A quantitative assessment model for students' sustainability: evidence from a Peruvian university

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Abstract

Purpose – The study of sustainability within universities is recognized as essential for debates and research; in the long term, the "sustainable university" concepts can contribute to sustainability from a larger perspective. This study aims to propose a conceptual model for evaluating the students' sustainability considering their interactions with the university and the environment. The proposed model is titled Sunshine model. It is applied to students of the La Salle University, Peru.

Design/methodology/approach – The model combines academic performance, happiness and the ecological footprint to quantify university students' sustainability. A structured questionnaire survey was elaborated and applied to get the raw data that feeds the three methods. The students' average grades evaluate academic performance. Happiness is quantified by the happiness index method, and the ecological footprint is measured by the demand for food, paper, electricity, transport and built-up areas. Results are evaluated under both approaches, overall group performance and clusters.

Findings – The proposed model avoids misleading interpretations of a single indicator or discussions on sustainability that lack a conceptual model, bringing robustness in assessing students' sustainability in universities. To have a low ecological footprint, the student needs to need up to 1 planet for their lifestyle, be considered happy with at least 0.8 (of 1) for happiness index, and have good academic performance with at least a grade of 7 (of 10) in their course. Regarding the case study, La Salle students show a high academic

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grade degree of 7, a high level for happiness index of 0.8 and low performance for ecological footprint by demanding 1.8 Earth planets, resulting in an "environmentally distracted" overall classification for students with 2019 data. From a cluster approach, 81% of evaluated students ($n = 603$) have low performance for ecological footprint, whereas 31% have low performance for indicators of recreational activities of happiness. Changing lifestyles and making more recreational activities available play crucial roles in achieving higher sustainability for the La Salle students.

Research limitations/implications – The happiness assessment questionnaire can be subject to criticism, as it was created as a specific method for this type of audience based on existing questionnaires in the literature. Although it can be seen as an important approach for diagnoses, the proposed model does not consider the cause–effect aspect. The decision-maker must consider the sociocultural aspects before implementing plan actions.

Practical implications – University managers can better understand why university students have high or low sustainability performance and provide more effective actions toward higher levels of students' sustainability.

Originality/value – The proposed model, Sunshine model, overcomes the single-criteria existing tools that access the sustainability of universities. Rather than focusing on university infrastructure, the proposed model focuses on the students and their relationship with the university.

Keywords Academic performance, Ecological footprint, Happiness, Sunshine model, Sustainable university

Paper type Research paper

1. Introduction

Universities are undeniably the cradle of social changes and the appropriate place for research and debate to initiate long-term changes. Recognizing this central role of universities, Chapter 36 of Agenda 21 outlined an action plan on Education and Sustainable Development (UN, 1993). The UN announced the years 2005–2014 as the United Nations Decade for Education and Sustainable Development (UN, 2002), declaring that education can contribute to a new vision of sustainable global development (UNESCO, 2015).

In 2017, the UN launched learning targets for the Sustainable Development Goals, aiming at the improvement of local and national educational policies (UNESCO, 2017), regarding the initiatives to promote sustainable development in education, following the 2030 Agenda, in which SDG 4 intends to promote education for sustainable development and global citizenship. Objective 4.7 directs specifically to ensure that students all over the world acquire knowledge and skills to support sustainable development through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of peace and nonviolence, valuing cultural diversity and the contribution of culture to sustainable development (UN, 2015). Indicator 4.7.1 proposes important features to consider when assessing the progress of Objective 4.7, such as measures of the extent to which education for global citizenship is performed and the degree to which education for sustainable development is integrated into national education policies; curriculum; teacher training; and student assessment (UN, 2017).

A concept that can contribute to achieving this goal and measuring Indicator 4.7.1 is the Sustainable University. A sustainable university seeks academic excellence and incorporates humanistic values into people's lives, promoting and implementing sustainability practices. A sustainable university can minimize adverse effects on society, the economy and the environment by guiding the students' lifestyles toward a sustainable transition (Velazquez *et al.*, 2006) and spreading more sustainable practices (Nejati and Nejati, 2013).

The literature on Sustainable University concepts mainly focuses on three different approaches: the institution's infrastructure (Almeida *et al.*, 2013; Oliveira *et al.*, 2018), the didactic–pedagogical system and the design of a sustainable curriculum (Lukman and Glavič, 2007; Van Weenen, 2000) focused on the students (Alves-Pinto and Giannetti, 2019; Giannetti *et al.*, 2021b). Regarding universities' infrastructure, several studies are focusing on their management operation systems, aiming to reduce the environmental impact of the university campus (Jain *et al.*, 2017; Savely *et al.*, 2007) by implementing a more sustainable physical structure (Jose and Chacko, 2017; Aisheh *et al.*, 2010). Several case studies were also performed in specific universities, either proposing changes or proposing actions to improve their environmental performance (de Deus *et al.*, 2015; Ferrer-Balas *et al.*, 2004) and studies that evaluate the sustainability of the campus (Gu *et al.*, 2019; Lambrechts and Liedekerke, 2014) related to its environmental performance (Almeida *et al.*, 2013; Oliveira *et al.*, 2018).

A second approach considers that the sustainability of a university can be achieved through its didactic–pedagogical system, focusing on the courses curricula and providing the students with knowledge and information to encourage their action in the society (Dagiliūtė and Liobikienė, 2015; Stough *et al.*, 2018; Lukman and Glavič, 2007) or improving teaching–learning techniques (Tejedor *et al.*, 2018; Daniela *et al.*, 2018; Mintz and Tal, 2014; López, 2013). The third, and perhaps least explored approach, includes the students as a decisive factor for the changes toward sustainable development to occur, measuring their impact on the environment in terms of carbon footprint (Li *et al.*, 2015; Versteijlen *et al.*, 2017) and transportation used (Miceli and Viola, 2017; Zhou, 2016).

