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Search for objective environmental performance indicators of primary schools

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Abstract

Purpose – The purpose of this paper is to seek to develop environmental scores to complement already existing academic scores in order to evaluate and compare school performance in the context of sustainable societies.

Design/methodology/approach – In a case study on one particular Brazilian school, the authors propose three indexes to grade school performance: academic achievement, sustainable design and environmental behavior.

Findings – The behavior refers to water and energy consumption, environmental education activities, waste production and sorting, noise level, food scraps and traffic density.

Research limitations/implications – The adoption of the scoreboard induces all members of the school community, students, teachers and service personnel, to participate in the measurements and in targeting.

Practical implications – All measured parameters are reduced to dimensionless fractions of ideal values in order to provide a basis for objective targeting within the school and for comparisons within the school universe.

Social implications – The scoreboard is transferable to the school universe in the quest for benchmaking environmental performance.

Originality/value – As a "bottom-up" management procedure, the study develops the ideal reference values suitable to the particular school in an effort to overcome their absence in the municipal context and to induce their application in that context.

Keywords Performance measurement, Benchmarking, Benchmarking in education, Environmental performance of schools, Environmental score of schools, Parameters for competition of schools, Performance targeting, Sustainable schools

Paper type Case study

Introduction

Enterprises of the production and service sectors routinely use environmental performance analyses, but its application in primary schools is uncommon.

Since 2004, the International Organization for Standardization (ISO) operates the Kid's ISO 14000 Program with the declared objectives "to develop environmental awareness among children, to teach them to implement environmental management in homes and communities and to open them to the value of networking with young people in other schools" (ISO, 2004). By 2009 an estimated 210,000 children worldwide had participated and achieved a 70,000-ton reduction of CO_2 emissions. Reports from Cambodia relate efforts to involve schoolchildren in the protection of the architectural, historical and cultural site of Angkor from deterioration by tourism (ISO, 2005).

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Mamede and Leite (1999), Leite and Medina (2000) and Coimbra (2004) describe the importance of environmental education in the school context, but the treatments remain general. No specific procedures for environmental performance analysis are given. Oyafuso (2004) defends the idea that a school is not an isolated entity. It is part of the social context of the city and as such, cannot remain inert with respect to its interaction with the municipal environment. Exactly this idea forms the basis of the present study. The query is "Does the school community know its impact on city infrastructure and what does it do to minimize it?"

UNESCO declared the decade from 2005 to 2014 the "Decade of Education for Sustainable Development" (UNESCO, 1999). This declaration attributes special responsibilities to educational institutions worldwide. The challenge is to stimulate new attitudes toward the environment that can lead the way to sustainable nations. The present study introduces the idea of measuring the environmental performance of a school community and setting a voluntary benchmark. This idea is original in the region where the school is located.

According to Feres and Antunes (2007), Brazilian primary schools have not yet assimilated the challenge put forth by UNESCO, such that, generally speaking, the corresponding course content has not extrapolated the classrooms. They describe the implementation of water and energy saving initiatives, but admit that this type of procedure is restricted to less than 1 percent of Brazilian primary schools. Those authors also state that environmental impacts of schools have become more visible due to increasing consumption of water and energy, increasing waste generation and increasing use of private means of transportation by students. This is a natural consequence of the growing importance of the service sector in general, and the school sector in particular, to national economic performance. Here is one more justification for the present study, which quantifies the environmental impact of a school in order to make it visible to the community. Pires *et al.* (2008) describe an experiment with eco-literacy activities, but do not provide any quantification.

Internationally, the ECO-Schools (2014) initiative recommends environmental reviews in schools. The reviews form the basis for action plans and typically contemplate the items "Litter, Waste Minimization, School Grounds, Biodiversity, Energy, Water, Transport, Health and Well-Being, Sustaining our World." The reference stipulates that the initiative of review and actions be in the hands of students. The UK section of ECO-Schools provides detailed review procedures for primary schools (ECO-Schools Review Manual for UK Schools, 2014). The following is an example of monitoring water consumption:

(1) Is there a water meter to record water use in the school?

