

A Transversal Sustainability Analysis of the Teaching-Learning Process in Computer Students and Groups

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Abstract

Since the first UN conference on the environment, in 1972, many agreements seeking to establish goals to balance economic and social growth with environment preservation have been made. Regarding Information Technology (IT), the Green IT concept comes up. Such concept can contribute to a more sustainable environment and ensure economic benefits. In this context, we conducted a transversal field research using the survey method on a sample of 150 students of a technical IT course from five campuses of the Sao Paulo Federal Institute of Education, Science and Technology in order to identify their competences (knowledge, abilities and actions) regarding sustainability in its broad aspect and applied to IT. As a result, there is an opportunity to work on the sustainability concept and use it to turn the students into a collective transformational agent. It was also identified the need to further develop their abilities related to Green IT and its importance to the IT field.

Keywords

Environmental education • Green IT • Professional education

45.1 Introduction

The United Nations Decade of Education for Sustainable Development: 2005–2014 (DESD), coordinated by UNESCO [1], states that sustainable development is comprised by three areas – society, environment and economy – that indicate a long term and continuous changing process supported by culture (values, diversity, knowledge, language, world perspective, way of being, relating, believing and acting). The DESD sustainable development view is “a world where everyone has the opportunity to benefit from quality education and can learn the values, behaviors and life

styles required to sustainable development and positive social transformation” [1]. For this reason, the Education for Sustainable Development (ESD) main theme is the respect and concern about a high quality education.

Sachs [2] corroborates this concept by defining that the sustainability tripod integrates social relevance, ecological prudence and economic viability. However, adding another four dimensions enhances this definition: cultural sustainability, balanced territorial distribution, political sustainability (by pairing development and biodiversity preservation) and international political sustainability (by keeping peace and preserving humanity’s legacy).

In Brazil, the National Environment Policy (NEP) states that every level and modality of the teaching process must address the sustainability theme and clarifies that environment covers the “interdependency between the natural, socioeconomic and cultural environments”. Operational guidelines for professional education in Brazil establish that all technical courses should preferably include three dimensions: “theoretical and practical skills of the

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profession; general knowledge related to the profession; common attitudes and competences related to a professional area and working in general” [3]. In an organizational context, these dimensions are defined as ‘knowledge’, ‘abilities’ and ‘actions’. Knowledge means ‘know-how’ and includes general, theoretical, operational and environmental expertise; abilities are the ‘how to do’ and relate to one’s professional experience; finally, actions mean the ‘how to be/act’ and refer to personal and professional attributes [4].

During 2008, the Federal Institutes of Education, Science and Technology (FIs) were first created in Brazil. Such institutes are specialized in offering professional and technological education; they seek to strengthen the productive, social and cultural arrangements and to encourage environment preservation researches [5]. By doing so, the FIs cover the economic, social, environmental and cultural dimensions stated by Sachs [2] and DESD [1].

‘Information and Communication’ is one of the guidelines of the courses offered by the FIs. In turn, Information Technology (IT) can contribute to a more sustainable environment and ensure economic benefits, characterizing a concept known as Green IT [6–8]. Finally, it is of common assumption that talking about Green IT in the classroom contributes to the appropriate use of IT and to the training of ecologically conscious citizens [9–11]. Considering those facts described above, made tried to identify - among senior students of the IT course from five campuses of the São Paulo Federal Institute of Education, Science and Technology (FISP) - their knowledge, abilities and actions regarding sustainability in its broad aspect and applied to IT through Green IT practices and conscious consumption. Given this context, this paper contributes to the sustainability transversality in the teaching-learning process by listing themes that can be discussed in IT courses and, consequently, be part of the students’ education on citizenship concepts and work qualifications.

45.2 Information Technology and Sustainability

The increasing consciousness about global warming, electronic garbage disposal and institutions’ images are turning the attention to environment protection. Regarding IT, the Green IT concept was conceived and its role is to provide a more sustainable environment and offer economic benefits at the same time [7].