Albeit recognizing the existing individual approaches as necessary, evaluations focused on students are still partial and lack a more cohesive and epistemologically structured conceptual model to assess essential aspects of their sustainability, as a university's primary function is to train and form citizens capable of disseminating knowledge and acting in favor of a more sustainable society. The literature on this field has identified that it is not enough to have a sustainable university with efficient resource usage, a greener infrastructure and mechanisms for reducing consumption if there are no changes in the students' lifestyles. As an attempt to collaborate on the discussions toward more sustainable universities, this work proposes a model for evaluating students' sustainability by combining fundamental aspects of their lifestyles that consider the planet's resources, state of happiness within the university environment and academic performance.

Thus, the questions "How can a student's sustainability be evaluated taking into account its multicriteria aspects?", "Which criteria are relevant to measure a student's sustainability?". A broader and multidimensional view is proposed to assess students' sustainability, differently from the works of Li *et al.* (2015) and Versteijlen *et al.* (2017), that have considered the carbon footprint exclusively, and to the works of Miceli and Viola (2017) and Zhou (2016) that accounted exclusively for the kind of transportation and distance. The present study is aligned with Van Weenen's (2000) concerns about the reliability in measuring the sustainability of universities exclusively by their infrastructure. Giannetti *et al.* (2021b) provided efforts in this direction, by assessing the sustainability of Mexican students. This motivated to propose a conceptual model of the indicators that bring in the evaluation of the students' sustainability, as well as to have objective parameters of the indicators more aligned to the university reality with a case study. An analysis of students in a cluster contributes to better decision-making in suggestions for improving the indicators. Still, this present study innovates by first presenting a conceptual model

supporting university students' sustainability assessment. Secondly, by classifying students into clusters based on details present in each aspect of a group of students lifestyle, the decision-makers should act to achieve a more sustainable university.

The study is structured on a theoretical background of the used methods to quantify students' sustainability, with a description of the indicators used (academic performance, happiness and ecological footprint), the general quantitative model for evaluating the sustainability of students (the Sunshine model), a case study of the application of the proposed model at La Salle University, the perception of the model by the university administration and final considerations.

2. Theoretical background of the used methods to quantify students' sustainability

2.1 Academic performance

Education plays a fundamental role in providing skilled labor to sustain economic growth and societal development. Generally speaking, education is directly linked to the reproduction of productivism, a prevalent global line of thought that presupposes that economic growth and paid labor are permanent and necessary features to the human existence, independently of their consequences (Andersson, 2008). UNESCO's vision of education is contrary to that of Andersson's (2008), but similar to that of Yang *et al.* (2015), who indicate the importance of universities in preparing students for the market, but mainly for life in its totality.

Regarding the measure of universities' performance focused on academic issues, Liu *et al.* (2019) studied the sustainability of Newly Formed World-Class Universities between 2010 and 2018, using three assessment tools for university ranking: Times Higher Education World University Rankings (THEWUR), the Quacquarelli–Symonds World University Ranking (QSWUR) and the Academic Ranking of World Universities (ARWU).

The THEWUR evaluates and ranks universities around the world; for the years 2015 and 2016, five areas were used to propose performance indicators (Times Higher Education, 2016), namely:

(1) teaching, for the learning environment on the university's offerings;

(2) research, focusing on income, volume and reputation;

(3) citations, for research influences;

(4) international perspective or relationship, for students, staff and the research itself; and

(5) industrial income, being a form of knowledge transfer between company and university.

The QSWUR is a UK university assessment. It features six metrics in its assessment methodology (QSWUR, 2019b):

(1) academic reputation: gathering the expert opinions of more than 94,000 people in the higher education environment on the quality of teaching and research in universities around the world (40% weight);

(2) employer reputation: evaluates the success of institutions in providing student preparation for the job market (10% weight);

(3) teacher/student ratio: assessment of students' access to the faculty (20% weight);

(4) citations by faculty: assesses the quality of institutional research using the total number of citations received for all works produced by an institution over five years, by the number of professors at that institution (20% weight);

(5) proportion of international professors: number of international faculty (5% weight); and

(6) proportion of international students: number of international students (5% weight).

Finally, Liu and Cheng (2005) propose the ARWU from the Institute of Higher Education, Shanghai Jiao Tong University. The criteria considered are number of alumni winners of the Nobel Prize and Fields Medal (10% weight); faculty members who have obtained such awards (20% weight); highly cited researchers in 21 general categories (20% weight); articles produced in the scientific journals Nature and Science (20% weight); science citation index and the social sciences citation index (20% weight); academic performance per capita in the indicators mentioned above (10% weight). ARWU is a scientifically sound, stable and transparent methodology, which makes it widely used and quoted as a starting point for identifying university strengths and weaknesses (Liu and Cheng, 2005; Mok and Hallinger, 2013; Kauppi, 2018).

Students are always the focus of university productivity assessments, and their average grade is usually used as a productivity metric. For example, Vasconcelos and Almeida (2019) assessed the teaching-learning process and academic success in engineering courses, comparing first-year students according to gender and students' average grades. The authors found that female students have a better organization of their time and study activities, are also more thoughtful and self-regulated learners and have a higher rate of successful curricular units and higher average grades. Gkontzis *et al.* (2019) propose an approach to measure distance-learning students' performance, concluding that the number of students' login accesses to the teaching platform and students' responses to quizzes are related with the average grade throughout the year. D'Alessio *et al.* (2019) used the average grade to assess the impact of critical thinking on the academic performance of Master of Business Administration executive students. They concluded that critical thinking positively affects the average academic performance of MBA students.