(2) Are there push-on or self-stopping taps in the toilets?

(3) Are there water-saving devices in the toilets?

(4) How often does the school run water-saving campaigns?

(5) Are pupils involved in taking and displaying readings? And if so, are the results recorded on graphs and shared with the rest of the school?

The Australian Institute of Architects adopts criteria for an environmental review in schools from the Foundation Environment Education Europe. There are seven criteria as follows (Australian Institute of Architects (AIA), 2003):

(1) litter and water management;

(2) hot water, insulation, radiators, electricity and heating system;

(3) vehicle use;
(4) washroom taps, toilets and rain water use;
(5) use of recycled paper and responsible purchasing;
(6) landscape and wildlife features; and
(7) environmental education, school interior and school involvement.

In addition, the same reference lists the items related to the Schools' Environmental Assessment Method as follows:

(1) recycling facilities;
(2) energy rating, low-NO_x combustion equipment;
(3) home-to-school transport policy;
(4) water savings and quality;
(5) caretaker training;
(6) use of recycled materials;
(7) site selection for new buildings;
(8) ventilation; and
(9) integrated lighting controls.

The present study incorporates many of those criteria in its set of environmental performance parameters intended for targeting and competition in schools.

The project competition for schools run by *The Guardian* (2015) specifically assigns value to projects that:

(1) measure the benefit to students;
(2) bring out ideas for improving school life;
(3) target long-term results; and
(4) are transferable to other schools.

The Trust for Sustainable Living (2015) runs a charity that organizes competitions for schools in a variety of environmental subjects. In 2014, it challenges students worldwide to answer the question "What does sustainable living mean to you?" and to produce a three-minute video on their school's best environmental project.

The method of key performance indicators (KPI) allows any school to choose the indicator considered most important by the community, such as the graduation rate of students and the success of finding employment after graduation (About Money, 2015).

Gough (2006) deals with Education for Sustainable Development as advocated by the UN. In quite general terms, "it should teach goals for conservation, social justice, appropriate development and democracy in order to build a society that is ecologically, socially and economically sustainable."

Brković and Milošević (2012) present proposals for school design that incorporates sustainability concepts. They argue that children spent most of their time in the school, and this environment ought to be inviting to them. They advocate concepts of good lighting, low energy use, good inside air quality, easy maintenance, water use efficiency, rain water harvesting and waste reduction as adamant to a sustainable school environment.

In a review paper, Kollmuss and Agyeman (2002) state that theoretically, environmental knowledge leads to awareness and from there to behavior that mimics the awareness. Their findings reveal that in practice, this process is not necessarily continuous. Knowledge does not always result in the pertinent behavior. In order to reach desired patterns of behavior, it is necessary to resort to direct experience. The present study uses this procedure in as much as it inverts the order of progress. It induces the community to measure the results of its behavior, which in turn will stimulate interest in acquiring knowledge. Exemplifying, the community measures its water consumption, and with this information starts asking questions about the availability of water in the city.

Shield and Dockrell (2008) perform experiments in British schools about the effect of noise on classroom performance of students. They provide evidence that external as much as internal noise negatively affects memory, motivation and reading ability and that it influences the results of standardized tests and exams.

The Environmental Performance Indicators (2014) is an initiative based on the statement "We are what we measure. It's time to measure what we want to be." It proposes to institutions that they measure their environmental impact in order to conceive plans for improvement.

The present study follows this line of thought and measures the impacts a school exerts on its neighborhood and on the municipal environment generally. Students are not usually conscious of this type of impact, because school performance measurements up to now are restricted to academic achievement. The primary objective is to quantify the impact in the form of a diagnosis as a first step toward creating environmental consciousness and involvement in the school community. The secondary objective is to develop an environmental performance index for targeting improvements in the school proper and to induce competition between schools. The foregoing references testify to the fact that competitions within the school universe are common events the world over, be it on academic or environmental topics. The present study pretends to prepare a school for this type of competition through a diagnosis of its performance and the search for suitable indicators to set environmental targets.

