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# Students' Conceptions of Environmental Pollution: Air, Water, Soil, Noise, Visual, Light, Electromagnetic and Radioactive Pollution, the Southern Suburbs of Beirut: A Case Study

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## Abstract

Environmental issues, particularly pollution, represent significant global challenges. It is essential to develop a thorough understanding of the various types of pollution and promote sustainable environmental attitudes and behaviors. This study aims to identify the conceptions of students from the southern suburbs of Beirut regarding the environment and pollution. A total of 127 students from grades 10 and 11 at a private school participated. The students completed a questionnaire assessing their conceptions across three dimensions: knowledge, attitudes, and behaviors. Additionally, they were engaged in socio-cognitive debate sessions, providing insights into their conceptions of the environment, and pollution. The results revealed that many students held misconceptions about pollution, including soil, noise, visual, light, electromagnetic, and radioactive pollution. Furthermore, many exhibited inappropriate environmental attitudes and behaviors. This study highlights the need for targeted educational interventions to promote sustainable positive environmental attitudes and behaviors among students.

**Keywords:** Pollution; Sustainability; Misconceptions; Socio-cognitive debate; Environment

## Introduction

The environmental landscape in Lebanon, particularly in the southern suburbs of Beirut, has worsened due to ongoing environmental pollution in its various forms. The environmental report "State and trends of the Lebanese environment" (2011), issued by the Lebanese Ministry of Environment in collaboration with the United Nations Development Program (UNDP), signaled the country's high levels of pollution, including air, water and soil pollution, as well as the spread of quarries and crushers that damage mountains and green landscapes. Additionally, issues like wildfires, unplanned urban expansion, biodiversity loss, and deforestation amplify the environmental degradation. In this context, the southern suburbs of Beirut are densely populated areas characterized by rapid and unplanned urbanization that ignores environmental considerations essential for human well-being and safety. This urban transformation is accompanied by numerous environmental problems including air pollution, groundwater pollution, improper disposal of waste, and more. Adding to these challenges is the proximity to the country's sole international airport, which generates noise pollution and harmful emissions from continuous flights. The accumulation of these issues reflects a societal lack of concern for environmental issues, inadequate environmental awareness, and a lack of responsibility towards the environment. Moreover, a large segment of the population

in this area faces challenging social conditions and prioritizes basic life needs for their families. These social conditions may contribute to apathy regarding the importance of the environment and its impact on individual lives and sustainability. This alarming situation required intervention at multiple levels. Since 2006, Lebanon has participated in international climate change talks and is officially part of the Group of 77, China, and the Arab Group. Additionally, Lebanon has been a member of the Climate Vulnerable Forum (CVF) since the twenty-second session of the Conference of the Parties (COP22) in Marrakesh in November 2016. This forum serves as an international partnership for countries highly vulnerable to global warming, providing a platform for cooperation among participating governments to address global climate change. Furthermore, Lebanon has been a member of the Group of Twenty (V20), which includes the most threatened economies by climate change, since spring 2017 [1]. Regarding educational policies and curricula, environmental concepts were integrated into the Lebanese curriculum in 1997, in accordance with the decisions of the first Rio Conference in 1992, which produced Agenda 21. Consequently, environmental education was merged into the updated Lebanese curricula. However, despite these changes and increasing concern for environmental issues, the environmental situation in Lebanon, particularly in the southern suburbs, has deteriorated due to the ongoing pollution in its various forms. A study of these curricula found that they adopt a reductionist linear approach centered primarily on scientific content, neglecting the development of environmental attitudes and values among students. This approach may have contributed to misconceptions about environmental pollution and hindered the acquisition of knowledge related to environmental issues, as well as the adoption of positive environmental values and behaviors. On the other hand, despite the fact that educational curricula address environmental topics, awareness programs that focus on the importance of the environment and its conservation are almost nonexistent. This reality was confirmed by Salameh [2] in her study, where she pointed out a significant gap between the objectives of the curricula and what is actually implemented in the classrooms. This situation could negatively affect environmental awareness and empathy toward the environment and its issues.

Given the deficiencies in the curriculum and the lack of effective environmental awareness programs, it is crucial to examine the underlying conceptions that may be hindering students' understanding and adoption of environmental values. These conceptions can be analyzed to reveal the obstacles that hinder learning [3] or to assess potential conceptual changes after a teaching sequence [4]. However, while these changes often facilitate the acquisition of new scientific knowledge, they are typically more challenging when it comes to altering opinions in areas such as behavior, attitude shifts, or the adoption of values that support environmental preservation [4,5]. This does not imply that acquiring new scientific knowledge is straightforward; Obstacles to new scientific knowledge acquisition and skills development remain crucial to identify and consider for effective teaching. It means that certain knowledge is supported by values and social practices that can hinder its renewal. This is evident in the history of science as well as in the evolution of individuals' conceptions [6,7]. To further explore these barriers and understand how they influence students' environmental attitudes, it is essential to consider the theoretical framework that explains how conceptions are formed. Indeed, Clément defines conceptions as being the result of the interaction between scientific knowledge (K), the value system (V) and social practices (P) [6,8]. The construction of notions relating to the environment is first influenced by all the specialized environmental information conceived as valid at a given time and for a specific audience (knowledge). It is then determined by the values (knowing how to be) of the students who intervene to "filter" this knowledge in some way. Finally, it is conditioned by a choice of knowledge according to its usefulness in terms of personal and social practices (knowing how to do and knowing how to participate) [8,9]. In this context, the construction of the concept of environment is governed by collective conceptions and the set of social values attached to it; thus, it occurs in relation to time and space [10,11]. With this framework in mind, it becomes evident that understanding students' conceptions can offer valuable insights into the obstacles they face when engaging with environmental issues. Hence our question is: How can the identification and the analysis of the conceptions of 10$^{th}$ and 11$^{th}$ grade students shed light on the obstacles concerning their relationship to the environment in general, and more particularly to pollution in its eight dimensions: air, water, soil, noise, visual, light, electromagnetic and radioactive?