Harmon, Demirkan, Auseklis and Reinoso [8] argue that the main IT sustainability goal is to enable companies to use computational resources in a more efficient way and to improve their global performance. Viotto [12] adds that IT

sustainability is not restricted to being concern about the environment and the reputation of organizations, since it can offer economic benefits, as pointed by Murugesan and Laplante [7].

Murugesan [13] suggests a few ways of how IT can contribute to sustainable development, such as: reducing electric power consumption of datacenters, computers and other computational systems; reconditioning and reusing old equipment, recycling obsolete ones; projecting computers, servers, cooling systems and datacenters focused on energy efficiency and environmental security; and manufacturing electronic components, computers and other subsystems with minimal environmental impact.

Besides that, some simple actions make a difference, like: preferring documents in digital format; reusing printed pages as draft; refilling used printer cartridges; configuring desktops to turn off their screens when idle or setting them to sleep when user is away; turning off any equipment not being used; acquiring products with energy efficiency compliance and/or manufactured by companies concerned about the environment [14–16].

Academic papers about the environmental issue are scarce and localized, but they are more common in the corporate world and specialized media. In 2009, Symantec interviewed IT executives from 1052 companies and found out that Green IT became a priority since it had been receiving bigger funding and more priority. The results also indicated that IT is now the center of such initiatives and professionals seek for a working environment that leans on sustainable practices [17].

In this sense, Tres [18] states that due to the market’s lack of professionals with practical knowledge on sustainability, Green IT certification programs have emerged. Some of them are Green IT Citizen and Green IT Foundation [19], CompTIA Green IT [20] and Foundation Certificate in Green IT [21].

From the academic point of view, the importance of working on this subject at all levels of education is evident. However, the lack of formal definitions regarding Green IT, the small number of institutions that offer content related to the theme and the scarcity of related programmatic content and guidelines in schools go beyond Brazilian borders [9, 10]. Evangelou and Page [9] propose themes and strategies grouped by education level in order to guide the production of academic material. Robila [10] proposed an introductory module that addresses sustainability in every IT course and reinforces that the development of abilities in Green IT is a competitive edge for these professionals.

Therefore, adding the concept of Green IT to IT courses may help to raise better citizens and professionals that meet the market’s demand on this subject.

45.3 Method

To identify the knowledge, abilities and actions regarding sustainability in its broad aspect and applied to IT through Green IT practices and conscious consumption of our sample, was conducted a transversal field research in November 2013, with exploratory and descriptive objectives using the survey method.

The subjects of this research were 150 senior students of the Computer Technician course (offered concurrently with high school) from FISP's campuses. The main differences between the Computer Technician concurrent with high school course and the Computer Technician alone are that the former lasts for 3 or 4 years, has subjects related to high school curriculum and the technical course and an internship period is optional. On the other hand, the latter is modular (lasts for three or four months), and the subjects are all related strictly to the technical scope, having a mandatory internship period.

Only senior students were interviewed due to their experience and their imminent job market insertion. The random probabilistic sample approach was chosen, stratified by the proportion of students by campus and course, thus ensuring the participation of all campuses. This method was applied to the whole population, adopting a confidence level of 90%, considering an error chance of 5% and having an amount of 98 students divided by campuses.

In the absence of a certified instrument to assess the competences on this matter, we created a survey – available at <https://pt.surveymonkey.com/r/D2ZC3LC> – with opinion measurement questions, grouped by matter and scope as shown in Table 45.1.

Except for the statements regarding the abilities which were focused on assessing the students' understanding of IT sustainability [14–16], the rest of them covered areas such as citizenship and conscious consumption [22]. On the latter, guidelines from the Akatu Institute [23] presented in Table 45.2 were followed.

Finally, at the end of each statement block, students were asked for the source of their knowledge, abilities and actions in order to better analyze the results.