The specific school chosen for the experiment is the full time public primary school CAIC located in the Municipality of Ituiutaba in Central Brazil. The collected data leads to the determination of performance parameters on a "per person per day" basis and to an exercise of extrapolation to show the extent to which the entire school universe affects the environmental situation of the city.

Ituiutaba is a city with 100,300 inhabitants located in the State of Minas Gerais, Brazil at longitude 49°W and latitude 19°S. The urban perimeter covers 24.2 km^2. Medium annual precipitation is 1,432 mm concentrated in the months of October to March (Mendes and Queiroz, 2011). The Human Development Index (HDI) of the city is 0.818. There are 33 nursery schools, 39 primary schools and five high schools (Wikipedia, 2007).

Methods

The items selected for performance evaluation closely follow those reported by the AIA (2003), although no copy is attempted.

Data collection proceeded from 2010 to 2011 for the following items:

- school population as per type of activity (Annual school statistics);
- academic performance of school as function of time (Ministry of Education statistics);

- solid waste production rate, sorting and destination (manual weighing of specific waste items produced per day on six random days in 2010);
- water consumption and specific forms of use (counts of valves and taps, showers, drinking fountains, hydraulic brooms and dish washing machines and times of use; analysis of water utility bills for 2010 and 2011);
- sewage production and destination (as a fraction of fresh water consumption from water utility bills);
- energy consumption and specific forms of use (counts of lamps and appliances and times of use; energy utility bills for 2011);
- noise levels around the premises (measured with decibel meter at different points and hours);
- soil areas: constructed and open (manual measurement of built-up area and open ground);
- quantities and types of food consumed in the canteen (manual weighing of purchased food and discards);
- vehicle counts at the entrance (documented visual observation);
- rain harvesting options (roof area from engineering projects); and
- regular extracurricular environmental education activities (number of weeks per semester with programmed activities).

The school administration granted permission for all data collections. The foregoing measurements provided the initial diagnosis of the environmental performance. In sequence, the authors' team developed the concept of regular updating in order to show the progress and motivate involvement of the community. This activity contributed to the creation of environmental awareness and to the pursuit of targets the community sets for itself in preparation for competitions with other schools.

Results

Regular learning activities take place in three daily turns: morning, afternoon and evening, from 7 a.m. to 10 p.m., 15 hours per day, five days per week, 15 weeks per semester, two semesters per year. This is a full-day school. According to legislation, meals or snacks are served to students every two hours.

School population

At the time of this study, in 2011, the school population comprised the following groups:

(1) nursery, ages zero to five: 248 children, morning and afternoon;

(2) primary school, ages 6 to 15: 580 pupils, morning and afternoon;

(3) adult students: 80 (persons who did not conclude primary school by the age of 15), evening;

(4) service personnel: 79;

(5) teachers: 82; and

(6) total population: 1,069 (908 students and 161 personnel).

Academic performance of school

The Brazilian Ministry of Education runs yearly evaluation campaigns for all schools based on exams in priority subjects. That method assigns a mark to each school on a scale of zero to ten, valid for one year (Ministry of Education, 2014). This is similar to the method used by National Alliance for Public Charter Schools (2013). It is outside the scope of the present study to enter into considerations of classroom activities, which are the source of academic performance. In 2011, when this research took place, the mark of the school was 5.7/10. The present study complements this measurement of academic performance with measures of environmental performance heretofore inexistent. This new information provides arguments for including subjects on environmental education into the course curriculum and for adopting an environmental performance index as guide in the quest for a sustainable school environment.

Solid waste production and destination.

The study identified three destinations for solid waste produced in the school:

(1) biodegradable material from the canteen – destination pig farming;

(2) dry packaging material – destination reverse logistics; and

(3) rubbish – destination landfill.