The literature shows different available approaches to quantifying the students' academic performance, each with its purposes, rules, weaknesses, strengths, focus and boundaries under attention. As all are well accepted, using one rather than the other must be correlated to the goals of the study under development.

2.2 Happiness

The concept of happiness can be defined in a variety of ways, all coming down to indicating an overall positive mood, an overall assessment of life satisfaction, living a good life or the causes that make people happy (Desmeules, 2002; Diener, 2006). Some concepts found in the literature and associated with happiness include well-being, quality of life, flourishing and contentment (Graham and Nikolova, 2015; MacKerron, 2012). The term happiness has been used in terms of subjective well-being, positive affect, life satisfaction and quality of life, and it denotes both individual and social well-being (Veenhoven and Vergunst, 2014; Bartels, 2015; Diener *et al.*, 2018). Abbe *et al.* (2003) state that happiness is associated with higher levels of self-esteem. Due to its systemic importance, happiness and its related concepts are receiving increased interest from researchers worldwide (Diener *et al.*, 2003; Fujita and Diener, 2005; Tamir, 2005; Boehm *et al.*, 2013).

Bhutan can be globally considered the first country to evaluate happiness by creating the Gross National Happiness index (GNH), which is mainly used to guide public policies (Helliwell *et al.*, 2021). The term GNH was cited in 1972 by the King of Bhutan, Jigme Singye Wangchuck, who claimed it is a more meaningful indicator than the gross domestic product (Dorji, 2012; Ura, 2012). The United Nations Sustainable Development Solutions Network

annually publishes the World Happiness Report (WHR), which features happiness-related studies and happiness ratings of nations based on respondents' ratings of their own lives (Helliwell *et al.*, 2021). Another example of happiness assessment is the Gallup World Poll (GWP), which conducts surveys in over 160 countries in 140 different languages (Gallup, 2016). The Gallup method is used in the WHR to rank countries, making it suitable for assessing happiness. As the GWP is globally applied, comparisons among countries can be easily performed (Deaton, 2008).

The Happiness Alliance, also called Gross National Happiness Index (GNH) is yet another happiness index that was directly inspired by Bhutan's GNH (Musikanski *et al.*, 2017). The Happiness Alliance was first published as the fifth sustainable Seattle sustainability indicator in 2010, used by communities, cities and businesses worldwide (Holden, 2006).

The Santa Monica Wellbeing Survey is another method for measuring people's happiness or well-being. This project was first implemented in Santa Monica City, CA, USA, due to having been the winner in the Bloomberg Philanthropies Mayors Challenge event in 2013 (The Wellbeing Survey, 2015; Musikanski *et al.*, 2017). This index aims to dynamically obtain information on people's well-being, providing solutions by decision-makers within the government sphere and replicating them in other communities (Happiness Alliance, 2019).

Many communities, organizations and interest groups develop and apply indexes to measure happiness by means elaborated questionnaires. Empirical studies suggest that self-reported happiness is vital for sustainability in neighborhoods and cities (Souza *et al.*, 2019). Warner and Kern (2013) point out that these happiness indices are continually moving toward greater precision and accuracy in their results. Happiness, or well-being, is becoming increasingly essential, and researchers have made great strides in determining the happiness-related constructions (Satici *et al.*, 2016).

In spite of the existence of several scientifically rooted questionnaires to quantitatively assess the happiness of different systems, none of them was elaborated and used for assessments in educational systems of the likes of universities. Happiness and education are closely linked aspects (Ruiu and Ruiu, 2019; Araki, 2022). Educators often present an ideal of lifelong learning, which influences people. Happier people are more willing and able to give and accept ideas from others. Thus, happy teachers are more inclined to accept changes and teach and help their students efficiently (Skaalvik and Skaalvik, 2018; Rahm and Heise, 2019). Academic communities are environments of influence between teachers and students, where happiness can be a fundamental variable.

The relationship between psychological happiness and motivational academic life achievements on sustainability deserves to be more deeply explored (Giannetti *et al.*, 2021b). Happy people can be healthier and more productive (Oswald *et al.*, 2015; Ma *et al.*, 2022). In this context, research on happiness and general well-being in educational institutions are essential for school management (Applasamy *et al.*, 2014).

2.3 Ecological footprint

The Ecological Footprint measures the load imposed by a given population on nature (Wackernagel and Rees, 1994; Wackernagel *et al.*, 2002). It represents the area of the Earth's surface that is needed to sustain levels of resource consumption and waste disposal by a given population (Wackernagel and Rees, 1994; Wackernagel *et al.*, 2002; Herva *et al.*, 2008). Pereira *et al.* (2016) define ecological footprint as the amount of land and water needed to sustain current generations, considering all the demanded resources such as materials and energy.

Two measures are needed for calculation procedures: the ecological footprint and biocapacity, both expressed in global hectares (gha), which means hectares of land or water normalized under the average world productivity of all biologically productive land and water

in a given period of time (Lazarus *et al.*, 2014; Galli *et al.*, 2007; Galli, 2015; Goldfinger *et al.*, 2014). Kitzes and Wackernagel (2009) added that using a common unit as gha makes ecological footprint analyses globally comparable. The difference between ecological footprint (gha) and biocapacity (gha) results in the number of planets needed to meet the specific demand for a given lifestyle. When biocapacity is larger than the ecological footprint, the system can be considered sustainable under biophysical aspects; however, when the ecological footprint is larger than the biocapacity, the system can be regarded as unsustainable.

