ORIGINAL RESEARCH

Do young people really engage in sustainable behaviors in their lifestyles?

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Abstract

In recent years, environmental problems have become a serious issue worldwide due to the increasing damage caused by climate change. People's environmental awareness has grown, and public opinion is now demanding effective action from governments. Young people around the world are playing an important role in this, with the Fridays For Future movement, calling on policymakers to make environmental protection one of their political priorities. Through a survey of 1,975 high school students, this paper aims to contribute to the study of young people's sustainable behaviors and their awareness to take effective action against environmental degradation, to explore their concerns and opinions about environmental issues, and to find out what ecological practices they are willing to adopt in their daily lives. Data analysis is conducted using tree-based methods to examine the sustainable behaviors and define the key practices that constitute them. The results of classification tree show that sustainable behaviors impact lifestyles, whether through less demanding actions such as turning off the faucet or appliances, or willingness to work as a volunteer, among others. The Random Forest provides us with a ranked list of sustainable behaviors that young people engage in to reduce and stop environmental degradation. The results of this study may be of interest to policy makers who need to plan educational pathways for students from elementary school to university, as environmental culture must be a cornerstone of our society.

Keywords Environmental problems · Sustainable behaviors · Classification and regression trees · Random forest

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1 Introduction

Global climate change is inflicting increasing damage on our planet, to such an extent that Bouman defines it "one of the most worrying issues mankind has ever faced" (Bouman et al., 2020). It is time to take decisive action to address this environmental, as well as social and economic, crisis. We need a broader awareness of the importance of sustainable development at the level of collective responsibility, involving both companies and citizens according to their roles. The challenge for a better future requires that people, whether adults or youths, adopt more virtuous behaviors.

Since the personality of the individual develops through the experiences and the socio-cultural environment, this awareness should begin at a young age and continue to be one of the basic principles in adulthood (Evans et al., 2019; Otto et al., 2014; Soydan & Samur 2017). In the first years of life, the family and the educational system play a crucial role in the formation of environmental sensitivity. They can influence the personal attitude of an individual in choosing which behavior to adopt towards the environmental problems. Environmental education can nurture the awareness that the sustainable development of a society can be achieved if individuals adopt environmentally friendly behaviors and an environmentally oriented lifestyle (Shutaleva et al., 2022).

The individual can choose to become an environmental activist, engaged as a member of organizations defending the planet, or a non-activist, simply observing proper social-ecological practices, or, less likely, remaining indifferent to the problem. In fact, social-ecological practices are composed of two main components: an individual's perception of the severity of environmental problems and a willingness to adopt and put into practice positive behaviors (Shutaleva et al., 2022).

An environmentally conscious lifestyle means responsible behavior in using natural resources in order to preserve them and includes simple but effective everyday actions such as saving water and electricity, recycling, buying ecological goods, using environmentally friendly means of transportation, as well as bike-sharing (Maranzano et al., 2021).

The challenge for the next few years is to balance needed economic growth with positive solutions to the most pressing problems: pollution of air, water and soil, along with wasting of non-renewable natural resources. In other words, we must strive for sustainable development, which can be called "sustainable" if it meets the needs of the present generation without compromising those of future generations (WCED 1987; Alaimo 2018). As Alaimo & Maggino (2020) remark, the concept of sustainable development has not a univocal definition due to its different fields of study, and has changed over time, following the evolution of the international debate. At the same time, the relationship between economic development and environmental management is complex and has implications for human health and the quality of life of individuals (Alaimo et al., 2021).

It was in 1987 that the Brundtland Commission (WCED 1987) gave the first definition of sustainable development (Alaimo et al., 2021) and called for both ensuring global equity for future generations and achieving sustainable growth through technological and social change that focuses on the three fundamental components of sustainable development: maintaining ecological and environmental health; creating economic welfare and ensuring social justice (Ariffin & Ng, 2020). These principles are reflected in the 17 Sustainable Goals of the UN2030 Agenda (UN, 2015), which lists the priorities that need to be addressed by policy makers at all levels of government, from local to international (Alaimo

et al., 2021), but also require strong commitment at the individual level. At the base of it all, however, are the individual behaviors of citizens and their ecological awareness, their sense of belonging to a community that wishes to preserve the future of the next generations.

Young people found a way to claim their concern about this complex problem by participating in an international protest environmental movement which have gained increasingly attention by public opinion. The movement, called Fridays For Future (FFF) is composed of students who, around the world, demand to policy makers to take actions to prevent global warming and climate change and make it a priority on the international political agenda (Fridays for Future, 2020). All those who wish for a more sustainable future are pinning their hopes on youth to reverse the harmful course of recent years. But to what extent are young people committed to sustainability through their daily ecological actions, and are they confident that their contributions as individuals could be effective in combating environmental degradation? Answering these questions could help identify specific sustainable best practices that can be disseminated among young people through the most effective means, i.e., educational institutions or volunteer associations, and that can be helpful in planning environmental education pathways.