Manual measurement by weighing produced the following results:

(1) biodegradable material 42.0 kg/day (5 days/week);

(2) dry packaging material 8.0 kg/day (5 days/week);

(3) rubbish 71.0 kg/day (5 days/week); and

(4) total 121.0 kg/day (5 days/week).

The sorting of biodegradable and dry material is inadequate. Much of this type of material is present in the rubbish. The sorting ratio of $(42+8)/121=0.413$ is subjectively considered insufficient.

The production of $121.0/1,069=0.113$ kg/(person × day) is considered acceptable for the full-day school context and additive to home production. No literature data are available on school waste production for comparison. The number 0.113 is an initial value open to improvement through environmental education activities. On a nation-wide basis, the solid waste production in Brazil in 2013 stood at 1.041 kg/(person × day) (Abrelpe, 2013). This indicates that production in the school (or elsewhere in the workplace) amounts to 10.9 percent of total waste produced by people. As for the sorting ratio, experiments reported from apartment buildings produced numbers in the range of 0.670 to 0.900 as consequence of intensive coaching (Fehr, 2014). They provide a reference for targeting in the school.

Food consumption and discards

The measurement of purchased food for the canteen showed the following monthly quantities:

(1) rice: 640 kg;

(2) beans: 220 kg;

(3) onions: 100 kg;

(4) salt: 6 kg;

(5) meat: 320 kg;

(6) pasta: 100 kg;

(7) cooking oil: 56 kg;

(8) vegetables: 437 kg; and

(9) total: 1,879 kg.

The biodegradable waste was as above 42 kg/day × 20 days/month = 840 kg/month.

The food waste ratio is 840/1879 = 0.447 (biodegradable waste/purchased food). Again, the literature does not provide data for direct comparison, but research in apartment buildings reported the number 0.394 for single families (Fehr, 2009).

Energy consumption and types of use

The school community consumes energy with lighting and with appliances. The light bulbs present in the institution were the following:

(1) 441 bulbs of 20 w;

(2) 819 bulbs of 40 w;

(3) one bulb of 100 w;

(4) 85 bulbs of 250 w;

(5) 16 bulbs of 400 w total bulbs; and

(6) 1,362, total power 69,330 w.

The appliances were shop equipment, computers, cloth and dish washers and dryers, pumps, electric showers and control circuits. The diagnosis estimated the times of use of all bulbs and appliances and arrived at the following monthly consumption:

$$\text{Lighting } 7{,}787 \text{ kwh} + \text{Appliances } 6{,}727 \text{ kwh} = \text{Total } 14{,}514 \text{ kwh.}$$

This number coincided with the monthly energy bill received from the electric utility company for April 2011. The contracted power demand was 55 kw. In April 2011, the maximum demand actually reached 64 kw, which generated a fine of 28 percent on the energy bill. This fact demonstrated that the school administration did not exert control over the contracted power usage.

As energy consumption parameter, the study produced the number of $14{,}514 \text{ kwh/month} \times (1 \text{ month}/20 \text{ working days}) \times (1/1{,}069 \text{ persons}) = 0.679 \text{ kwh}/(\text{person} \times \text{day})$, in the school, which is an initial value for discussion and future targeting by the school community.

Vehicle counts at the school gate

Visual observation during three consecutive days in August of 2011 determined the traffic density at the main gate. It divided into vehicles that stop at the gate to drop off or pick up students, and vehicles that pass by without stopping. The types of vehicles were private cars, motorcycles, trucks, school buses, commercial buses and police cars.

The mean daily frequencies were as follows: vehicles that stop: 129; vehicles that pass by: 44; total: 173. Apart from the motor vehicles, 44 bicycles passed the gate per day: bicycles that enter: 34; bicycles that pass by: 10; total: 44.

From that data, 75 percent of motor vehicles (129/173) and 77 percent of bicycles (34/44) using the street in front of the gate do so as consequence of the existence of the school.