To convert the biologically productive areas from regular hectares (ha) to global hectares (gha), two factors are used: the equivalence factor and the yield factor (Kitzes and Wackernagel, 2009; Monfreda *et al.*, 2004; Wackernagel and Rees, 1994). Equivalence factors represent the potential world average productivity of a given bio productive area concerning the world average potential productivity of all bioproductive areas. Specifically, an equivalence factor is a number of global hectares contained in an average hectare of arable land, built-up land, forests, pasture or fisheries (Monfreda *et al.*, 2004; Mancini *et al.*, 2016). On the other hand, yield factors describe the extent to which a biologically productive area in a given country is more or less productive than the global average of the same bioproductive area. Each country has its own set of yield factors, one for each type of bioproductive area (Monfreda *et al.*, 2004; Mancini *et al.*, 2016).

The ecological footprint represents the demand by humans on the Earth's bioproductive areas, which are understood as the availability of nature to provide ecosystem services (Monfreda *et al.*, 2004). Galli (2015) explains this relationship between biocapacity and ecological footprint: while biocapacity is responsible for nature's ability to regenerate environmental goods and services, the ecological footprint reflects the humans' demand for those ecological goods and services.

Costanza (2000) states that the ecological footprint method is a powerful pedagogical and communicative tool on the effects of resource consumption by humans. Among other systems such as companies, public authorities and non-governmental organizations at different levels (personal, organizational, cities, regions, countries), the ecological footprint method has been widely used to assess the sustainability of universities (Li *et al.*, 2015; Gottlieb *et al.*, 2013; Lo-Iacono-Ferreira *et al.*, 2016; Lambrechts and Liedekerke, 2014). The method contributes to monitoring ecological performance, determining where the most significant impact occurs and raising awareness among staff and students by involving them in the calculation process (Gottlieb *et al.*, 2012).

3. Modeling proposal for quantifying the sustainability of students

3.1 The "Sunshine" conceptual model

Aiming to overcome the identified lack of conceptual models in assessing the sustainability of university students, the proposed model represented in Figure 1 uses the energy symbols as explained in Odum's (1996) book of environmental accounting. This model is named "Sunshine", an acronym for Sustainable UNiverSity HappINEss. In Figure 1, the students are at the center of the process, considering their local and global influence on the primary flow interactions with energy, material, labor and information. The highlights in red line in Figure 1 represent where the indicators that will be evaluated in this study are located. This representation is elaborated according to the student's energy flows and its more extensive area of influence, embracing a systemic view. Universities have their internal resources (assets) as computers, infrastructure, pedagogical resources and information accumulated over time. This information is represented by the accumulated knowledge that can be observed in the library, databases and the expertise of professors and administrators regarding the didactic-pedagogical processes.

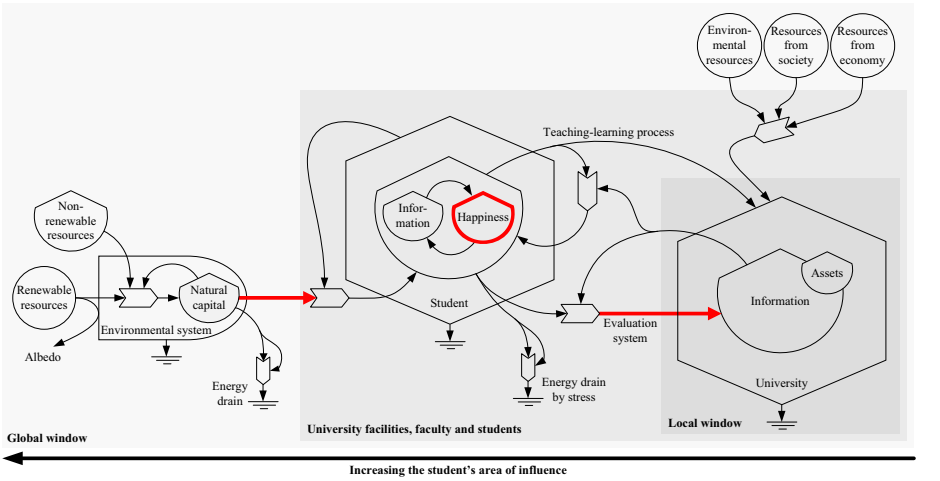


Figure 1.
The epistemological basis for the modeling proposal is the energy diagram of students and their local and global interactions

Notes: Symbols from Odum (1996): circles represent energy sources, the tank symbol represents storage, the hexagon represents people, the rounded rectangle represents natural systems, and arrows indicate the flow of energy, matter, and/or information
Source: Authors' own creation

A university receives matter, energy and information from the natural environment and the larger economy. The environmental system provides mainly resources considered essential for the maintenance of daily needs, such as water and electricity. The society offers manufactured products, goods and services, such as road cleaning, urban mobility and health. The economic sector of cities, public and private sectors offer scholarships, research support, internationalization of students and employment in organizations. In this way, the university can allow for the gain of knowledge by students.

Happiness and information stocks are within students. Happy students are more willing to participate and undertake complex tasks, thus devoting more in-depth thoughts about problems and the development of new solutions. This renders happiness a fundamental emotional approach to learning. The student and the university have two cyclical flows: a student carries a load of previously obtained information that the university interacts with.

A flow of information carried by the student is fed back to the university, and can be used by the university to improve its pedagogical processes by observing student learning gaps. This flow is known as the teaching-learning process. Another cyclical flow is the assessment of student learning, which is influenced by the level of knowledge acquired by the student during the teaching-learning process. The students' knowledge measured as a proxy of their learning process can be quantified through periodic tests and qualifying exams; such measure can also be used by the university to observe the quality level of its teaching processes.