The purpose of this paper is to explore whether young people simply share ethical statements about environmental protection driven by social desirability (Binder et al., 2020), or whether they believe they can be protagonists in the fight against environmental degradation.

The survey was conducted in 2018, and at that time Fridays for Future took the first steps toward its endorsement. Thanks to its leader Greta Thunberg, who denounced the emergency of global climate change and the inaction of politicians, the movement received media attention that culminated at the 2019 United Nations Climate Summit, when her harsh assertions stirred consciences and had a positive impact on public engagement, sparking young environmental movements (Sareen, 2020).

Martiskainen et al., (2020) conducted an in-depth analysis of the motivations, emotions, and actions of climate strikers who participated in the 2019 FFF global strike in six cities: Brighton and London (United Kingdom), Montreal (Canada), New Haven and New York (USA), and Stavanger (Norway) (Martiskainen et al., 2020). By interviewing 64 strikers, the researchers found different levels of knowledge about climate change and different daily behaviors to combat climate change, as well as different motivations for participating in climate strikes. Martiskainen et al., (2020) believe that the phenomenon is still underresearched and call for more scientific attention to study the multidimensional characteristics of young climate strikers as the phenomenon is "dynamically evolving".

To explore young people's concern about environmental issues, a survey of high school students was conducted in 2018 to understand the extent to which young people care about the environment, whether they truly feel the gravity of the situation, and whether they want to commit to a more sustainable world. The goal of the analysis is to determine the pattern of sustainable behavior among young people who believe they are making an effective contribution to combating environmental degradation, as opposed to those among their peers who share ethical statements about environmental protection only because they are socially desirable.

Identifying sustainable behaviors could be useful for spreading best practices among young people, whether through educational programs, volunteerism, or role models that are particularly effective in the context of youth, to encourage them to adopt sustainable behaviors as a lifestyle.

The paper is organized as follows: after the introduction, section two deals with a description of the survey on environmental issues and sustainable behaviors of young people. Section three illustrates the methodology and Sect. 4 discusses the results of the analyses. Section five concludes with some brief remarks.

2 Environmental problems and sustainable behaviors of young people

The survey on environmental problems and sustainable behaviors of young people was carried out among 1,975 students of Apulian high schools (Southern Italy) within the framework of the Italian Ministry of Education national Project for a Scientific degree in Statistics – PLS (PLS, 2022). Students' participation in the survey was anonymous and was granted through formal privacy consent. They were approached with a web questionnaire consisting of 28 questions divided into three sections, namely: (I) Knowledge about the phenomenon and main concerns about environmental problems. (II) Sustainable behaviours and lifestyle. (III) Future expectations and suggestions on the role of institutions and citizens. Students expressed their opinions and perceptions about environmental issues using a five-point Likert scale (from 1=lowest value and or 5=highest value) for most items or by means of multiple responses. A total of 2,327 questionnaires were collected, but after a careful cleaning phase, only 1,975 were included in our analysis. The study assumed that environmental attitudes can become positive practices when people are concerned about environmental problems and feel that, as citizens or as part of a community, they can effectively change the situation through their actions.

Therefore, an exploratory analysis was conducted to learn respondents' opinions about the severity of climate change problems and their willingness to contribute to environmental protection through their daily actions, as well as their vision for the future.

Although the student respondents were a "convenience sample," it has proven to be very effective for exploratory analyses that aim to examine little-studied phenomena or populations (Baker et al., 2013) without testing some hypotheses about the overall population. Compared to random sampling, it also has the advantage of rapid and less costly data collection. However, the students interviewed can be considered quite representative of their peers (%F=53.3; %M=46.7), either if we consider the reference population of Italian students (%F=55.4; %M=44.6) or the students of southern Italian schools (%F=56.6; %M=43.4). The source for these data is the Ministry of Education and Research for the year 2018–2019 (MUR, 2022). The main statistics summarizing the students' responses and their characteristics can be found in Table 1. The average age of the students surveyed is 16.3 ± 1.5 years and, as for their Italian peers, ranges from 13 to 21 years, with very few outliers excluded. The majority of students surveyed reported being fairly well informed about environmental issues (60.5%). The most frequently used sources of information are events that deal specifically with this topic (36.5%), newspapers (33.3%), very far from that is school (12.6%) and the Internet (8.4%). The last two answers are a bit surprising, as is the very low percentage of the alternative "family and friends" (2.1%). On the one hand, it had been expected that respondents would discuss environmental problems mainly with relatives and friends or with teachers in class; on the other hand, we had also expected a higher relevance of the Internet due to the massive use of social media among young people (Shutaleva et al., 2022; Pickard, 2020). Both hypotheses could not be proven in our data. Rather, students inter-

Table 1 Main characteristics of respondents and their knowledge of environmental problems (n=1,975)