The traffic parameter of the school proposed for monitoring is:

$$129/1{,}069 = 0.121 \text{ motor vehicles stop at gate}/(\text{person} \times \text{day}).$$

This item is quite low because many students reside in the neighborhood and arrive on foot or by bicycle.

Water consumption and points of use

Water is consumed in the canteen for food preparation and dish washing, in drinking fountains, in toilets, in the nursery for hygiene and washing, in house cleaning and in irrigation of green spaces. The total consumption is provided by the main hydrometer, which serves the utility company for billing. From the utility bills for 2010 and 2011, the mean monthly consumption was 1,067 m^3/month. This excludes the months without school activity. In terms of individual daily consumption, this reduces to the water use parameter of:

$$1{,}067{,}000 \text{ liters/month} \times (1 \text{ month}/20 \text{ active days}) \times (1/1{,}069 \text{ persons})$$

$$= 50 \text{ liters}/(\text{person} \times \text{day}) \text{ in the school.}$$

This value is high due to the type of school with nursery and canteen. The average water consumption in homes of this city is 180 liters/(person × day) (Ituiutaba, 2014). As the consumption is additive, the numbers indicate that persons who frequent the school consume 180 + 50 = 230 liters/day.

The utility company bills sewage collection and treatment as 70 percent of water consumption. This flow cannot be measured. Accepting the fraction indicated, the sewage parameter of the school would be 50 × 0.7 = 35 liters/(person × day).

Rain water harvesting

Storm water catchment has never been considered in this school. The present study quantified the possibilities and provided numbers for discussion. The mean annual precipitation in the city is 1,432 mm (INMET, 2014). The school has 4,898 m^2 of roof area available for capture. Presently, all rain water runs off to a nearby creek. The possible annual catchment from roofs is 4,898 m^2 × 1.432 m = 7,014 m^3/year. The water consumption as calculated above is 1,067 m^3/month or 8,536 m^3/year (eight months with school activities). This means that rain water could attend to more than 80 percent of water use, specifically to non-potable water uses, such as toilets, house cleaning and irrigation. The metering system does not allow for discrimination between potable and non-potable uses. Additional hydrometers would be required. The present rain contribution ratio is zero, but the target could be 7,014/8,536 = 0.822, which indicates the fraction of water use that rain harvesting could provide if the corresponding equipment were installed. The concept of sustainable school design of Brković and Milošević (2012) supports and recommends this type of installation.

Rain infiltration

The school is located at the outskirts of the city in an area of 18,310 m^2, of which only 6,256 m^2 are impermeable. The rest of 12,054 m^2 is open ground covered by grass and trees.

This is an extremely advantageous situation probably not available to many schools. It leads to the enviable infiltration ratio of 12,054/18,310 = 0.658, a valuable environmental asset.

Noise levels

The school is located in what the law on noise defines as a mixed area, predominantly residential with a few commercial establishments. For this type of urban area, the law limits noise levels to 55 decibels (db) during the day and 50 decibels (db) at night (State of Minas Gerais, 1990). This research verified noise levels in all parts of the school with a decibel meter. The noise was within the established limits in all sectors, except for the workshops with 67 db and the gym with 56 db. It will be relatively easy to correct those excesses. The noise excess ratio is 67/55 − 1 = 0.218.

Regular extracurricular environmental education activities

This item contemplates all kinds of activities carried out during any semester with the aim of improving the environmental performance of the school. As the semester has 15 lecture weeks, the number of weeks with programmed activities divided by 15 could provide the value of a performance ratio. The types of activities depend on the creativity of the school administration. Ideally, they involve the students in the control of the performance. Examples are involving students in reverse logistics, in reading the water and energy bills, in controlling the traffic at the gate, in measuring the noise levels and the like. At the time of this research, there was no such activity, so the corresponding ratio was zero.