A flow coming from the student that cannot be excessive is one called energy drains by stress, an existing energy loss from the teaching–learning cycle; otherwise, it will decrease the student's happiness level and consequently his/her learning capacity. This interaction between student and university has a local scope as far as the student's area of influence is concerned. Students have a larger area of influence with the natural systems, demanding resources to sustain themselves and meet their physiological needs; a drain can also be seen in the natural environmental systems, indicating an excessive human pressure on the

available natural capital. Students consume resources from the biosphere to meet their lifestyle; simultaneously, the biologically active land areas are put under pressure by means of residues disposal and gas releases into the atmosphere, which can be measured, among others, by the ecological footprint method.

3.2 Procedures to apply the "Sunshine" model

The "Sunshine" model is fed by three indicators: ecological footprint, happiness index and academic performance. The analyst can set other indicators; however, these must comply with and be supported by the "Sunshine" conceptual model. Each indicator is applied individually, according to its concepts, definitions and rules, as explained in the following subsections.

3.2.1 Student academic performance. Academic performance assessment is based on the average grade perceived by the student in the course. In the structured questionnaire survey in Appendix 1, an open question was assigned to students on a scale from 0 (zero) to 10 (ten), representing their average grade in the course in general. Grade 7 (seven) was taken as a threshold, by which higher and lower values mean high and low-grade performance, respectively. The idea is to use the grade indicator as a proxy to quantify the evaluation systems flow as demanded by the Sunshine model. The Grade 7 (seven) is chosen as the threshold reference because it is used by the university where the project is applied. This threshold score can be altered according to the institution's academic performance characteristics.

3.2.2 Measuring happiness. To assess student happiness, raw data were obtained using a questionnaire drawn from the existing and widely used GWP, Happiness Index–Happiness Alliance and Santa Monica Wellbeing Survey (Appendix 2). After selecting these questionnaires that measure happiness in the literature, we selected questions that were related to each other and could be asked in a university context for students. This was the criterion for selecting the questions for this work's questionnaire, totaling nine questions. In addition, each questionnaire elaborates the question in a different way, but measuring the same aspect. In this case, when in Appendix 2 it mentions "This work" it means the elaboration of the questionnaire question by rewriting it.

The questionnaire developed in this study (see final version in Appendix 1 – Questions 7–15) only considers the questions related to students in their university environment, when the student answers alternatives "a" and/or "b", it is understood that the intention of the question was not reached; these are aspects that need to be improved by the university. On the other hand, alternatives "c" and/or "d" indicate that the aspect was satisfactorily achieved. While alternatives "a" and "b" are assigned a score of 0, alternatives c and d receive a score of 1. Based on the students' responses, the Alkire and Foster (2007, 2011) method quantifies the individual and sample happiness index, the algebra of which is presented in equation (1). A student is considered happy when he/she answers (by ticking either alternative "a" or "b") the minimum of seven questions out of the nine proposed questions about happiness; fewer than seven answered questions indicates that the student is not happy. Thus, the cut-off for the happiness index is 0.8 (7/9): IF values above 0.8 indicate that the individual and/or group is happy, while IF below 0.8 suggests that the individual and/or group is not happy:

$$HI = 1 - (A * N) \tag{1}$$

Where:

HI = happiness index (dimensionless);

A = is the percentage of students who are still not happy. It is the fraction of the number of students not yet happy by the total number of students evaluated; and

N = is the percentage of the intensity of the students who are not yet happy. Fraction of indicators not yet met by the total number of existing indicators, considering only students who are not yet happy.

The happiness index can also be analyzed by the three domains and/or by the nine indicators described in Appendix 2, providing more detailed data about the reasons for not reaching a higher level of happiness. This approach is vital for decision-making to work on those indicators and domains that deserve attention for improvements.

3.2.3 Ecological footprint assessment. The ecological footprint represents the difference between the demand for resources measured and standardized in global hectares (gha) with the biocapacity available to provide the resources, also measured in gha. The result indicates the number of planets needed to sustain the entire world with a population, hypothetically, with the same consumption patterns as the sample (university students, in this case). The cut-off (threshold) of this method is one planet Earth; when the result is greater than one planet, the students are in a situation of unsustainability. Equation (2) presents the ecological footprint calculation for each product consumed by students to maintain their lifestyle:

$$PE = \left(\frac{P}{Y_N} * YF * EQF\right) \Big/ BC \tag{2}$$

Where:

P = consumption of a product (ton/year);
YN = national average income referring to P (ton/ha year);
YF = income factor, being the difference between national productivity and the world average within a given land use category;
EQF = equivalence factor that weights different types of land based on their ability to produce biological resources concerning the global average productivity on all types of land used (ha/gha); and
BC = biocapacity of a given area to supply a demand for resources (gha).

Initially, the Appendix 1 questionnaire was designed to obtain raw data on individual consumption and lifestyle from the sample of students being evaluated. The questionnaire has eleven questions about consuming vegetables, fruits, meat, milk and dairy products, paper, transport, electricity, fish and built-up residential areas. With these data, it is possible to assess the six land use areas established by the traditional methodology (Wackernagel and Rees, 1994; Monfreda *et al.*, 2004), including cultivated and pasture areas, forest area, carbon footprint, fishing area and built-up area. With the raw data obtained from the questionnaire, the coefficients in Table A2 – Appendix 3 are used to convert the consumption declared by students into standardized consumption of each displayed item.

The other variables of equation (2) are calculated as follows: the national average income (Yn) of the declared items was taken from the Food and Agriculture Organization (fao.org/faostat/en/#data), as shown in Table A3 – Appendix 3. The YF, EQF and BC coefficients were taken from the National Footprint Accounts (NFA; data.footprintnetwork.org), 2018 edition, which contains data from 2014 (Table A4 – Appendix 3).