After data gathering through the online survey, a quantitative analysis of this data was performed following three steps:

1. Convert the data to a Microsoft Excel format;
2. Perform a statistical analysis to synthesize and correlate the data using the IBM SPSS software; and
3. Analyze and interpret the correlations and create charts using Microsoft Excel.

The variables used in the statistical analysis came from the survey statements and were used to calculate Person's

correlation coefficient. The analysis was focused on the positive and negative correlations with a 95% or 99% certainty.

45.4 Results

The statistical analysis did not show any meaningful correlations between each campus. It is explainable by the fact that all campuses follow the same didactic-pedagogic guidelines, even though they offer different courses. Besides that, the school was pointed as the main source of knowledge, abilities and actions, followed by life experience, family and work (Fig. 45.1).

An interesting data was that 50% of the students said that the school was their only source of knowledge, abilities and actions. When analyzing each course individually, results pointed that the proportion of the Computer Technician course was 76%, whereas the proportion of Computer Technician concurrent with high school course was 74%. This confirms that the course itself does not interfere in this matter.

Regarding the knowledge matter (Fig. 45.2), 62.5% of the students answered all statements correctly, and each statement by itself had a correct answer rate greater than or equal to 50%. Regardless of course, 83% of the students were aware of the environmental impact caused by the world economic and production activities; they agreed that knowing the products' lifespan can help to reduce the amount of electronic garbage. An opportunity to work on the conscious consumption concept was identified: to only buy what one really need; to know and understand one's rights as a consumer; to collect information about companies and their products; and how to correctly discard them are, according to Akatu Institute [22]. These actions that can turn a consumer into a collective transforming agent – given that the act of consuming has an impact on society and on the environment.

The most significant correlations indicated that:

1. 37% of the students said that conscious consumption is related to income;
2. Those who said they were aware about the impact of economic and production activities (89%) agreed that it is important to know more about the products' lifespan (93%), but they do not always donate devices that are no longer being used (36%); and
3. The 74% who acknowledged that individual activities have an impact on everyone else also agreed that it is the government's sole responsibility to eradicate poverty and to protect the environment (84%), and also stated that they would appeal to a consumer protection agency (51%).

Table 45.1 Statements by matter

Matter	Statements
Abilities	I set my computer to turn off the screen when idle
	I set my mobile device to power saving mode
	I set my computer to sleep whenever I am away
	I divide my computer components into ones that can be recycled or reused from those that must be discarded
Knowledge	The world economic and productive activities are modifying the Earth's climate and that can cause severe damages that must be prevented or avoided
	The origin of the products we use is very important since its production may have caused damages to the environment and to society
	Though we live on the same planet, it is an overstatement to say that what one person does affect all others
	Conscious consumption is only possible for people above a certain paygrade because the poor cannot afford to "consciously choose things"
	Plastic, glass, metals and boards are the main components of a computer that can be recycled
	When equipment turns into electronic waste, its best destiny is a chop shop in order to remove its toxic components and recycle its materials
	Only the government has the power to ensure society's balance and address issues like poverty eradication and environment protection
	Replacing meetings by videoconferences contributes to reduce carbon emissions
Actions	When printing, I set the printer to use both sides of the paper sheet
	Instead of throwing away my electronic equipment, I donate them
	I usually do not buy products from certain companies as a way of punishing them for harming society, the environment or local communities
	I usually replace my electronics by newer models
	I shut down equipment not in use
	I prefer to buy equipment with energy efficiency certifications
	I take batteries to a collection station
	I avoid printing
	I already purchased something weighing its environmental pros and cons
	I take into account the proximity and ease of access between my home, work and school/university and try not to go around town
	Whenever possible, I tell people that for them to be healthy it is important to balance eating, physical activities, family time, recreation time and work, among other things
	I use printed pages as draft
	I reuse printer cartridges
	If an advertisement bothers me by being inappropriate or awkward, I speak out and encourage others to do the same
	If I have problems with a product or service and am not able to find a solution with its respective company, I appeal to a consumer protection agency
	I treasure cultural diversity and individual characteristics of each person and stimulate everyone to find and follow their own opinions and feelings