Summary of parameters considered for evaluation

For ease of discussion and argumentation, the parameters experimentally determined are summarized in Table I. They are divided into positive and negative impacts. Positive impacts refer to parameters to be maximized. Negative impacts refer to parameters to be minimized. As this study is specifically concerned with environmental behavior, the parameters of academic achievement and school design are not considered further in the development of an environmental performance indicator. As this type of measurement had never been done in the school, the community, students as much as staff, were not knowledgeable about their impact on the municipal infrastructure.

Discussion

The case study provides a picture of the environmental interaction of the sample school with the urban infrastructure. Table I represents a preliminary proposal for reporting

Positive impacts	
Solid waste sorting ratio	0.413 sorted waste/total waste
Programmed activities ratio	0/15 weeks with extracurricular activities
Negative impacts	
Solid waste production	0.113 kg/(person × day)
Food scraps ratio	0.447 bio-waste/purchased food
Energy consumption	0.679 kwh/(person × day)
Traffic density	0.121 motor vehicles/(person × day)
Water consumption	50 liters/(person × day)
Noise excess ratio	0.218 noise fraction above legal limit

Table I. Environmental performance parameters for CAIC school primary school with 1,069 persons, situation in 2011 environmental performance of primary schools. The interaction with the municipal infrastructure is apparent. The sorting ratio of waste measures the amount that is recycled through reverse logistics and does not go to the landfill. The energy and water consumptions allow for comparisons with availability in the city. The food scraps ratio provides a measure of the efficiency of food use.

The numbers listed are initial values subject to constant evolution in any school, originating from administrative measures. The numbers, once known, serve the primary purpose of targeting. They also allow for comparisons between schools. The table has taken the guesswork out of environmental performance evaluation. Precisely defined numerical values are now available to school administrators for verification and steady improvement. The school community can set its own collective targets and document its numerical progress. As all parameters are defined clearly in terms of easily measurable values, they can be readily adopted by schools anywhere. This is the original contribution of the present study to environmental performance determination in schools. It is in line with the requirement for transferability of school projects supported by *The Guardian* (2015).

The parameters relating to academic performance, rain water harvesting and infiltration are a consequence of classroom activities and school design. The measurements appear in the results section to illustrate that overall, school performance divides into academic achievement, sustainable design and environmental behavior, but the objective of this study addresses environmental behavior only.

The noise excess index is the simplest candidate for correction. Adequate instructions to the workshop personnel solve the problem. The importance of this parameter is stressed by Shield and Dockrell (2008) who provide evidence on the negative impact of noise on classroom performance.

The traffic density serves as a guide for administrative intervention. If it rises to a level where congestions occur, traffic control would be in order during rush hours. Each school can determine the critical value of the parameter, according to the physical infrastructure and visual observations. The choice of means of transportation is an individual decision. It is beyond the authority of the school administration to interfere in the choice, but it is within its authority to organize the traffic at the gate. Consequently, this parameter considers traffic density only. It does not include data on air pollution.

The parameters referring to solid waste are controllable up to a certain limit. Administrative talent will provide instructions and examples for improvement. The sorting ratio is the first candidate for intervention. In city residences, Fehr (2014) attained values in the range of 0.670-0.900. This range presents itself as reference for imitation.

Finally, the energy and water consumption parameters are the most visible performance indicators, because the utility bills remind the administration month after month. Here again, design changes may help. Modern water taps and toilet flushing devices as well as solar panels for water heating and electricity generation are readily available. Savings will result from new technologies and from educational measures. These two items are of direct interest to the city administration, who might consider providing specific instructions to all schools. There are 77 schools in the city with a total student population of 7,172 (Wikipedia, 2007). Table I will show the city administration, e.g. that the daily water consumption in this universe reaches $7{,}172 \times 50 = 358{,}600$ liters. Depending on the supply situation in the municipality, coercive measures may come into play.