Gender	53.3
Female	46.7
Male	
Age	16.3(1.5)
Mean age±SD, year	
Section 1: Knowledge of the phenomenon and perceptions	
Level of information about environmental issues	1.5
None	26.4
Poor	60.5
Fair	11.6
Good/Excellent	
Main sources of information (% of responses)	36.5
Events on the topic	33.3
Newspapers	12.6
School	8.4
Internet	9.2
Other (TV, Books, Family or friends, Voluntary associations)	
Degree of personal concern about environmental protection	0.5
Not concerned	2.6
Slightly concerned	30.7
Fairly concerned	49.6
Very concerned	16.6
Extremely concerned	
Degree of importance that Municipality of residence attaches to environmental protection	2.4
Not all important (never cares)	19.4
Slightly important (rarely cares about it)	65.5
Moderately important (neither neglected nor extremely considered)	12.0
Very important (among the priorities of the political agenda)	0.9
Extremely important (very much focused on it)	
Perceived level of sensitivity of school attended to environmental issues.	8.9
None (we never discuss environmental issues)	35.6
Mild (we rarely discuss them)	38.9
Moderate (environmental issues are neither neglected nor given extreme attention)	15.2
High (environmental issues are often discussed)	1.4
Very high (environmental issues are one of the main topics)	
Perceived degree of pollution in living territories	2.1
None	28.9
Low	48.1
Moderate	18.4
High	2.5
Very High	
Level of satisfaction about quality of public and green areas	16.3
Not all satisfied	48.9
Slightly satisfied	28.2
Moderately satisfied	6.6
Very/completely satisfied	
Willingness to increase the quality of public and green areas as a volunteer	52.3
No	47.7
Yes	

viewed showed very responsible behavior by increasing their knowledge through personal engagement (attending events and reading newspapers). Almost every second respondent answered that they consider environmental protection very important (49.6%). A large part of the students felt that neither the city administration nor their teachers paid enough atten-

tion to this issue, regardless the type of school attended[1]. And yet, it is undeniable that for the formation and spread of an environmental culture, it is necessary that the socio-educational system, which includes not only the teachers but also the relatives, understands its crucial role. From the initial responses, it is clear that students are concerned, and to understand the reasons for this, we have asked some questions to capture the perception of the severity of the problems in the residential areas, but also in a broader context. Nearly 80% of respondents indicated that they considered the level of pollution in their area to be low to moderate (77.0% overall) but in the same proportion (77.1%) are slightly to moderate satisfied of the quality of of public and green areas. Despite the 52.0% of students surveyed who are decidedly willing to volunteer so that the community can benefit from public spaces (see Table 2), our interest is focused on the 35.9% of insecure youth, as they are more likely to be taken without much effort.

However, as shown in Table 2, given the high scores, respondents' overall concern about key climate changes is quite high. In terms of the goals of our analysis, this could be interpreted as a good background for developing strong environmental awareness.

Among the most frightening environmental problems, students ranked damage to livelihoods such as air and water pollution first, followed by planetary threats such as global warming and deforestation. Electrosmog received the lowest score, and we can imagine that the reason for this is that people are still not fully aware of the effects of electromagnetism on their health due to a lack of information about this area of research. However, this is not surprising because we expect people to be more concerned about what can be seen or perceived as an urgent threat.

Section 2 of the questionnaire addressed the ecological practices that the respondents use as individuals or as a family (see Table 3) and contains the key variables for the aims of our analysis.

Table 2 Percent distribution of respondents by evaluation of the main environmental problems

Environmental problems	Ratings (*)					Mean ratings	Median ratings
	1	2	3	4	5		
Water pollution	7.3	13.5	22.3	24.1	32.8	3.7	4.0
Air pollution	2.4	9.0	17.8	28.6	42.3	4.0	4.0
Depletion of natural resources	4.5	11.5	22.8	27.1	34.1	3.8	4.0
Global warming	3.4	9.8	18.1	29.2	39.4	3.9	4.0
Deforestation	5.0	9.0	19.6	30.0	36.4	3.9	4.0
Noise pollution	7.9	19.8	32.1	26.6	13.6	3.2	3.0
Soil pollution	8.4	22.7	30.0	23.1	15.8	3.2	3.0
Electromagnetic pollution	11.5	23.7	28.2	21.4	15.2	3.0	3.0
Mobility	6.5	20.2	34.9	25.2	13.2	3.2	3.0
Lack of public green areas	8.3	21.4	27.3	23.3	19.6	3.3	3.0

(*) % of positive answers in each point of the scale

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[1] In recent decades, many Italian schools have merged into larger institutions to reduce costs and make better use of educational resources. They have changed their names to Higher Education Institutes while offering different educational tracks, abandoning the traditional distinction between lyceum, technical or vocational curriculum.