Table 45.2 Guideline on conscious consumption from the Akatu Institute

Theme	Orientation
Consumer's power	Every purchase is an act of power because it has an effect on society and on the environment. By using this power for good, the self-aware consumer becomes a collective transforming agent
Why buy It	Buying only what is necessary is a great lesson on conscious consumption
What to buy	To consciously choose between one product and the other is to compare their effects on social relationships, the economy and the environment, from its production to its disposal
From whom to buy	By choosing products or services from socially and environmentally responsible companies, the consumer contributes to these companies' success
How to use it	Using a product until the end of its lifespan avoids waste, helps to sustainably use nature's and society's resources and avoids garbage hoarding
How to buy	By choosing payment conditions, having the possibility of doing exchanges and getting informed about companies, products and services, the consumer changes himself and society
How to discard	Recycling all materials that can no longer be used is essential to a sustainable use of nature's and society's resources and to avoid garbage hoarding

Fig. 45.1 Sources of competence regarding sustainability

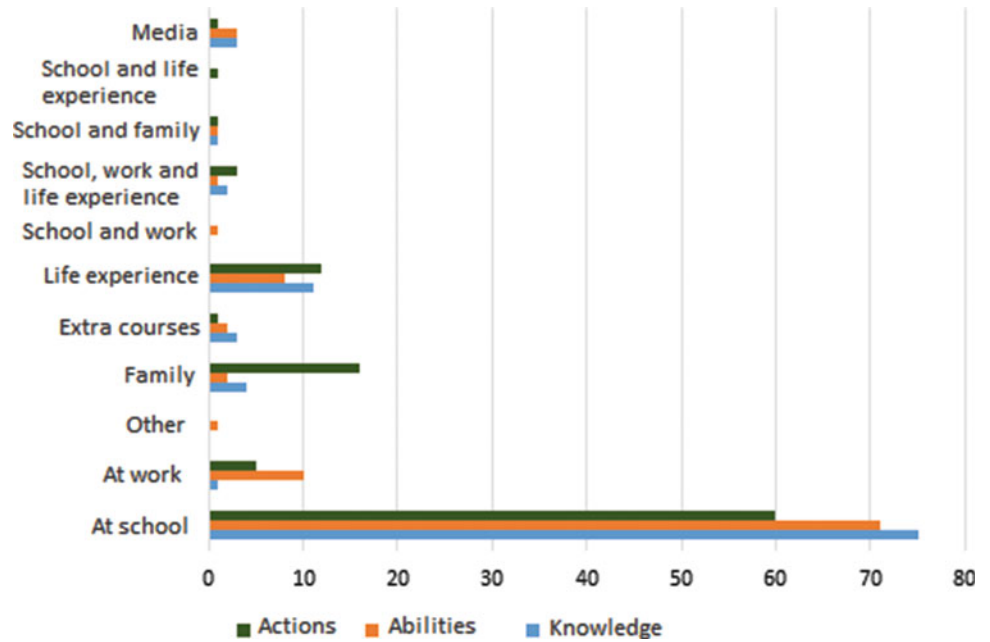
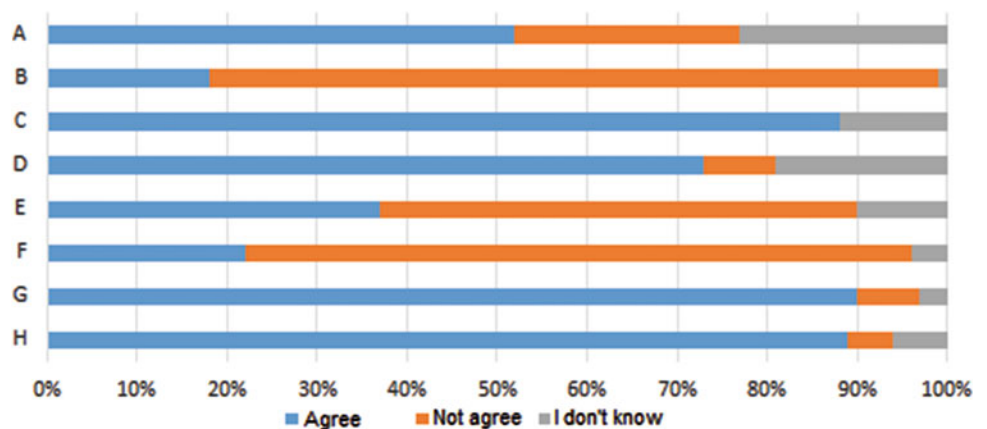