## Materials and Methods

We used a scientific approach based on mixed methods research within a perspective that integrates qualitative and quantitative methods to understand the complex nature of reality [11,12]. This type of research facilitates the triangulation of results by diversifying methods (methodological triangulation), ensuring greater accuracy of the conclusions drawn by the researcher based on various data (ibid).

### Sample and instruments

The study sample and instruments are detailed below:

**The sample of the study:** The sample of the study consisted of a total of 127 students from 4 classes (2 from the tenth grade and 2 from the eleventh grade) at a private school in the southern suburbs of Beirut.

**The instruments:** A survey using a questionnaire was designed and directly administered by the researcher. This survey, followed by a multifactorial analysis, allowed us to identify the students' conceptions related to environmental pollution in its different forms. Our questionnaire included 60 items related to environmental knowledge, attitudes and environmental behaviors. Additionally, five questions concerning (age, gender, class, parents' profession, and parents' level of education) were designed to better define our sample and explore possible correlations between these variables and the students' conceptions.

In addition, the students participated in socio-cognitive debate sessions, with 4 sessions held per class. These sessions were managed in a way that allowed students to freely express their opinions. The teachers adopted several methods that motivate students to participate, such as starting with problems that address environmental topics of interest to the students. They also used Problem Tree Analysis (PTA), a participatory tool to identify the problem, its causes, and its effects. Additionally, the teachers encouraged students to work in groups and take on different roles, which enriched the discussions and helped them present their ideas while learning about their peers' perspectives. We were able, through observation of discussion sessions, to obtain information related to the students' environmental knowledge and attitudes. This information helped us identify a number of learning obstacles faced by the students. The questionnaire and the debate sessions tackled the 8 types of pollution: Air, water, soil, noise, visual, light, electromagnetic and radioactive pollution.

**Validity and reliability of the survey questionnaire:** The questionnaire was initially distributed to a random sample of thirty students outside the boundaries of the study sample. The responses were collected and assessed for validity and reliability using factor analysis and Cronbach's alpha coefficient, which measures the internal consistency among the questions. The key factors we measured using factor analysis were as follows:

a) Kaiser-Meyer-Olkin (KMO) Measure: This is used to assess the suitability of factor analysis. Its value ranges from 0 to 1. The closer the value is to 1, the more suitable the factor analysis is, and vice versa. (It should be greater than 0.5).

b) Bartlett's test of sphericity: This test examines the correlation matrix of all variables to determine whether they differ significantly from zero. This indicator should be less than the 5% significance level to establish a correlation between the variables, making it feasible to conduct factor analysis on these variables.

c) Cronbach's alpha coefficient: This test measures the internal consistency among the questions and indicates whether any variables need to be eliminated. (This indicator should be greater than or equal to 0.7 to ensure internal consistency among the variables).

The results showed, according to the Kaiser-Meyer-Olkin measure, that the items were suitable for factor analysis. Bartlett's test also indicated a correlation between the items, making factor analysis applicable. Finally, the Cronbach's alpha coefficient (greater than 0.7) confirmed high internal consistency among the items. The questionnaire was also validated by 2 experts in environmental education.

**Procedure of administration:** In the first stage, a questionnaire was distributed to the students of 4 classes. The students were given 40 minutes to complete the questionnaire under the supervision of the researcher. In the second stage, the teachers, who were trained by the researcher, conducted 16 socio-cognitive debate sessions, with 4 sessions in each class.

**Statistical analysis:** The survey results were processed using the SPSS software (Statistical Package for the Social Sciences) according to the following:

a) Descriptive statistics: In the first part, descriptive statistics were used to present the results obtained. Descriptive statistics involve presenting the statistical results for each question of the survey before moving on to inferential statistics, which compare the results according to the study variables.

b) Inferential statistics: In this section, the t-test and ANOVA (Analysis of Variance) tests were used to compare the mean scores of the axes. These tests compare the mean scores of the criteria, and examine the differences based on the independent variables. Additionally, the chi-square test was used to study the relationship between independent variables and qualitative dependent variables. The significance level (Sig) was compared with the error margin α (0.05). If this indicator is smaller than α, statistically significant differences are present; otherwise, they are not.

As for processing the results of the socio-cognitive debate sessions, we made audio recordings of all the sessions and then listened to the recordings again, transcribing them for analysis. We then conducted in-depth and repeated readings of the information, identifying parts of the texts with common meanings to classify them into specific categories. After the classification phase, we analyzed the information by linking it and highlighting common features and points of difference, providing our conclusion or summary based on the students' interventions.