Table 3 Percent distribution of respondents by environmental practices

Secton2: Habits and behaviors	
Means of transportation used daily	12.9
Public transport	41.8
Car/motorcycle	2.4
Bicycle	42.9
On foot	
Recycling habits of the family	84.0
Yes	16.0
No	
Type of materials recycled (Yes)	96.3
Paper	98.8
Plastic	93.8
Glass	87.3
Organic	41.0
Oil	56.5
Batteries	57.9
Drugs	31.7
Electric cables	
Degree of knowledge about the preparation process for recycling materials	4.9
	23.2
None	45.8
Low	26.1
Moderate	
High/very High	
Degree of knowledge about the use of materials collected for recycling	9.2
	31.4
None	35.0
Low	24.5
Moderate	
High/very High	

About mobility, since they live in a big city where there is no subway but only city busses, they probably live near the school and reach it on foot or are brought there by their parents in a vehicle (car or motorcycle).

Environmentally friendly behavior is a matter of public consciousness because it involves practices that serve the common good of environment, which should take precedence over the good of the individual.

As expected, recycling is a widespread practice (83.8%), and the percentage of positive responses increases for plastic (98.8%), paper (96.3%), glass (93.8%), and organic materials (87.3%). However, these are mandatory measures prescribed by municipal law, while the non-mandatory measures (recycling of waste oil, proper disposal of batteries and electric cables) are left to individual sensibilities. These actions were found to be less frequently performed, with a difference of almost 50% compared to the other group. So, we could argue that the respondents are conscientious in carrying out the recycling measures required by law. Nevertheless, this should be taken for granted and the corresponding behaviors cannot be considered as an index of the presence of a consolidated environmental sensitivity.

If, on the other hand, we turn to the so-called "non-mandatory" practices, which depend solely on the will of the individual, we can find out the significant variables that make the difference between a positive impact on environmental protection and a low respect for the environment. To conclude the analysis of the students' knowledge of the whole process of recycling materials, including the subsequent use of the collected materials, we found that it was classified as moderate.

According to the aim of this study, the most interesting results can be obtained by focus-

Table 4 Percent distribution of respondents by frequency of application of the main "non mandatory" ecological practices

Ecological practices	never/sometimes	often/always
Reuse of paper sheets	53.4	46.6
Turn off faucet	44.2	55.8
Devices stand by off	67.3	32.7
Use of ecological products	76.6	23.4
Use of draught products	83.3	16.7
Reuse of shopping bags	22.8	77.2

Table 5 Percent distribution of perceptions of respondents about the future and the role of main actors for environmental safeguard

Section 3: Future expectations	
Perception of changes in the quality of the environment	21.2
Yes, it has really deteriorated	32.5
Yes, it has slightly deteriorated	18.3
No, it has remained unchanged	26.1
Yes, it has improved slightly	1.9
Yes, it has improved a lot	
Perceived degree (%) of dependency relationship between the health of the individual and the quality of the environment in which he/she lives.	3.4
	11.4
	26.6
0–19	37.0
20–39	21.6
40–59	
60–79	
80–100	
Perception of environmental problems in the future	0.7
No, there will be any problem	18.3
Yes, and they will be incurable	19.5
Yes, but there is still time to protect ourselves	58.3
Yes, but they are curable only if we act restrictively and immediately	3.1
I do not know	
Perceived degree (%) of improvement in the current environmental situation due to specific controls.	3.7
	15.8
0–19	34.1
20–39	33.8
40–59	12.6
60–79	
80–100	
Actors responsible for improving environmental protection (% of responses)	48.3
	13.5
Italian public institutions (municipalities, regional authorities, Italian government)	8.8
International institutions (EU, ONU, …)	16.9
Educational institutions (schools, universities)	12.5
Third sector (environmental associations)	
Citizens	
Personal behavior perceived as effective in combating environmental degradation	57.0
	43.0
No	
Yes	

ing on the "non-compulsory" behaviors, since they can really make the difference for environmental protection. Table 4 shows the students' attitudes towards daily practices related to environmental awareness, evaluated by the frequency of execution of the proposed types of environmentally friendly behaviors. The data show that respondents are well acquainted with the most common practices such as very often reusing shopping bags (77.2% from often to always) and sheets of paper (46.6%) as well as turning off the faucet (55.8%), but less so with others that are equally important, such as turning off appliances without leaving them in standby mode (32.7%), or using eco (23.4%) or draught products (16.7%), the use of which helps avoid buying new plastic containers. Thus, these could represent suitable predictors to be used in further and more sophisticated analyses.

Finally, the third part of the questionnaire aimed to investigate how respondents perceived the current situation and the future, both in terms of the possibility of repairing the damage by reducing the effects of climate change and in terms of the role played by the various actors in preserving the environment.

It is important to note that the majority of students believe that there is a strong connection between the health of individuals and the quality of their living environment (see Table 5) and this is in line with the findings in Alaimo et al., (2021). The number of those who believe that the quality of the environment has deteriorated in recent years far exceeds the number of their optimistic peers (52.7% versus 28.0% respectively). Despite this negative picture of the current situation, 58% of the students surveyed believe that the problems are still curable, but people need to take restrictive and immediate measures. In order to solve the existing environmental problems, five different groups of people who should be in charge of it were asked to be selected through multiple choice questions: Italian public institutions (municipalities, regional authorities, Italian government) come first, followed by third sector organizations (especially environmental associations), international institutions (EU, ONU, …), citizens and, finally, the education system. It is interesting to understand the respondents' point of view, because it can be interpreted in two ways.