The parameters address all stakeholders of the environmental engineering and management community. Engineers will design and install solar panels, rain harvesting equipment and water-saving devices. Managers, like school principals and municipal department heads will organize the solid waste movement and the traffic control. Table I offers to all of them data for comparison and extrapolation, and allows for the establishment of targets. As the community itself runs the regular diagnoses, it is exposed to what Kollmuss and Agyeman (2002) refer to as direct experience, which is a more powerful tool for building consciousness and forming patterns of behavior than indirect experience like lectures.

The parameters in Table I have dimensions. This makes it complicated to perceive the overall performance improvement achievable by working individually on any one parameter. Therefore, the authors propose transforming the parameters into fractions of ideal values, such that one single performance index defines the situation of the school. The procedure is as follows.

A reference value is established for each parameter. For the positive impacts, the reference is placed in the denominator and the measured value in the numerator. For the negative impacts, the reference is placed in the numerator and the measured value in the denominator. Each fraction, then, aspires to unity as the positive impacts increase and the negative impacts decrease, and the average value of all fractions represents the overall performance index.

The reference values proposed for the particular school studied here are shown in Table II. They are guides for the school community in the quest for continuous improvement of its own index. Obviously, the choice of the references is subjective as long as no universal, national or municipal indicators are available. Every school has to exercise discretion when defining its reference values. If the municipal administration pretends applying the index method to all schools, then it has to stipulate municipal reference values or KPI.

Tables I and II allow for the calculation of the overall performance index of the school. As illustration of a positive impact, the solid waste sorting index is $0.413/0.670 = 0.616$. The reference appears in the denominator. As illustration of a negative impact, the water consumption index is $40/50 = 0.800$. The reference appears in the numerator.

Table III shows the complete calculation of a possible overall index based on the subjective reference values stipulated.

Table III is the typical result of a practical approach to measuring and influencing environmental behavior.

The method has drawn on the experience of ECO Schools (2014) and AIA (2003) and has adapted them to the specific local context.

Table II. Reference values of environmental performance parameters

Positive impacts		
Solid waste sorting ratio	0.670	Sorted waste/total waste
Programmed activities ratio	15	Weeks with extracurricular activities
Negative impacts		
Solid waste production	0.100	kg/(person × day)
Food scraps ratio	0.400	Bio-waste/purchased food
Energy consumption	0.550	kwh/(person × day)
Traffic density	0.121	Motor vehicles/(person × day)
Water consumption	40	Liters/(person × day)
Existing noise	55	Highest db measure in the school

Note: CAIC school, established by debate within the community and subject to modification from experience

Table III. Present environmental behavior index of school CAIC

Positive impacts	
Solid waste sorting index	0.413/0.670 = 0.616
Programmed activities index	0/15 = 0
Total	0.616
Negative impacts	
Waste production index	0.100/0.113 = 0.885
Food scraps index	0.400/0.447 = 0.895
Energy consumption index	0.550/0.679 = 0.810
Traffic density index	0.121/0.121 = 1.000
Water consumption index	40/50 = 0.800
Noise index	55/67 = 0.821
Total	5.211
Overall performance index (0.616 + 5.211)/8 = 0.728	

It is an initial proposal subject to modification through discussions and debates within the school community. This is a direct consequence of the absence of universal environmental KPI for schools. The present study contributes its modest share of arguments to compose a common set of KPI at least at the municipal level. The index represents a reference toward which the community can work in preparation for national and international contests.

It depends on the adoption of realistic long-term behavioral targets agreed upon by all members of the community as a consequence of environmental education. This represents the most important outcome of the study. It fosters the idea that present-day school life is not only about classroom performance, and it puts into practice the teachings of the Environmental Performance Indicators (2014), which state, "We are what we measure."

The following hypothetical example illustrates the type of progress that could be targeted for one year. The administration implements an environmental education program lasting ten weeks per semester to involve students in pursuing the targets waste sorting ratio 0.600, food scraps ratio 0.420, energy consumption 0.590 kwh/(person × day), water consumption 45 liters/(person × day), excess noise level 0.000. Upon attaining those targets, the original environmental behavior index of Table III would change to that shown in Table IV.