## Results

### Students' conceptions related to environmental pollution

In this part, descriptive statistics were used to present the results obtained. Descriptive statistics involve displaying the statistical results for the questions in the questionnaire.

**Students' knowledge about the different types of pollution:** The results of the questionnaire (Figure 1) demonstrated that nearly one-third of the students lacked knowledge about pollution in general (33.06%) and specifically about noise pollution (28.68%). In addition, these results indicated that approximately half of the students lack knowledge about air pollution (40.57%), and water pollution (41.34%). While approximately two-thirds of them lacked knowledge about visual pollution (62.27%) and soil pollution (66.41%). On the other hand, the majority of the students showed lack of knowledge regarding radioactive pollution (78.81%), light pollution (83.46%), and electromagnetic pollution (89.66%). This knowledge gap among students may indicate a shortcoming in the educational curricula and negligence from the media, which tends to highlight certain types of pollution while ignoring others.

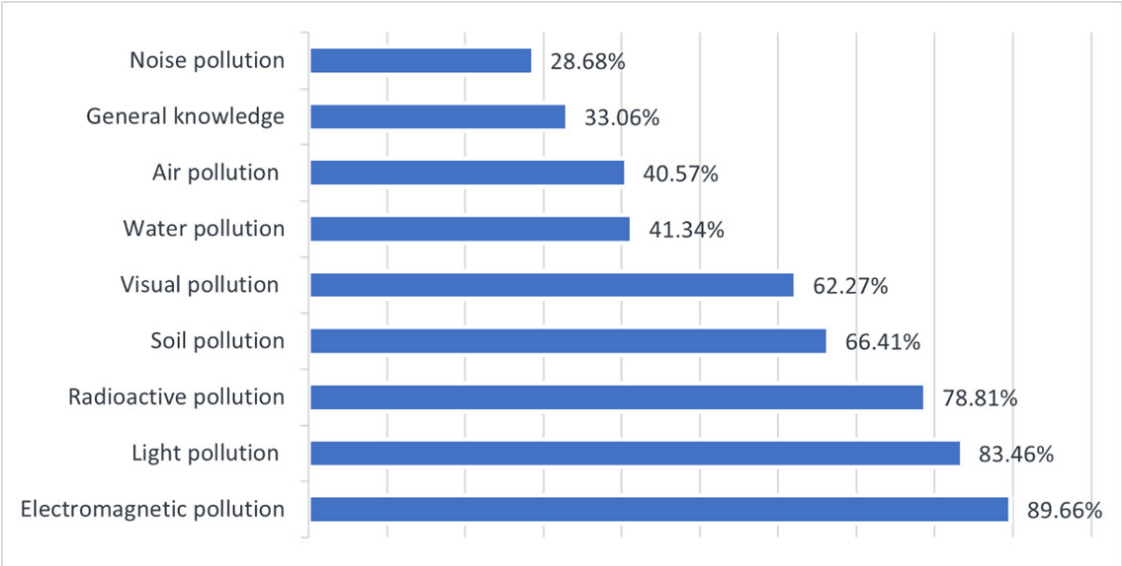



**Figure 1:** Percentages of students' lack of knowledge regarding the different types of pollution.

In parallel with the mentioned results, the analysis of the socio-cognitive debate sessions revealed that the students are most familiar with three types of pollution: air, water, and soil. However, regarding the other types (noise, visual, light, electromagnetic, and radioactive pollution), students showed a greater lack of knowledge. This was evident, for example, in their comments on a picture of a city lit up at night; most students associated the scene with air pollution due to oil consumption for electricity generation, without considering the impact of nighttime lighting on light pollution. Thus, the students' perspectives align with the results of the questionnaire, which indicated a lack of knowledge about the various types of pollution. This lack of knowledge was lowest for noise pollution and increased, reaching its maximum for electromagnetic pollution (Figure 2). Here, we can also suggest that this knowledge gap could be due to deficiencies in the educational curricula and the media's negligence, as it tends to focus on some types of pollution while overlooking others. The following Figure 2 shows the percentages of students' lack of knowledge about the different types of pollution in ascending order.


**Figure 2:** Students' lack of knowledge about the different types of pollution in ascending order.

**Students' environmental declared behaviors:** Regarding declared behaviors (Figure 3), the results indicated that only 17.05% of the students reported adopting negative behavior regarding light pollution, while almost half of the students reported adopting negative behavior concerning visual pollution (44.19%), air, water and soil pollution (45.74%) as well as noise pollution (51.94%). In addition, 71.2% reported adopting negative behavior regarding electromagnetic pollution. The results suggest that students are not aware of the consequences of different types of pollution, and this is maybe due to a combination of lower visibility in educational efforts, media coverage, and personal experience where students may not feel directly affected by the different types of pollution in their daily lives. In addition, the percentage of students indicating negative behavior was lowest for light pollution and increased, reaching its highest level for electromagnetic pollution (Figure 4). The results suggest that while students may demonstrate lower levels of negative behaviors associated with light pollution due to a lack of awareness, this does not necessarily indicate active positive engagement. Instead, it may reflect a need for education and awareness-raising efforts to help students understand the significance of light pollution and inspire more conscious behaviors. The following Figure 4 shows the percentages of students reported negative behaviors in ascending order.