The first is that the students surveyed believe that the authorities are capable of solving the environmental problems and that the current situation would improve considerably if their controls were more effective; about two thirds of them expect an improvement of 40 to 80%. Alternatively, young people may prefer to entrust institutions at various levels or the community of citizens in general with solving problems because it may be more convenient to leave critical decisions to "others." This interpretation is obvious if we read the answers to the last question right away: only 47.7% of the respondents would be willing to actively work for the protection of the environment. And this will be the central topic we will investigate in the following analysis using the Tree based methods.

3 Methodology

In this section, we briefly explain the statistical technique used for the data analysis of the student survey. We present both a classification tree (CART) that allows us to identify the path obtained by a series of personal behaviors perceived as to be effective in combating environmental degradation, and the Random Forest method, applied to assess and rank the sustainable behaviors that young people adopt to reduce and stop environmental degradation.

A classification tree identifies the relationships between a response variable, Y, and a set of predictor variables $(X_1, X_2,\ldots,X_p)$. In particular, a classification tree is a binary segmentation procedure of the data matrix that aims to generate nested sub-partitions of it that are more informative with regard to the response. In our opinion, the use of a tree-based method is preferable here, rather than simply fitting a (generalised) linear model because OLS-based regression only returns one type of best fit to the data, namely a hyperplane that is a combination of the independent variables with little power to interpret interactions among them. Moreover, the classification tree approach is chosen among the most commonly used supervised machine learning algorithms apt to cope with a categorical target, since the flexibility and robustness it offers to analyse such kind of data. A strong tolerance to missing responses as well as the absence of strict constraints in terms of distributional assumptions about the data — along with the intrinsic capability of addressing in an easy way interaction, nonlinear effects, and causal priorities — coupled with the possibility of attaining a high degree of interpretability of the classification rules, makes it a very good candidate for an explorative approach to our data (Fasanelli et al., 2020, 2017; Iorio et al., 2015; Siciliano et al., 2010). Tree-based methods are often used in data mining contexts with large datasets to study, such as social science surveys, indeed.

For an extensive introduction to tree-based methods, we refer to Breiman et al., (1984) and Hastie et al., (2013). The Random Forest (RF) method is a widely used approach for classification and regression (Breiman, 2001). In brief, RF is an iterative process that builds a set of classification or regression trees (Breiman et al., 1984) using bootstrap samples iteratively drawn from the original learning data set. Observations not used to construct a tree are termed out-of-bag observations for that tree. In order to reduce the correlation between the trees in the forest, each split in each tree is identified by using the best among a subset of predictors randomly chosen at that node.

The Random Forest method was used to philtre and rank the behaviours that young people consider useful in addressing sustainability issues, as is common among respondents who perceive themselves as effective in reducing and hopefully reversing environmental degradation.

The RF is used to further harness the informative value in our data, by strengthening the identification of influent variables via resampling. Instead of resorting to the ensemble method for prediction — something we are actually not interested in at this stage — we exploit RF as a tool to rank variables based on their ability to predict the response which is assessed by the variable importance measures (VIMs).

Given an error measure M (e.g., misclassification rate or mean squared error), VIM is defined as:

$$VIM_j^M = \frac{1}{ntree} \sum_{t=1}^{ntree} (MP_{tj} - M_{tj})$$

where *ntree* is the total number of trees in the forest, MP_{tj} denotes the error of the *t* tree when predicting all observations that are out-of-bag for tree *t* after randomly permuting the values of the *j-th* predictor variable, M_{tj} indicates the above-mentioned error of the tree *t* before permuting the values of the *j-th* predictor variable.

The RF method has the same above-mentioned advantages: it is not parametric, since no specific distribution of the response variable is assumed and does not require any specifica-

tion of the type of relationship (linear or nonlinear) between the response variable and the predictors. Moreover, it provides results for a more robust assessment of the importance of the variable compared to classical tree-based methods. For a review of RF methodology, we refer to Breiman (2001) and Boulesteix et al., (2012).

Classification trees were performed using the software SPSS version 25 (IBM, 2019) and Random Forest using *randomForest* package (Liaw & Wiener, 2002) in environment R (R Core Team, 2022).