Items related to carbon dioxide emissions, including student transportation and electricity consumption, were converted according to the approach proposed by Mancini *et al.* (2016), equation (3):

$$EF_{carb} = \frac{P_c * (S_{ocean})}{Y_w} * EQF \quad (3)$$

Where:

YW = is the annual rate of carbon dioxide sequestration per hectare of forest for the world average) = AFCS/0.27;

AFCS = average forest carbon sequestration, expressed in tC/ha/year (0.73 was used according to the study by Mancini *et al.* (2016); 0.27 represents the share of C in the CO_2 molecule and is used to convert tons of carbon to tons of carbon dioxide;

P_c = annual anthropogenic emissions of carbon dioxide (tCO_2). The emission factors of a given means of transport were multiplied by the distance traveled and converted from kilograms to tons;

S_{ocean} = fraction of anthropogenic CO_2 emission sequestered by the oceans in a given year. The data from Khatiwala *et al.* (2009) were used by the NFA, and the fraction of oceanic catchment for the year 2010 was 28% (Lazarus *et al.*, 2014; Borucke *et al.*, 2013), so there is the factor of 0.72; and

EQF = equivalence factor used to weight forest areas (1.29, Table A4 – Appendix 3).

3.2.4 Interpreting the "Sunshine" model. According to the Sunshine conceptual model of sustainability, a Boolean criterion is considered to identify performances that are above or below the or thresholds for each method: academic performance, happiness and ecological footprint. This means that a student or a group of students can either achieve or not achieve good academic performance, be or not be happy and be either sustainable or unsustainable under environmental constraints.

There are no different ratings or levels for indicators. This aspect implies the existence of eight possibilities (Table 1) when considering the three methods together under the Sunshine model, representing the overall performance for students' sustainability. The eight possibilities range from the sustainable students (or group of students) to the unsustainability performance, crossing over ineffective, environmentally distracted, unfocused, focused, socially distracted and effective. These classifications are useful for diagnosis purposes and promoting comparative discussions with other similar studies.

4. Application of the proposed "sunshine" model in the students at La Salle University

To verify the potentialities of the proposed approach, it is applied to the students of Universidad La Salle de Arequipa in Peru, which is part of the International Association of Lasallian Universities. It has three degree programs: Administration and International Business, Law and Software Engineering. In 2019, it signed an institutional agreement with Paulista University in Brazil, starting collaborative work to promote the "Sunshine" project; this is why La Salle University is a case study, but the approach can be applied to any other university. The university is cited as the case study in the application of the proposed model, but it is important to highlight that university students are the object of study.

The structured questionnaire survey (Appendix 1) was applied in 2019, in loco, during the class period, to students of the three undergraduate courses at La Salle. A total of 603 (n = 603) students completed the questionnaire, which is a significant sample of the institution's student population, reaching 56% of the total. Table 2 presents the profile for the sample studied, indicating balanced representativeness for the gender variables. The frequency in percentage was considered the total number of respondents in the alternatives

Ecological footprint	Happiness	Academic performance	Cluster name	Cluster characteristics
🔴	🔴	🔴	Unsustainable	Group of students who do not meet any indicators of the sustainability model. These students' consumption is above biocapacity, they are still not considered happy and have low academic performance
🔴	🔴	🟢	Effective	Group of students who have high academic performance, but their consumption is greater than their biocapacity and are still not considered happy
🟢	🔴	🔴	Socially distracted	Group of students who do not meet the indicators of happiness and academic performance, but consume within their biocapacity
🔴	🟢	🔴	Focused	Group of students who only meet the happiness indicator. They do not consume resources within biocapacity and have low academic performance
🟢	🔴	🟢	Unfocused	Group of students who just do not meet the happiness indicator. They consume resources within their biocapacity and have high academic performance
🔴	🟢	🟢	Environmentally distracted	Group of students who do not consume resources within the biocapacity, but they are considered happy and have high academic performance
🟢	🟢	🔴	Ineffective	Group of students who have low academic performance but consume resources within their biocapacity and are considered happy
🟢	🟢	🟢	Sustainable	Group of students who meet all indicators of the sustainability model. These students consume resources within their biocapacity, are happy and have high academic performance

Table 1.
Clusters identified according to indicators performance feeding the sunshine model

Notes: A red circle means that indicator is below its cut-off (threshold), whereas a green circle means that indicator is equal or above its cut-off
Source: Authors' own creation

of the questions. At the same time, most students are between 16 and 24 years of age (which is expected for undergraduate students), and fully dedicated to their studies (do not have formal jobs). They are distributed between Business and International Business and Law courses.

The organized Excel® spreadsheet containing all data obtained individually from 603 students and the algebra operations to calculate their academic performance, happiness and ecological footprint are available as Supplementary Material to this article (it can also be obtained from direct contact with the corresponding author). From an overall group evaluation by considering the entire sample of 603 students, results showed an academic performance of 7, a happiness index of 0.8 and environmental sustainability of 1.8 Earth planets. These results lead to a final cluster classification of "environmentally distracted" (Table 3), while academic performance and happiness show good performance, the ecological footprint showed low performance.