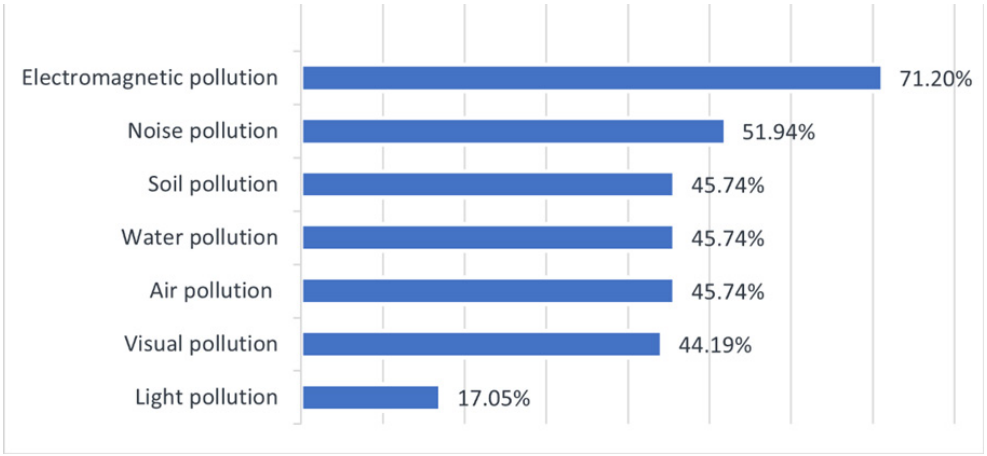



**Figure 3:** Percentages of students' reported negative behaviors regarding the different types of pollution.

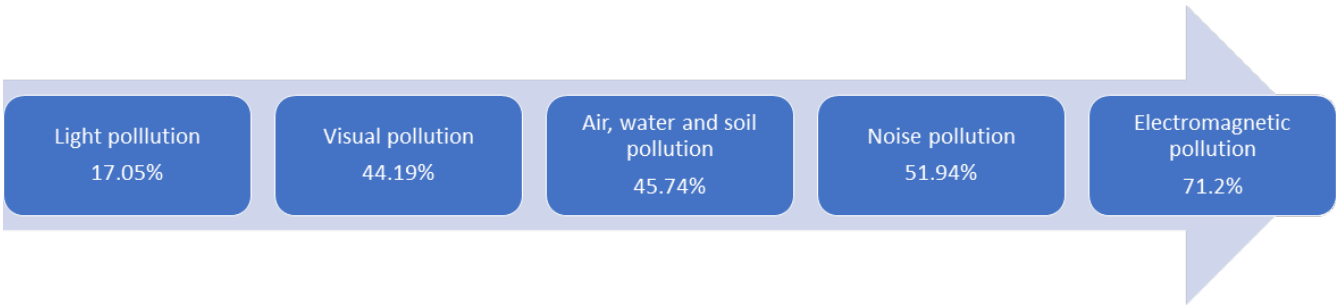



**Figure 4:** Students reported negative behaviors regarding the different types of pollution in ascending order.

**Students' attitudes toward the environment:** Concerning the student's attitudes toward the environment in relation to different types of pollution (Figure 5), the responses on the questionnaire indicate that some of them show negative attitude at varying rates, with 14.15% regarding water pollution, 17.83% regarding visual pollution, 21.03% regarding noise pollution, and 24.68% regarding soil pollution, while nearly one-third of them (32.17%) adopt negative attitude regarding air pollution. On the other hand, almost half of the students show negative attitude regarding radioactive pollution (45.83%) and electromagnetic pollution (50.29%) while the majority of them show negative attitude regarding light pollution (87.50%). Students may adopt negative attitudes regarding the different types of pollution due to a combination of lack of awareness, societal norms, exposure to pollution, media representation, educational gaps, perceptions of responsibility, and conflicts of interest. In addition, the percentage of students adopting negative attitude was lowest for water pollution and increased, reaching its highest level for light pollution (Figure 6). The negative attitude can stem from a lack of awareness. This underscores the necessity for targeted education and awareness initiatives to help bridge this gap, fostering both understanding and proactive attitudes regarding various types of pollution, with a particular emphasis on light pollution. The following Figure 6 shows the percentages of students reported negative attitudes in ascending order.