4 Results

Exploratory data analysis revealed that students are very concerned about the future of the planet and are aware of most behaviors that could contribute to its preservation. They are confident that it is still possible to intervene to repair the damage that has been done. They live in families that conscientiously recycle materials (glass, plastic, paper, organic waste)

Table 6 Description of the classification tree model: *response variable* and selected predictors

Acronym	Description	Nature	# of categories
PEBEV	*Perceived behavior to be effective in combating environmental degradation*	*Nominal scale*	*2*
GEND	Gender of respondents	Nominal scale	2
VOLNT	Willingness to work as a volunteer	Nominal scale	2
GLASSR	Recycling of glass	Nominal scale	2
ORGR	Recycling of organic waste	Nominal scale	2
PLASTR	Recycling of plastic and metal waste	Nominal scale	2
OILR	Recycling of cooking oil	Nominal scale	2
BATTD	Disposing of batteries	Nominal scale	2
DRUGD	Disposing of medicines	Nominal scale	2
ELCABD	Disposing of electrical cables	Nominal scale	2
SHEETR	Reuse of sheets of paper	Nominal scale	2
BAGSR	Reuse of grocery bags	Nominal scale	2
FAUCOFF	Turning off the faucet	Nominal scale	2
STBYOFF	Turning off the devices	Nominal scale	2
HSATT	Attention paid by teachers to environmental issues at school	Nominal scale	2

as required by law. However, as stated earlier, this practice should be taken for granted and therefore tends to be a weak predictor of environmental sensitivity. For this reason, we focused on the behaviors that depend solely on the will of the individual in order to extract the significant variables that allow us to identify the patterns that correspond to the "best sustainable practice". Therefore, we decided to include the variables related to voluntary behaviors, such as reusing paper and shopping bags, saving water and energy, properly disposing of special materials (batteries, oil, medicines, and power cords), along with respondents' gender and willingness to voluntarily participate in cleaning public areas, as predictors (see Table 6) for a more detailed analysis using classification trees (Breiman et al., 1984) and the Random Forest (Breiman, 2001). The response variable was based on the answer to the question of whether respondents considered their personal behavior to be effective in combating environmental degradation. As it was difficult to collect information on the socio-economic status of the respondents' family for reasons of data protection, the analysis of the relationship between socio-demographic and economic characteristics of the respondents and their ecological behaviour could not be carried out.

The classification tree was built using the generalised Gini splitting function based on squared probabilities of membership for each category of the dependent variable. It reaches its minimum (zero) when all cases in a node fall into a single category. In other words, the cost of misclassification is given by the absolute differences in scores assigned to the categories within the response. In this paper, the classification tree is used for exploratory purposes, hence we are not pursuing the highest possible rate of correct classification, that expresses the gain corresponding to the ability of the tree to classify the observed entities reasonably well, but instead a model easily interpretable. The classification tree obtained had 10 terminal nodes, as shown in Fig. 1, and key information about each node is summarized in Table 7. To interpret the paths of the decision tree in terms of the most interesting terminal nodes, the response variable was used as the key variable and refers to the 43.0% of respondents who believed that their behavior had an effective impact on environmental protection.

The first split that allows us to follow the path of the "very committed environmentalist" is the practice of proper battery disposal. It separates the right side of the graph, where we find the nodes with students who declare to practice this (62.9%), from the left side,

Fig. 1 Classification tree for Contribution to environmental protection. Overall percentage of correct classification: 62.4%
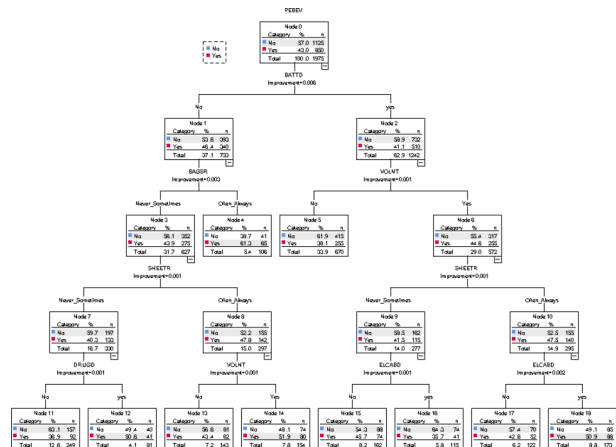
	Node	Size (prop)	Mode	Prop (Yes)	Prop (No)	Path
Table 7 Classification tree in tabular form	4	106 (0.054)	Yes	0.613	0.387	BATTD ∈ *No*∩ BAGSR ∈ *Often/Always*
	5	670 (0.339)	No	0.381	0.619	BATTD ∈ *Yes*∩ VOLNT ∈ *No*
	11	249 (0.126)	No	0.369	0.631	BATTD ∈ *No*∩ BAGSR ∈ *Never/ Sometimes*∩ SHEETR ∈ *Never/ Sometimes*∩ DRUGD ∈ *No*
	12	81 (0.041)	Yes	0.506	0.494	BATTD ∈ *No*∩ BAGSR ∈ *Never/ Sometimes*∩ SHEETR ∈ *Never/ Sometimes*∩ DRUGD ∈ *Yes*
	13	143 (0.072)	No	0.434	0.566	BATTD ∈ *No*∩ BAGSR ∈ *Never/ Sometimes*∩ SHEETR ∈ *Often/Always*∩ VOLNT ∈ *No*
	14	154 (0.078)	Yes	0.519	0.481	BATTD ∈ *No*∩ BAGSR ∈ *Never/ Sometimes*∩ SHEETR ∈ *Often/Always*∩ VOLNT ∈ *Yes*
	15	162 (0.082)	No	0.457	0.543	BATTD ∈ *Yes*∩ VOLNT ∈ *Yes*∩ SHEETR ∈ *Never/ Sometimes*∩ ELCABD ∈ *No*
	16	115 (0.058)	No	0.357	0.643	BATTD ∈ *Yes*∩ VOLNT ∈ *Yes*∩ SHEETR ∈ *Never/ Sometimes*∩ ELCABD ∈ *Yes*
	17	122 (0.062)	No	0.426	0.574	BATTD ∈ *Yes*∩ VOLNT ∈ *Yes*∩ SHEETR ∈ *Often/Always*∩ ELCABD ∈ *No*
	18	173 (0.088)	Yes	0.509	0.491	BATTD ∈ *Yes*∩ VOLNT ∈ *Yes*∩ SHEETR ∈ *Often/Always*∩ ELCABD ∈ *Yes*