Variables	Subvariable	Quantity	Frequency (%)
Gender	Male	289	49
	Female	306	51
Age	16 to 24	497	88
	25 to 61	67	12
Work	Employee	218	36
	Unemployed	383	64
Courses[a]	IBA	322	53
	LAW	252	42
	SE	29	5
Student level	Freshman	153	25
	Sophomore	347	58
	Senior	103	17
Period	Daytime	294	49
	Nightly	309	51

Notes: [a]IBA = International Business and Administration; LAW = Law and SE = Software Engineering
Source: Authors' own creation

Table 2. Profile of the sample collected from La salle university students

Cluster classification	Academic performance	Happiness	Ecological footprint	% distribution for the 603 students
Environmentally distracted	🟢	🟢	🔴	34
Effective	🟢	🔴	🔴	19
Unsustainable	🔴	🔴	🔴	12
Focused	🔴	🟢	🔴	16
Sustainable	🟢	🟢	🟢	8
Unfocused	🟢	🔴	🟢	6
Ineffective	🔴	🟢	🟢	3
Socially distracted	🔴	🔴	🟢	2

Source: Authors' own creation

Table 3. Assessment of La Salle students' sustainability by clusters

Students have grade behaviors between 3 and 10, but as 81% of students have an average rate between 6 and 8, the final average rate of 7 is considered high performance. However, 33% of evaluated students need attention from the university faculty due to their grades below 7. A better understanding of the reasons for such a low academic performance for these students is important in identifying and putting strategies into practice including theorical and practical classes added to the academic curriculum, including.

Regarding the happiness index, as the questions related to happiness in the structured questionnaire survey (Appendix 1) were elaborated according to different existing surveys (Appendix 2), Cronbach's alpha statistical index was calculated to validate the reliability of the questions applied to students. The obtained Cronbach's alpha of 0.72 (Supplementary Material) indicates that happiness related-questions can be considered statistically adequate (Shemwell *et al.*, 2015). In a general comparison, the obtained HI = 0.8 performance for the happiness index obtained by the La Salle students shows higher performance than the average value of 5.75 for the Peruvian population, as measured by the WHR 2021 (values between 2013 and 2020, from a scale of 0–10; Helliwell *et al.*, 2021). Under the same method, the world average happiness performance in 2020 was 5.51. Although the WHR goals are

broader than the happiness calculated in this present study, results indicate that students of La Salle University can achieve higher levels of happiness from a perspective of their lives related to university activities.

Students at La Salle are considered happy; however, when observing the happiness indicator in detail, it is possible to identify some aspects that can be improved. For instance, Figure 2(a) shows that the welfare domain was the only one unable to achieve minimum standards for a sufficiency level of 0.8. Among the indicators within the welfare domain [Figure 2(b)], satisfaction with life (0.7) and recreational and cultural activities (0.5) were both below the sufficiency level. In fact, among all the happiness indicators, recreational and cultural activities have the lowest rate, indicating that students perceive that university can do more on these aspects. Low performance is also obtained for other indicators, such as the relationship between teachers and students, volunteer activities, the desire to continue the course and the vision of a more sustainable future. Although some happiness-related indicators can be improved to reach the desired efficiency level, the students understand that university can provide a promising professional future, from an overall perspective.

Finally, the ecological footprint of La Salle students showed an unsustainable environmental scenario by demanding 1.8 Earth planets to sustain their needs of energy and material to sustain life, which is very close to the 1.7 planets needed by the world average, as calculated by the 2018 NFA Edition (data.footprintnetwork.org). Among the ecological footprint areas, the grazing site is the only one showing a deficit [its consumption is higher than the biocapacity; Figure 3(a)]. Grazing areas have a significant total representation because their low performance leads to an overall low performance, resulting in a −1.29 global hectares deficit. Students' demand for grazing areas is a result of the high demand for meat and dairy products, achieving 1.01 and 1.39 gha, respectively [Figure 3(b)]. These findings are similar to Vintilă (2010), who applied the ecological footprint method to assess the Romanian students' environmental sustainability, and the demand for proteins from red meat also resulted in a higher footprint. Although considering observed behaviors of students in reducing the demand for paper (in general), using lower levels of fossil energy for transportation and demanding less electricity, the game-changing practical issue to improve the ecological footprint of La Salle students is related to their diets, at home or even at the university. Thus, strategies to replace the demand for dairy products and red meat play a crucial role.

Although all these discussions focused on the overall group performance are important to diagnose the entire sample and rank it for further comparative assessments, the decision-

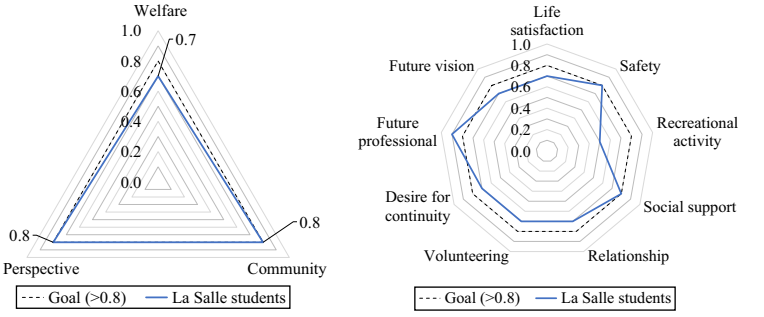


Figure 2.
Results for happiness performance of La Salle students focusing on (a) domains and (b) indicators

Source: Authors' own creation

maker demands more detailed information to plan strategic actions focused on those aspects that need urgent amendments. As usual, political, economic and even cultural issues make it challenging to apply changes that would result in overall changes. Small-oriented changes are easier to put into practice. Thus, the La Salle students' performance is assessed through the cluster approach (Table 3).

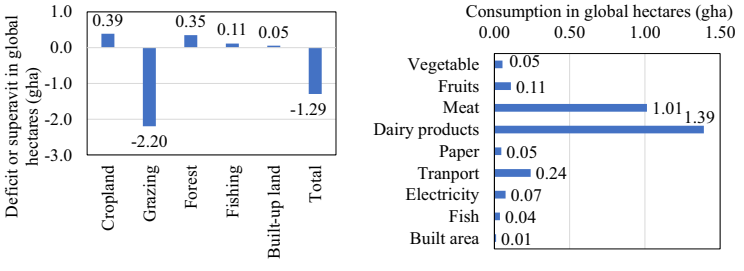
It is noticeable that the first four clusters are the most representative, totaling 81% of the students evaluated. At least one indicator does not meet minimum sufficiency among these four clusters. Initially, it is recommended that the decision-maker work on action plans to improve the unmet indicators of the representative clusters. Acting in representative clusters will reach more students, improving results faster. Specifically, to obtain an indicator of the Ecological Footprint of a planet, it would be necessary to reduce the indicator by 44%, where environmentally distracted, unsustainable and focused clusters, do not show satisfactory results from the indicator. There is a deficit in pasture area for the Ecological Footprint, resulting from the high consumption of dairy and meat derivatives, respectively. Actions to reduce these consumptions by students would be one of the focuses for a more sustainable lifestyle.