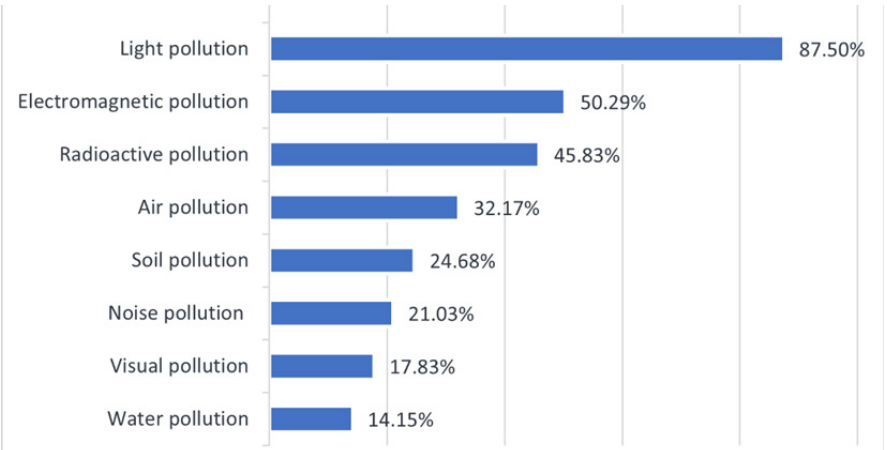



**Figure 5:** Percentages of students' negative attitudes regarding the different types of pollution.


**Figure 6:** Students' negative attitudes regarding the different types of pollution in ascending order.

Many students expressed adopting attitudes that align with preventing pollution, protecting the environment and its natural resources, and preserving nature, such as the necessity of waste sorting (68.22%), not posting advertisements (68.99%), not using chemical fertilizers (57.36%), and not using the horn constantly while driving (75.97%). On the other hand, many students also expressed adopting attitudes and behaviors that contradict pollution prevention, environmental protection, and the preservation of natural resources. For example, they stated that they care more about their health than environmental preservation (48.06%) and they dispose waste outside trash bins when they are full (39.53%), even though they all agreed and were dissatisfied with the sight of piled-up waste. They also prefer to travel by car instead of walking (54.26%), despite the fact that most of them (96.12%) were dissatisfied with the sight of fire. They prefer permanent street lighting regardless of its negative environmental impact (92.25%). These findings show that students support actions that benefit the environment as long as these actions do not conflict with their individual interests.

**Students' conceptions during the socio-cognitive debate sessions:** In the socio-cognitive debate sessions, the students' responses demonstrated their empathy for the environment when shown a video displaying the mixing of sewage with seawater. All students expressed discomfort with the behavior of fishermen who fish near sewage discharge areas, attributing this behavior to either a lack of awareness, ignorance, or negligence. Similarly, all students expressed their displeasure when shown images of waste and randomly placed billboards. On the other hand, most students supported organic farming over the use of chemical fertilizers that pollute the soil. This indicates that these students tend to reject pollution, protect the environment, and preserve nature. In contrast, most students supported the sale of exhaust gas converters due to necessity, despite the environmental damage. Proponents of the sale justified their choice with several phrases, some of which are presented in the following Table 1.

**Table 1:** Phrases used by the proponents of the sale.

| Class | Percentage of Proponents of the Sale | Used Phrases |
|---|---|---|
| 10th grade English section | 0.695 | Why should I follow the rules alone when the whole community is not?<br>I will sell and not worry about others<br>The environment won't be cleaned up by just one person |
| 10th grade French section | 0.6071 | The car won't threaten all of humanity<br>I am more important than the environment<br>I won't be affected by pollution now; the impact is long-term<br>If I don't sell, others will<br>Why should I follow the rules alone when the whole community is not? |
| 11th grade English section | 0.6765 | The financial status is more important than the environment<br>One person won't make a difference<br>Social circumstances are more important than environmental preservation |
| 11th grade French section | 0.6452 | Why should I care about the environment?<br>I don't care<br>The environment is not a priority for me<br>People should think of their own interests first |

The students' responses reveal a contradiction with their expressed empathy for the environment. Responses such as ("I will sell and not worry about others", "Why should I care about the environment?", "I don't care," and "The environment is not a priority for me") demonstrate a lack of concern for environmental protection, pollution prevention, and nature preservation.

Additionally, some responses like ("The environment won't be cleaned by one person", "Why should I follow the rules alone when the whole community is not?", "One person won't make a difference" and "If I don't sell, others will") highlight a significant number of students' lack of awareness about the importance of individual contributions to environmental conservation. Other responses such as ("Financial status is more important than the environment", "Social circumstances are more important than environmental preservation" and "People think about their own interests") reveal that students support environmental actions only when these actions align with their material interests. When environmental protection behaviors limit their material benefits, they refuse to adopt them. Moreover, some responses such as ("Why should I care about the environment?" and "The environment is not a priority for me") reveal a significant level of disregard and lack of empathy towards the environment.

## Effect of student's descriptive variables on their conceptions

The inferential statistics compare the results based on the study variables. The purpose of this analysis is to determine whether the descriptive variables of the students, such as gender, language, grade, parents' occupation, and educational level of both father and mother, affect their conceptions. Only the significant results (significance level (Sig) less than the error margin α=0.05) are shown. Regarding the gender variable, the results (Figure 7) showed that females exhibited less negative environmental attitudes related to noise pollution compared to males and demonstrated greater empathy towards the environment. The greater empathy exhibited by females suggests a stronger emotional connection to environmental issues, leading to more positive attitudes regarding the environment. Socialization often encourages females to be more nurturing and empathetic, which may translate into these positive environmental attitudes. This underscores the importance of targeted educational efforts that consider these differences to effectively promote positive environmental attitudes across genders. Regarding the language variable, students studying in French displayed a higher level of empathy toward the environment and possessed less negative environmental attitudes related to air pollution, as well as visual and radioactive pollution (Figure 8). This shows that students in the French sections tend to place greater importance on environmental issues compared to their peers in the English sections. This disparity may stem from variations in teaching approaches, cultural influences, or differences in peer groups. Finally, with respect to the grade variable, 11th grade students showed less negative environmental attitudes related to soil pollution and radioactive pollution. In contrast, 10th grade students demonstrated less negative environmental attitudes related to air, noise, water and electromagnetic pollution (Figure 9). These differences may reflect variations in educational focus, cognitive development, and the need for targeted interventions to foster positive environmental attitudes across grade levels.