Fig. 45.2 Results for the knowledge matter



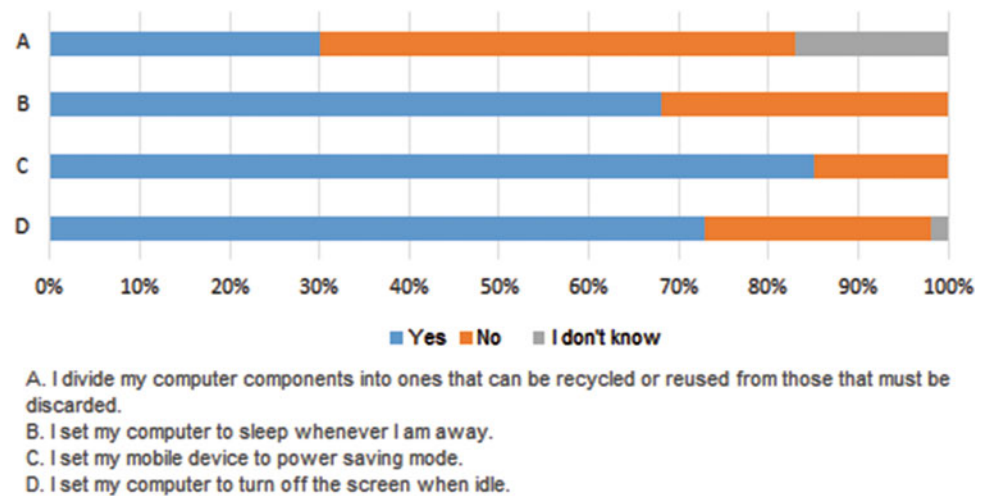
- A. Replacing meetings by videoconferences contributes to carbon emissions reduction.
- B. Only the government has the power to ensure society's balance and address issues like poverty extinction and environment protection.
- C. When equipment turns into electronic waste, its best destiny is a chop shop in order to remove its toxic components and recycle its materials.
- D. Plastic, glass, metals and boards are the main components of a computer that can be recycled.
- E. Conscious consumption is only possible for people above a certain paygrade because the poor can't afford to "consciously choose things".
- F. Though we live on the same planet, it is an overstatement to say that what one person does affect all others.
- G. The origin of the products we use is very important since its production may have caused damages to the environment and to society.
- H. The world economic and productive activities are modifying the Earth's climate and that can cause severe damages that must be prevented or avoided.

Regarding the abilities (Fig. 45.3), it was noted that students who said they know how to do the procedures mentioned in the statements also had a positive response regarding Green IT. However, when dealing with a more complex activity, most of them (70%) did not know how to do it, which indicates they were not familiar with the subject

or that it was poorly developed during hardware classes. On the correlations:

1. Those who knew how to set the computer to turn off the screen when idle (73%) also knew how to set sleep mode when they are away (75%);

Fig. 45.3 Results for the abilities matter



- Those who knew how to turn on the power saving mode in mobile devices (85%) also knew how to set the sleep mode (72%) and usually preferred buying products with an energy efficiency certification (89%); and
- Those who knew how to distinguish recyclable components from disposable components (30%) had already thought about the effects of a purchase on the environment (53%) and usually do not buy some products as a way to punish companies (73%).