For the happiness indicator, the focused and unsustainable clusters did not achieve a level of sufficiency. The decision-maker can define to improve the happiness indicator by the unmet domains or unmet indicators. As for the domain, the only one not met was well-being, which has two indicators not met: satisfaction with life and recreational activities. Another path to be improved is the other indicators not met, such as relationships, volunteering, desire for continuity and vision of the future.

And, for academic performance, the unsustainable cluster did not obtain the indicator's minimum sufficiency. The suggestion would be that the decision-maker understands the reasons for the low performance of the students in terms of teaching and learning and then put forward an action plan to improve the process.

4.1 La Salle University's administrative perception of its student's sustainability

Aiming to close the knowledge circle and present the results to those responsible for decision-making, the results of La Salle students' sustainability were presented *in situ* to the La Salle's Academic Director, Director of the Department of Legal Sciences, Director of Quality and Accreditation, Director of the Department of Engineering and Mathematics and the Dean. Additionally, questions such as the perception of the "Sunshine" model, the expected results, the possibility of integrating the model into the university's management and other possible perspectives were also addressed.



Source: Authors' own creation

Figure 3.
Results for ecological footprint performance of La Salle students focusing on (a) ecological deficit or surplus and (b) consumption

The university's senior management perceives that this model can establish a solid reference for management. Some results were surprising, such as happiness levels below the target, but as data collection was performed at the beginning of the Covid-19 pandemic, results could likely be improved under normal circumstances. Low performance for the happiness index regarding the offer of recreational and cultural activities by the university was not expected. Interviewed managers emphasized that the "Sunshine" model can integrate university processes in its strategic planning by socializing the model with all the interest groups within the university to allow better perception and sustain discussions. Furthermore, considering that the present model is fundamentally student-based, students should be deeply analyzed for a better understanding of individual preferences and/or the reasons some indicators of academic performance, happiness and ecological footprint showed such low performance. From this systemic approach, more efficient solutions and plans can be implemented.

La Salle managers' perspective on the "Sunshine" model emphasizes that it can be used to design teacher training from a psycho-pedagogical support system and tutoring, which would generate high value for the product offered by the university to the society. Regarding the happiness index, understanding that it includes other local aspects, the La Salle managers can apply the model to the entire university, including professors, administrative agents and other stakeholders. Overall, the "Sunshine" model and its application to the La Salle students were well received by the La Salle managers, that showed great interest in using it as a reference tool for decisions and future studies, aiming to achieve higher sustainability for its students during their academic life as well as their professional life.

It is important to highlight that this study initially proposes a model for assessing the sustainability of students, and performs a case study applying the model with students at a university. For generalization of the model, more experience will be needed to generalize the use of the model.

5. Final remarks

The proposed "Sunshine" sustainability model is epistemologically based on a conceptual model relating to the university and its students. Compared to other alternatives available in the literature, the Sunshine model avoids misleading interpretations of a single indicator or discussions that lack a conceptual model. It brings robustness in assessing the sustainability of students in universities. The indicators chosen to feed the "Sunshine" model are largely accepted as references for measuring academic performance, happiness and environmental sustainability. The assessment allows for an integrated perception of the characteristics of the evaluated sample of students. Although additional applications of the "Sunshine" model are vital to assess its strengths and weakness (e.g. students from different courses and countries), it can be considered an advancement, when compared to other available approaches in quantifying the sustainability of university students.

The evaluated group of Peruvian students at La Sale University was classified as "environmentally distracted", as it shows characteristics of excellent academic performance (grade of 7), reaches sufficient level for happiness index (HI = 0.8), while demanding a high number of resources to sustain their lifestyle (1.8 Earth planets). From a detailed analysis, the cluster approach in assessing students allows the stratification of results for more efficient targeted decision-making. The cluster approach showed that 81% of the 603 students evaluated have low performance for the ecological footprint, highlighting that changes in individual behavior concerning lifestyle would bring significant improvements for the overall

students' sustainability; precisely, data showed that avoiding the consumption of red meat and dairy products are of paramount importance. Additionally, 31% of students have low performance in the welfare domain of happiness, precisely as for recreational activity indicators. Actions such as promoting events for awareness of healthier eating, adding sustainability aspects in the course curricula and promoting accessible recreational activities more often are all fundamental actions that La Salle should offer to its students.

The practical implication that can be highlighted is the use of the results of the evaluation of students' sustainability for decision-making by university managers. Understanding the indicators with a detailed approach is necessary so that improvement actions are better targeted. Theoretical implications of the work contribute to the literature in a proposal of a multidimensional model in the evaluation of students' sustainability. The proposed model places the student at the center of the process and evaluates conceptual relevance indicators discussed in the literature.

Future research can contribute to a cause-and-effect analysis between the indicators, as well as assessing whether there are dependencies between the indicators. An example could be whether students can be happy without depending on a high consumption lifestyle. Analyzes like these can be treated with several approaches, evaluating students from different courses, their sociocultural, economic characteristics, among others.

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Supplementary material

The supplementary material for this article can be found online.

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