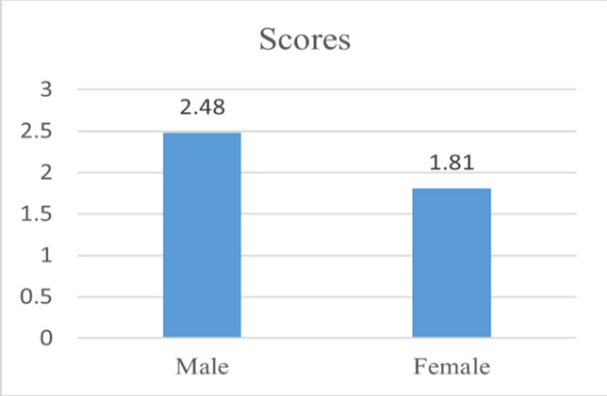
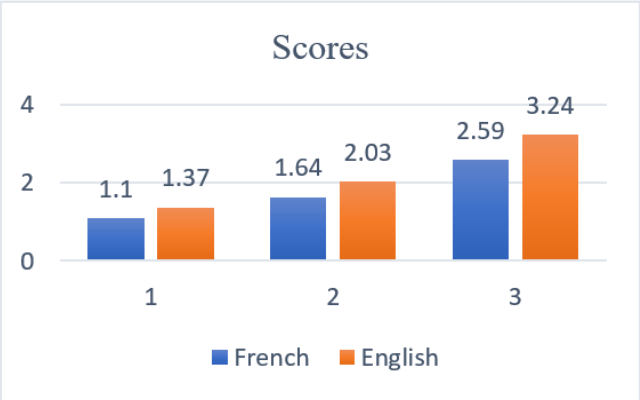



**Figure 7:** Effect of students' gender on their negative attitudes related to noise pollution.

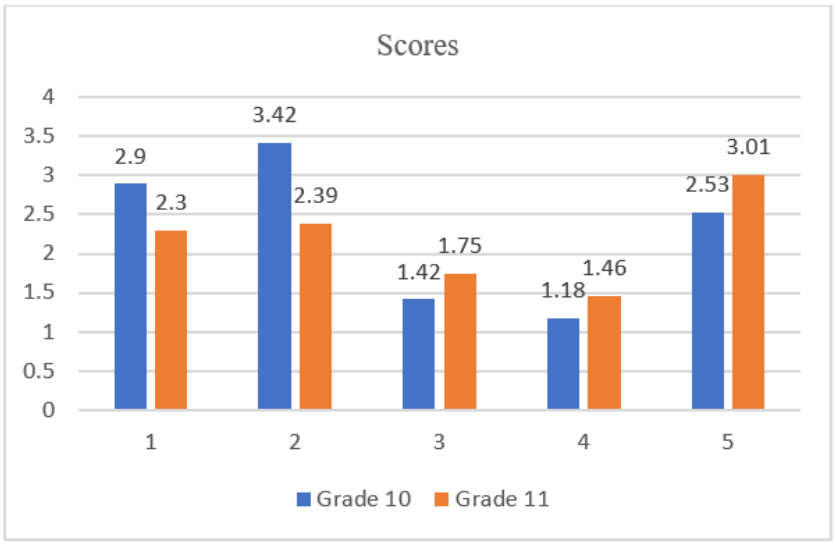



1: Degree of satisfaction with the burning waste scene (air pollution)

2: Degree of satisfaction with the random billboards scene (visual pollution)

3: Degree of satisfaction with the nuclear waste scene (radioactive pollution)

**Figure 8:** Effect of student's language on their attitudes related to air, visual and radioactive pollution.




1: The farmer has the right to increase the use of chemical fertilizers to boost agricultural production (soil pollution)

2: Degree of satisfaction with the nuclear waste scene (radioactive pollution)

3: Degree of satisfaction with the traffic congestion scene (air and noise pollution)

4: Degree of satisfaction with the polluted water scene (water pollution)

5: Degree of satisfaction with the cellular signal towers scene (electromagnetic pollution)

**Figure 9:** Effect of students' grade on their attitudes related to air, water, soil, noise, radioactive and electromagnetic pollution.

