in general, only academic performance is below the target, classifying the group in general as "ineffective". However, when observed on a smaller scale, the Happiness Index is below the desired level in some courses, such as accounting, environment and informatics. For the ecological footprint indicator, all courses are within the biocapacity.

Table 2 Results indicators ecological footprint (planets), happiness and performance for the courses

Course	Ecological footprint	Happiness	Academic performance	Classification
Administration	0.79	0.89	0.71	Ineffective
Logistics	0.88	0.93	0.8	Sustainable
Accounting	0.79	0.75	0.61	Unfocused
Environment	0.91	0.78	0.56	Unfocused
Informatics	0.86	0.75	0.73	Unfocused
Agricultural	0.93	0.81	0.63	Ineffective
General	0.87	0.81	0.67	Ineffective

In this educational institution, for the evaluated courses, three clusters of different students were identified. There is a course classified as "sustainable", considered a utopian group within the indicators evaluated, three courses classified as "ineffective", with the academic performance indicator below the target, and three courses classified as "unfocused", with indicators of happiness and academic performance below the target. The institution for better decision making should analyze all indicators below the target, but the "unfocused" group should be prioritized due to two unmet metrics.

This is only a form of group prioritization for problem-solving because as one indicator can be improved, another group also has the same indicator below the goal together. Table 3 presents the dimensions and variables of the indicator of happiness for accounting, environmental and informatics courses since it is the courses that did not achieve sufficiency of the indicator.

For the well-being dimension only the accounting course has reached the goal, community dimension no course reached the goal, and only perspective environment reached the goal. In the three dimensions for the courses with low happiness rate present problems, however, it may be that for each course specific problems happen.

For the variables, we highlight recreational activity, social support, volunteerism and desire for continuity, since for the three courses they did not achieve sufficiency. These variables require prioritization due to their comprehensiveness in courses.

Correction actions can be treated by the institution in a specific or comprehensive manner, depending on the causes detected.

Table 3 Dimensions and variables of courses with non-sufficiency of the happiness index

		Accounting	Environment	Informatics
Dimensions	1. Well-being	0.80	0.75	0.66
	2. Community	0.70	0.55	0.66
	3. Perspective	0.61	0.85	0.74
Variables	1. Life satisfaction	0.83	0.76	0.63
	1. Safety	0.94	0.84	0.73
	1. Recreational activity	0.61	0.65	0.63
	2. Social support	0.67	0.60	0.69
	2. Relationship	0.78	0.69	0.90
	2. Volunteering	0.67	0.35	0.39
	3. Desire for continuity	0.44	0.65	0.53
	3. Future professional	0.67	0.98	0.96
	3. Future vision	0.72	0.91	0.74

7 Conclusions

This paper proposes an Input-State-Output model to evaluate the sustainability of students in different courses. The indicators that represented the model were the ecological footprint, happiness and average grade of the student in the course. In addition, this work offers a questionnaire for the evaluated system, where the most appropriate questionnaires for this evaluation were not evidenced in the literature.

The ZipGrade application is a practical way of collecting data. It contributes to a quick collection and output of the results and can interact with other interfaces. In the case of this work, it could easily interact with Microsoft Excel.

For the case studied, students in general of the courses are classified as "ineffective", presenting ecological footprint within the biocapacity, are happy and with low academic performance. When analyzed by courses, happiness in some courses presents indicators below expectations, such as accounting, environment and information technology. In this way, analyzing students' sustainability in a more specific way is necessary, since student groups can be worked for better university sustainability.

This research was limited to the case study evaluated to the method used. A case study was conducted at a school. The Input-State-Output model also has its limitations, such as the use of three indicators to evaluate the system.

Future research may evaluate students of different characteristics, make decisions about specific courses or even the institution as a whole. The student is placed in a context. Depending on the breadth of evaluation, it is possible to classify the students' sustainability through the evaluated system.