With the elaboration and dissemination of monthly progress reports, the school community can follow the improvements achieved and can find stimulation to

Table IV. Hypothetical environmental behavior index after attaining yearly target

Positive impacts	
Solid waste sorting index	0.600/0.670 = 0.896
Programmed activities index	10/15 = 0.667
Total	= 1.563
Negative impacts	
Waste production index	0.100/0.113 = 0.885
Food scraps index	0.400/0.420 = 0.952
Energy consumption index	0.550/0.590 = 0.932
Traffic density index	0.121/0.121 = 1.000
Water consumption index	40/45 = 0.889
Noise index	55/55 = 1.000
Total	= 5.658
Overall behavior index (1.563 + 5.658)/8 = 0.903	

contribute. In case of the hypothesis at hand, and with reasonable collective effort, the environmental performance index could move from 0.728 (Table III) to 0.903 (Table IV) within one year. This procedure represents a powerful educational tool in the hands of dedicated school administrators. Table IV provides information on the main remaining bottlenecks. Programmed environmental activities, water consumption and waste production have the lowest values. The index procedure brought those facts to the attention of the school community.

This hypothetical example illustrates how a school community can agree upon a set of targets in order to challenge itself and derive satisfaction from new patterns of behavior.

Although in an ideal case, KPI for schools are established at the municipal or regional level, nothing prevents individual schools from taking the initiative and providing benchmarks even in the absence of those KPI. In fact, the idea of the present study was exactly this: induce bottom-up procedures that might provoke actions by municipal or regional administrators. The method of index targeting is in accordance with the project competition parameters of *The Guardian* (2015) in as much as it brings out ideas for improving school life, targets long-term results and is transferable to other schools. The relevance of the index resides in its simplicity. A single number with known significance conveys to the community continuous information on its progress in pursuing behavioral targets.

The practice of regular measurements to update the diagnosis is in accordance with Kollmuss and Agyeman (2002) who concede that direct experience is more effective in producing behavior change than indirect experience like lectures on the environment.

Conclusions

Students are not conscious of the impact their school exerts on the municipal environment, because school performance measurements up to now are restricted to academic achievement.

The environmental performance of the sample school has been quantified in form of a diagnosis as a first step toward creating environmental consciousness and involvement in the school community. An environmental performance index has been developed for purposes of targeting improvements in the school proper and of inducing competition between schools.

The environmental performance of the particular school studied, has been quantified in terms of solid waste sorting, frequency of environmental education activities, solid waste production, food scraps ratio, water and energy consumption, traffic interference and noise levels.

Performance parameters on a "per person per day" basis have been transformed into fractions of ideal values in order to provide a framework for comparisons and target settings in the school universe. This is the theoretical contribution of the study to school performance analysis.

Specific design parameters have been identified for consideration in the planning of new schools. They include the provision of solar panels, of rain harvesting facilities and of open ground areas for rain infiltration.

The definition of an environmental performance index as fractional approach to perfection simplifies comparative performance evaluation.

This performance index has been calculated for the school studied as the sum of the fractional approaches to perfection for all measured parameters, and is proposed as example for other schools in the absence of a municipal or regional reference value.

The reference values used for calculating the performance index are dynamic. They have to respond to local realities and create new challenges to school communities.

The general dimensionless nature of the proposed indexes gives them universal significance and applicability.

The study demonstrated to the community that school performance consists of academic, environmental and structural aspects.

The procedure insisted on direct experience with the environment by involving students in the measurement of all parameters studied, and prepared the community for participation in national and international contests.

The index method represents a benchmarking experience in the region for evaluating environmental impacts of schools and is transferable to other schools.

The most appropriate way to close this report is to repeat the statement from the Environmental Performance Indicators (2014): "We are what we measure. It's time to measure what we want to be," and by extending an invitation to school communities worldwide to use the method proposed here to measure what they want to be.

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