On the actions related to the conscious consumption and citizenship themes (Fig. 45.4), the absolute majority of the students were aware that material goods are not related to quality of life and that they value and respect cultural diversity and individual characteristics of each person. Nevertheless, students still need to be aware that an act of consumption must be bounded by real needs and that their rights as consumers must be respected.

On the Green IT practices (Fig. 45.5), given the ease of access to information and the development of abilities in school, there is a great probability that these practices will start to be used more often and change behaviors as long as they increase awareness.

45.5 Conclusions

Even though there is a political will on Brazil's professional education area to present and work on the sustainability theme, it is still not discussed in the classroom. Nonetheless, the field research showed that the school is considered the main source of knowledge, abilities and actions. These findings confirm that it is important to work on sustainability in its broad aspect and applied to IT in the school environment, as stated by Evangelou and Pagge [9], Robila [10] and Ramalho, Costa, Lopes and Young [11].

When reviewing the state of the art, we noted that most researches about IT and Green IT comes from private organizations. On Green IT practices, the papers prioritize the definition and implementation of techniques to reduce power consumption and decrease carbon emissions. Regarding the method used in this paper, we had no difficulties in getting access to the sample and conduct the survey. However, we had to devote some time creating the survey because there is no other validated instrument available to measure the competences on this paper's theme. We consider the survey presented here as one of the main contributions of this research. It was able to fulfill its goal, and even though the presented results are restricted to our sample, we believe that our method can be applied in other scenarios where such competences must be evaluated.

On the knowledge matter, the students obtained a hit rate of 62.5%, which is considered average in a school environment. On the more complex abilities matter, 70% of the students did not know how to execute them. This might indicate that such matter is not discussed in the classroom. In light of this, we believe that the sustainability theme is discussed in an indirect and maybe unaware manner, covering only citizenship exercise, respect (to others, to the environment and to diversity) and waste reduction.

On the IT contributions to a sustainable development, this paper showed that even though technological evolution is constantly demanding infrastructure and power and contributing to environmental pollution and electronic waste, it is possible to decrease the environmental impact and provide economic benefits through Green IT. We showed the importance of discussing this theme in the IT area in an economic, environmental and social sense, both to organizations and to professionals.

Finally, we hope that this research – available at <https://pt.surveymonkey.com/r/D2ZC3LC> – can serve as a guideline for other education institutions when including