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Appendix 1—Questionnaire

1. How would you rate your happiness level now?

    a. Not yet happy
    b. Somehow happy
    c. Happy
    d. Very happy

2. Is your physical integrity protected within the academic community?

    a. No
    b. A little

c. Yes
d. Much

3. Does your school offer recreational and cultural activities?

a. No, it doesn't
b. Offers few options
c. Offers and I think it is enough
d. It offers a lot of options

4. How often do you feel lonely in school?

a. Always
b. Most of the time
c. Sometimes/Rarely
d. Never

5. How would you rate your relationship with colleagues and teachers?

a. Unsatisfactory
b. Regular
c. Good
d. Great

6. Does your school offer volunteer activities?

a. No, it doesn't
b. Offers little
c. Offers
d. It offers a lot

7. Do you intend to continue being a student of the course?

a. No, I don't
b. I intend, but I would make many changes
c. I intend to make few changes
d. I intend without changes

8. What is your expectation of professional success taking into consideration your school learning?

a. No positive expectation
b. Low expectation
c. Normal expectation
d. High expectation

9. Does the course allow the formation of forward-looking leaders of a more developed and sustainable world?

a. No, it doesn't
b. Poorly
c. Yes, it allows
d. Yes, very much

10. How often do you eat meat during the week?

a. I do not eat meat
b. Rarely (one serving per week)
c. Occasionally (four or more servings per week)
d. Often (two or more servings per day)

11. How often do you eat fish during the week?

a. I do not eat fish
b. Rarely (one serving per week)
c. Occasionally (four or more servings per week)
d. Often (two or more servings per day)

12. How often do you eat vegetables during the week? (vegetables and greens)

a. I do not eat vegetables
b. Rarely (one serving per week)
c. Occasionally (four or more servings per week)
d. Often (two or more servings per day)

13. How often do you eat fruits during the week?

a. I do not eat fruits
b. Rarely (one serving per week)
c. Occasionally (four or more servings per week)
d. Often (two or more servings per day)

14. How often do you have dairy products during the week?

a. Never
b. Rarely (one serving per week)
c. Occasionally (four or more servings per week)
d. Often (two or more servings per day)

15. Which means of transportation do you use the most on your way to school?

a. Car
b. Motorcycle
c. Public transportation
d. I do not use motorized means of transportation to come to school

16. How far is your university from your place?

    a. Up to 15 km
    b. 15 to 45 km
    c. More than 45 km
    d. I live inside the university

17. What is your paper consumption during the week? Consider any type of paper you use for writing or printing.

    a. Up to 20 sheets of paper
    b. 21 to 50 sheets of paper
    c. 51 to 100 sheets of paper
    d. More than 100 sheets of paper

18. What is the area of your home?

    a. Small—up to 100 m^2
    b. Average—101–200 m^2
    c. Large—201–400 m^2
    d. Very large—more than 401 m^2

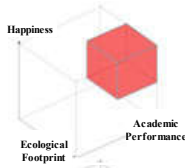
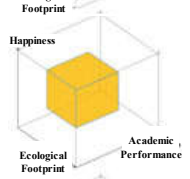
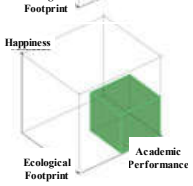
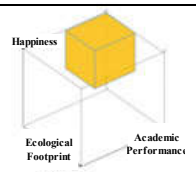
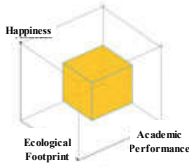
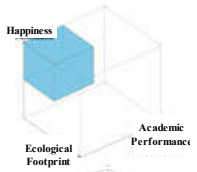
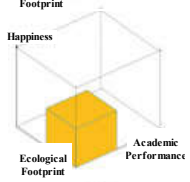
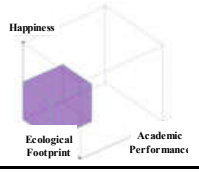
19. How many people live in your home—including you?

    a. 1 person
    b. 2 persons
    c. 3 persons
    d. More than 3 people

20. How would you rate your electricity consumption?

    a. Low
    b. Medium
    c. Normal
    d. High

Appendix 2—Representation and Graphic Interpretation of Results

Scenarios	Graphic Representation	Input: Ecological Footprint	State: Happiness	Output: Academic Performance	Classification
A					Individualist
B					Focused
C					Quase artificial
D					Sustainable
E					Disconnected
F					Ineffective
G					Inhospitable
H					Unfocused

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