where we find those who do not (37.1%). This is undoubtedly a good predictor of the presence of environmental awareness, since batteries are highly polluting materials and must be disposed of in appropriate containers which, however, are not as widespread as those for glass, paper and plastic. It is worth noting that the students interviewed are more likely to find the battery collection bins in their schools, as a means of concrete participation in the implementation of environmental education programs.

Consequently, in order to identify the path of respondents who are convinced to take active action against environmental degradation, we can examine the end nodes number

4, 14 and 18. The willingness to voluntarily participate in cleaning beaches, public places and green areas is the discriminating factor in these nodes and the modal value is "yes". In node 5 follow the respondents who are not willing to volunteer and are aware that they do not carry out the other necessary practices to reduce the degradation of the planet, maybe considering them more demanding. More likely, they behave according to social desirability when they dispose of batteries in school trash cans. Node 8 sheds light on other interesting paths that can be built up to the final nodes 15 to 18. Node 18, in fact, contains respondents who are aware of how effective it is to commit to the planet as individuals: they are conscious of the need to volunteer to conserve valuable natural resources, not to comply with norms, but to really help the planet. They perform both simple everyday activities such as reusing paper frequently and disposing of electrical cables properly. It is fair to say that these respondents are highly sensitive to the environment.

The left path in the tree generated by the first split concerns not practicing battery disposal and contains the nodes characterized by practicing or not practicing simple daily actions such as reusing shopping bags or paper and, near the end, medicines. In node 11 we find respondents who never or sometimes recycle shopping bags, paper and medicines. It is worth noting that for them to be perceived as active contributors, it is sufficient that their family separates waste into glass, paper, and plastic. More likely, they tend to engage in socially desirable behaviors and simply follow legally mandated guidelines. Respondents in node 12 differ from those in node 11 only in the correct disposal of medicines. Finally, node 13 is characterized by respondents who are aware that frequent reuse of paper sheets without adopting other ecological practices is not enough to consider themselves active contributors. They probably prefer to leave it to their family.

To complete our analysis, we used the Random Forests (Breiman, 2001) technique in order to study the importance of the predictors in explaining how students perceive whether or not their behavior is effective in combating environmental degradation, as expressed by the dichotomous recoding of the response variable (see Table 5).

The forest was built with 5,000 trees using the Gini impurity measure, in this way we obtained a robust ranking of predictors. Figure 2 shows the ranking of variables according to their importance.

The first five variables show larger VIMs. In particular, these variables are willingness to volunteer ranked first, followed by turning off the faucet when the water flow is not needed, disposing of cooking oil properly, gender, and turning off appliances in standby mode. The first five variables are able to identify the everyday behaviors that have a high level of environmental awareness, as they depend solely on the will of the individual.

Fig. 2 Measure of variable importance (%)
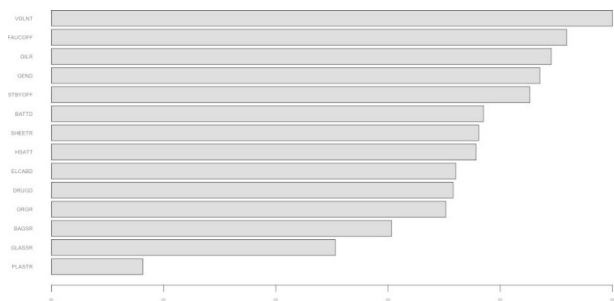
A few further variables (BATTD, SHEETR, and HSATT) also play an important role in the perception that the respondents' behavior is effective in combating environmental degradation. Disposing of batteries has almost the same importance as reusing sheets of paper. Considering that respondents can easily find battery bins in their schools, it is reasonable to assume that both behaviors can be performed equally by a high school student. The need for teachers to pay more attention to environmental education also plays a crucial role.