Fig. 45.4 Results for the action: conscious consumption and citizenship matter

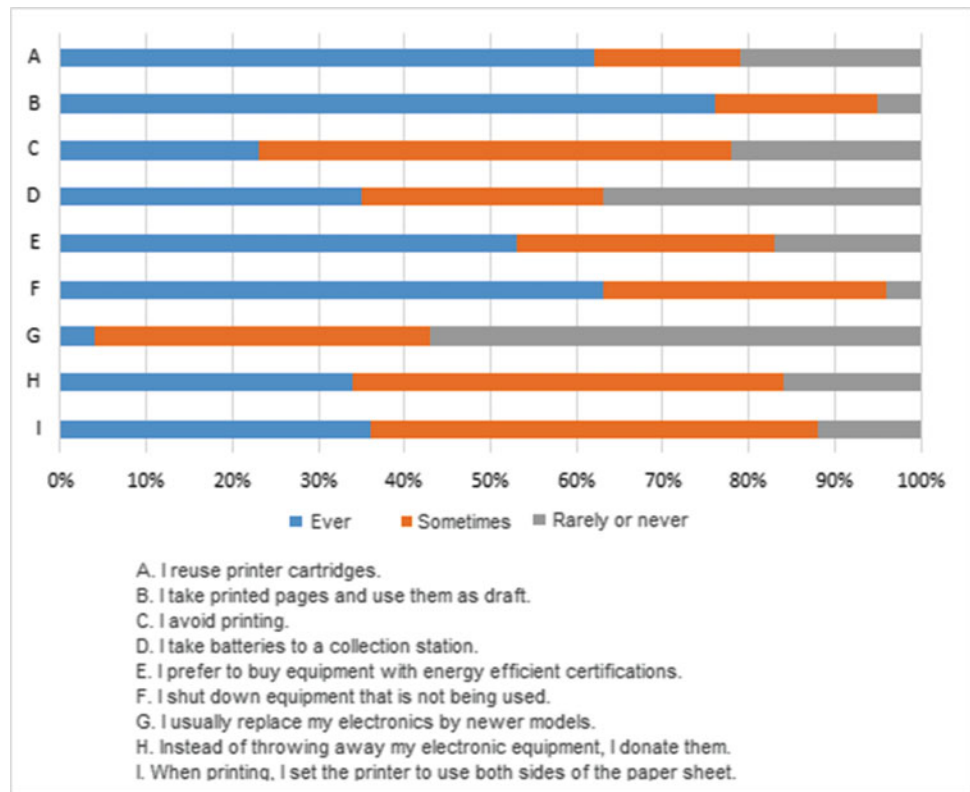
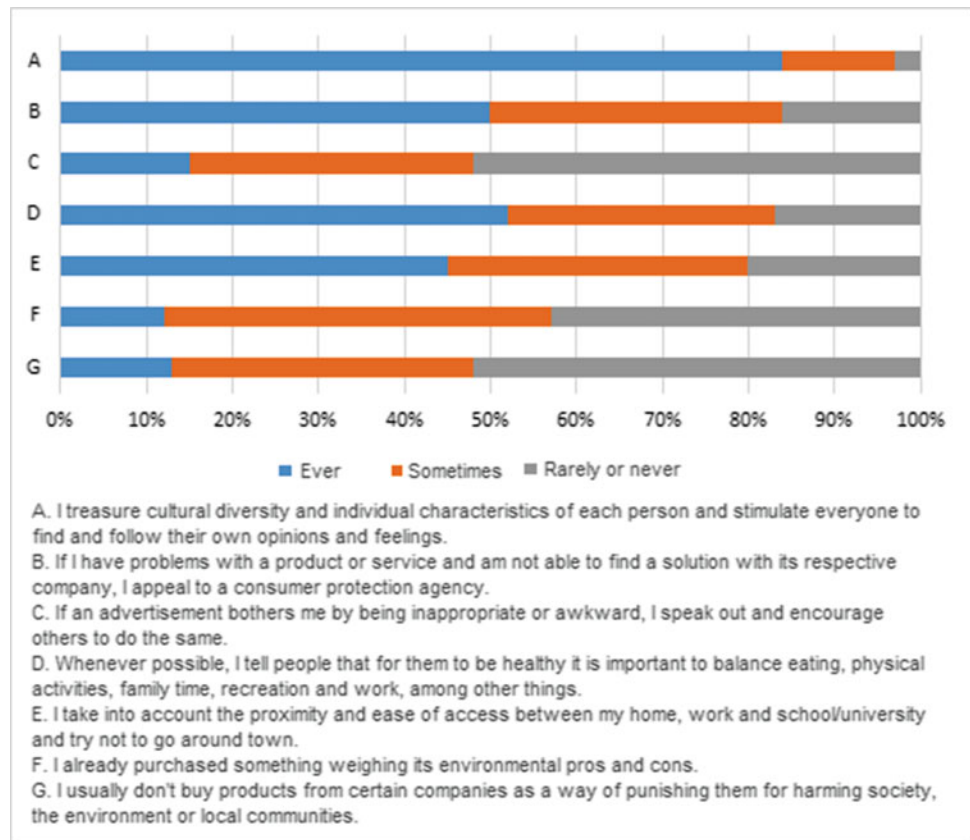


Fig. 45.5 Results for the action: Green IT practices matter



environmental education in a transversal way for their educational projects. Regarding IT courses, we hope that their curriculums will be updated in order to comply with the market demand for Green IT professionals and, above all, to train students to be empathetic with this matter and aware of their role in the world.

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