## Discussion

### Students' knowledge of environmental pollution

The results from the questionnaire showed a lack of knowledge about all types of pollution (Figure 1), where it is more evident for visual (62.27%), soil (66.41%), radioactive (78.81%), light (83.46%) and electromagnetic pollution (89.66%). These results were supported by the socio-cognitive debate sessions, which revealed that students were more familiar with air and water pollution. This knowledge gap regarding noise, visual, light, electromagnetic, and radioactive pollution may be attributed to the educational curricula that focus on air, water, and to a lesser extent on soil pollution, as well as the media's emphasis on these types of pollution during environmental awareness campaigns. The lack of knowledge may be responsible for the negative behavior of the students regarding the different types of pollution since a lack of knowledge may impact students' environmental behaviors, as Gifford and Nilsson [8] suggest that individuals' behaviors towards the environment develop through awareness of environmental issues. Similarly, Blake [13] argues that insufficient information negatively affects environmental behaviors. However, other researchers have indicated that knowledge alone does not guarantee the adoption of environmental behavior; rather, behavior often stems from the intention to act [14,15]. In reality, Kempton, Boster, and Hartley [15] found that individuals with insufficient environmental knowledge can still engage in environmental issues. Thus, knowledge is just one of the factors influencing environmental behavior (knowledge, attitudes, and values). Toniolo [16] suggests an inverse relationship between knowledge and behavior, indicating that while changes in knowledge may not lead to noticeable changes in behavior, changes in behavior can be better understood through shifts in knowledge.

### Students' environmental attitudes: an indicator of their negative relationship with the environment and disconnection from it

We assess the relationship of students in the four classes with the environment by comparing it with the results of studies conducted by Reaidi [17] and Salameh [2]. Reaidi's research was based on the theoretical framework of Searles [18] which explains how an individual's connection to the environment influences their environmental behaviors. According to this framework, the stronger the connection with the environment, the more behaviors will be in favor of the environment. Thus, without a sense of belonging to nature, individuals may struggle to engage in its protection. Reaidi [17] designed a questionnaire to study an individual's connection with the non-human environment and categorized this connection into three levels according to Searle's model [19]. The first level is fusion, where individuals experience a symbiotic relationship with the non-human environment, feeling as though they are composed of the same natural elements, which may lead to a loss of their human identity. The second level is relatedness, where Individuals maintain their human identity while developing a mature relationship with the non-human environment, characterized by a sense of belonging and a desire to protect it. The final level is disconnection, where individuals reject the natural environment, becoming completely detached and focusing solely on human issues, excluding anything non-human. An individual who is isolated from the non-human environment only cares about human problems and excludes any element without human origin. Research indicates that a relatedness to the environment nurtures a sense of responsibility towards it [18]. In this context, individuals maintain a balanced intellectual and emotional relationship

with their surroundings, being both aware of and empathetic toward their environment [11]. Disconnection can lead to a lack of motivation regarding environmental issues, while fusion may result in an overwhelming emotional response that hampers knowledge acquisition [11]. Building on the theoretical framework of environmental conceptions, it is important to assess how these conceptions influence students' emotional and behavioral connections to the environment. To this end, we examine the relationship of students in the four classes with the environment by comparing it with the results of studies conducted by Reaidi [17] and Salameh [20]. A comparison between Reaidi's results, which involved a sample of 244 students (205 French and 39 Lebanese), and Salameh's results, which involved a sample of 841 students from schools in the southern suburbs of Beirut (70% private and 30% public), showed that students in the southern suburbs of Beirut are less connected to the non-human environment and emotionally isolated from nature. These results align with those obtained in our study. The questionnaire showed that students adopt negative attitudes regarding the different types of pollution (Figure 5) (14.15% regarding water pollution, 17.83% regarding visual pollution, 21.03% regarding noise pollution, 24.68% regarding soil pollution, 32.17% regarding air pollution, 45.83% regarding radioactive pollution, 50.29% regarding electromagnetic pollution, and 87.50% regarding light pollution). These results are consistent with the findings during the socio-cognitive debate sessions in the four classes, where students demonstrated a weak connection to the environment through their responses (e.g., "I am more important than the environment," "Why do I care about the environment?", "It doesn't matter to me," "The environment is not a priority to me"). This lack of engagement can be attributed to the students' limited interaction with the environment and the environmental issues facing the southern suburbs, where access to nature is nearly non-existent. A sense of relatedness with the environment helps predict individual environmental behaviors [2]. Therefore, the stronger the individual's relatedness with the environment, the greater their desire to protect it. In this context, Reaidi [17] notes significant positive correlations between feelings of relatedness or fusion and the desire to engage in environmental protection measures. Conversely, she observed significant negative correlations between disconnection from the environment and commitment to environmental protection. Thus, an individual's experience, sense of belonging to the environment, and environmental behaviors are closely related. Alongside these dimensions, we can add the knowledge an individual holds, the environmental values they possess, and the attitudes they display [2]. Therefore, negative environmental attitudes among students indicate their adoption of negative environmental values and behaviors.

## Students' Environmental Attitudes: an indicator of their adoption of utilitarian environmental relationship and behaviors

Our results revealed that students adopt contradictory environmental attitudes and behaviors. This contradiction indicates a utilitarian relationship with the environment; students support actions that benefit the environment as long as these actions do not conflict with their individual interests. Consequently, when environmental protection efforts threaten their well-being, they tend to reject them. Students consider themselves entitled to misuse the environment for personal purposes and attribute a utilitarian relationship mainly related to economic gain. They view nature as a potential raw material ready for exploitation in various fields. Despite many students adopting negative environmental attitudes, our results showed that females are more inclined to adopt positive environmental attitudes related to noise pollution compared to males (Figure 7). This gender difference was confirmed and explained by a study conducted on 119 students, which found that females have higher levels of socialization compared to males, making them more socially responsible [21]. Another study highlighted that females are more concerned about environmental issues due to a higher perception of the risks associated with these issues [22].