The subsequent predictors, in terms of importance, are a group of environmental practices carried out by the respondent or his/her family. However, their importance is rather small compared with the importance of the first eight variables.

5 Final remarks

Social environmental behavior by individuals is the most effective means of combating climate change and protecting the environment. Social environmental behavior means, on the one hand, adopting an environmentally oriented lifestyle that helps to save natural resources from destruction and depends on ecological awareness; on the other hand, ecological awareness comes from ecological education and knowledge about the related problems to deal with. People's environmental awareness is the cornerstone of environmentally friendly everyday practices, and changing ecological attitudes is closely related to knowledge and information.

Baldassare & Katz (1992) and Samdahl and Robertson (1989) argue that the level of education affects people's ecological habits because higher levels of education and consequently higher levels of wealth lead people to higher consumption and more concerned attitudes about changing ecological habits. Some researchers (Gkargkavouzi et al., 2019) also add personal relationship with nature to these two factors, arguing that people's perception of nature influences their emotional connection to it. Healthy space can increase well-being and sustainable behaviors (Barbaro & Pickett, 2016; Cojocaru et al., 2014). In turn, the well-being of a community is also promoted by the fact that people perceive safety and legality in the social environment in which they live and expect this to be guaranteed by the authorities and the government. The presence of these shared values helps to strengthen the sense of belonging to a community (Forrest & Kearns, 2001; Burton & Mitchell, 2006) and subsequently civic engagement.

As individuals form their value systems based on their experiences and culture, educational institutions must promote ways to preserve the natural and sociocultural environment, including the development of soft skills and competencies of students from middle and high schools through university. Environmental awareness translates into ecological practices when people are concerned about the seriousness of the situation, are sustained by a sense of personal concern, and believe that they can change the current situation through personal involvement (Schwartz, 1994). Our findings are consistent with Schwartz in that the majority of students surveyed were well aware of the dangerous effects of climate change and the need to take personal action to combat the destruction of the planet. However, we also found that a part of them considered that ecological practices are entrusted to the family or community in a broader sense and did not have the perception that they could be also effective as individuals. This is a phenomenon that affects young people around the world, as highlighted by Martiskainen et al., (2020), who identified seven categories of FFF protesters

based on the responses collected in their survey. These categories are defined according to the level of engagement and include "frontline protesters" but also "disengaged protesters" who declared to attend the FFF event only to stay with friends, partners or family members.

Considering all these findings, it is clear that, in planning effective strategies to protect the environment, we need to develop educational programs aimed at raising people's environmental awareness (Filho et al., 2018).

Sustainable development means that people must adopt various forms of environmental practices, not just those required by law, if we truly want to leave a better world for the future generation. In relation to all these issues, our results show that young people believe that there is still a chance to solve these problems if they are addressed without further delay. Looking at respondents' perception of taking effective action to protect the environment, less than one in two believe in the power of personal action, while the others need to be "inspired" to adopt sustainable behaviors in their daily lives.

Above all, it is essential that ecological practices become part of the culture of our communities. In general, individuals tend to behave in ways that are socially desirable, but their moderate environmental awareness must be transformed into a strong interest that immediately translates into best practices for sustainability.

To get all young people to become more involved, the most effective way must be found quickly, even if it is not easy to make a direct link between values and action. Families can undoubtedly play a fundamental role in directing environmental education, but other actors outside families, such as volunteer associations, should do so as well. Volunteer associations are composed of young people who are role models for sustainability and can be emulated by their peers (Zelenski and Desrochers, 2021; Arnold et al., 2009). It is critical to capture young people's interest by using compelling messages, appropriate language, and appropriate tools to keep them interested.

Schools can also have a positive impact on young people's environmental education, but the majority of respondents indicated that teachers pay little attention to the environment. Since students spend most of their childhood and adolescence in school, educational institutions should pay more attention to the debate on environmental issues in order to positively influence and shape students' environmental culture. It is worth noting that the Internet and social media are among the most important sources of information for young people and provide another opportunity to improve citizens' environmental literacy (Gudmanian et al., 2020; Baytiyeh, 2021).

Although it could be an interesting area of research to shed light on young people's perceptions of the effectiveness of sustainable behaviors to prevent environmental damage, as stated by Martiskainen et al., (2020, page. 16) "*We also need further research on who is, and who is not, able to take part in climate change action and how issues such as class or education may come into play*", we are aware that this study also has some limitations. It deals with the opinions and sustainable behaviors of young people attending a high school in a large city in southern Italy. Undoubtedly, it would be better to replace the convenience sample used with a sample that includes all Italian students. However, this requires collaboration with schools and universities at the national level. One possibility would be to collaborate with universities participating in PLS to conduct the same survey at once. In this case, the research interests of the universities and, more importantly, the educational pathways of the project's school partners would meet with the same goal.

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