## Obstacles that emerged during students' expression of their environmental conceptions

Following the analysis of students' environmental conceptions, we identified key obstacles that impact their understanding and engagement with environmental issues. These obstacles are categorized into didactic and ideological dimensions, which affect their knowledge, awareness, and attitudes towards the environment. The cognitive dimension is associated with the content of educational curricula and the teaching methods used by educators in the classroom. In this context, the lack of emphasis in curricula on topics such as noise, visual, light, electromagnetic, and radioactive pollution, in addition to the use of non-active teaching methods when addressing environmental topics and issues, may create didactic obstacles [23]. These obstacles hinder students' understanding of these types of pollution, environmental issues, and how to address them. Building on the identification of didactic obstacles, we also found that students' environmental awareness and attitudes are shaped by deeper ideological factors. These ideological obstacles are connected to students' beliefs about the environment, which influence their attitudes and behaviors. Environmental awareness and attitudes are linked to students' beliefs about the environment. In this case, the ideological obstacle emerges, connected to students' beliefs [24]. This is evident in their adoption of a utilitarian relationship with the environment, where the environment is seen as a means to achieve direct benefits, rather than being valued as an entity with intrinsic worth. This utilitarian relationship is reflected in students' environmental attitudes and behaviors, which explains their adoption of negative environmental attitudes and practices.

## Limitations

We conducted our study using a limited sample of first and second-year secondary students from both the English and French sections. The sample consisted of 127 students from the four grades. Therefore, the results of the study cannot be generalized, as generalization was not one of the objectives of our research. The study focused on a case study in a private school in the southern

suburbs of Beirut, with the aim of conducting an in-depth analysis of the impact of an educational program implemented in the school on students' environmental conceptions.

## Conclusion

This study provides a comprehensive analysis of students' conceptions regarding environmental issues, The findings highlight several key points:

### Knowledge gaps

Data indicate a lack of knowledge about different types of pollution, including visual, radiation, light, and electromagnetic pollution. In contrast, students demonstrate better knowledge of air, water, and soil pollution, likely due to the emphasis placed on these topics in educational curricula and media campaigns. This lack of knowledge may negatively affect students' environmental behaviors, as the literature confirms that awareness plays an important role in promoting pro-environmental behaviors. However, it is also clear that knowledge alone is insufficient to ensure behavior change.

### Attitudes and relatedness

The study reveals a disconnection between students and the environment, as evidenced by their responses during socio-cognitive debates and comparison with existing research. A weak sense of connection and negative attitudes toward the environment are consistent with the results of studies such as that of Reaidi [17] and Salameh [20] suggesting that emotional isolation from nature contributes to a lack of motivation to protect the environment. This disconnection is associated with decreased environmental engagement, supporting the idea that developing a sense of relatedness to nature is the key to promoting pro-environmental behaviors.

### Environmental connection and behaviors

The analysis of students' environmental relationship reveals a largely utilitarian view, where environmental actions are only supported if they align with personal interests. This viewpoint reflects an emphasis on economic gain and personal well-being at the expense of environmental concerns. Despite this, there is a notable difference between the genders, with females showing more positive attitudes towards environmental issues, especially noise pollution. This is consistent with previous research suggesting that females may possess higher levels of social responsibility and risk perception regarding environmental issues. In conclusion, addressing the identified obstacles, enhancing students' connection to nature, and fostering a deeper appreciation of the environment are critical steps in improving environmental behaviors. Educational interventions should aim to broaden students' understanding of different types of pollution, enhance emotional connections with nature, and encourage attitudes that prioritize environmental protection over utilitarian interests. By incorporating these elements into environmental education and awareness programs, we can better equip students to actively participate in environmental protection and contribute to a more sustainable future. Thus, it is essential to create a pedagogical framework that integrates socio-cognitive debate and project-based learning within a holistic approach. This framework should consider the complex nature of environmental issues and the various systems to which students belong, aiming to facilitate conceptual change and help students acquire new values, attitudes, and behaviors toward the environment. To support this, work should emphasize the following:

a) Integrating environmental topics across the curriculum so that students gain a multi-disciplinary perspective on the interconnectedness of environmental challenges.

b) Using Project-Based Learning (PBL) to create long-term, real-world environmental projects that promote collaboration and problem-solving. For example, students could tackle local environmental issues and work on proposing and implementing solutions.

c) Fostering critical thinking by encouraging students to analyze and debate environmental issues from multiple perspectives.

d) Promoting emotional and ethical connections by designing activities that foster empathy for nature.

e) Developing policies that incorporate environmental education into national curricula, ensuring its integration across disciplines and prioritizing the protection and sustainability of the environment.

f) Supporting teacher training and providing educational resources, enabling educators to access up-to-date environmental materials and training for the effective delivery of environmental topics.

g) Creating partnerships with environmental organizations, allowing schools to collaborate with non-governmental organizations and local businesses to offer students hands-on experience and practical knowledge of environmental issues.

h) Encouraging family and community engagement by promoting initiatives that involve parents and local communities in environmental education efforts, strengthening the connection between classroom learning and real-world applications.

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## Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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