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Educational Interventions for Contemplating and Raising Awareness of Urban Heat Island and Relevance of Remote Sensing

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Abstract

Educational interventions have consistently proven effective in raising awareness and building capacity among diverse demographic groups, including both students and educators. Research indicates that the integration of environmental topics into school curricula and professional development programs significantly enhances knowledge and encourages environmentally responsible behaviors. The present study investigates the perspectives of A and B Grade students at Pafos High School in Cyprus—both those who have elected to study Physics and those who have not—as well as the views of their Physics teachers, regarding the phenomenon of the Urban Heat Island (UHI) and application of Remote Sensing. To collect the necessary data, a questionnaire was designed comprising demographic questions (e.g., gender, origin), items measured on a five-point Likert scale, and binary (positive/negative) response questions, and it was administered to both teachers and students. The same questionnaire was administered to students and to teachers in two phases: initially, to capture their views prior to any intervention, and subsequently, after an educational session on the UHI phenomenon and application of Remote Sensing. Students received the information during a designated class period, while teachers attended a 45 min joint session. All responses were submitted via Google Forms. Descriptive statistics, including means and standard deviations, were calculated and presented through graphical visualizations to facilitate interpretation and comparison across groups and phases. The pre-intervention results revealed a knowledge gap between the teachers and student groups: compared to teachers, students exhibit a significantly lower baseline understanding of both the Remote Sensing and UHI topics. Following the intervention, the results have shown marked improvements in both groups, with mean scores for knowledge and perceptions rising substantially, implying that the intervention was beneficially impactful for both demographics. Also, the post-intervention results demonstrated near-identical scores across both groups, indicating that the intervention successfully closed the initial knowledge gap.

Keywords: urban heat island; temperature; remote sensing; global climate change; educational program; educational intervention

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1. Introduction

Remote sensing and Urban Heat Islands (UHIs) are critical research topics in environmental science, particularly in the context of rapid urbanization and climate change. As urban areas continue to expand and temperatures rise, the ability to monitor and mitigate the effects of these changes is increasingly important. Remote sensing technology has emerged as a powerful tool for environmental monitoring, enabling scientists to track changes in land use, temperature, vegetation, and other critical factors. Urban heat islands, a phenomenon where urban areas experience significantly higher temperatures than their rural surroundings, primarily due to human activities, have become a focal point in climate studies due to their contribution to local warming and the exacerbation of global climate change. Raising awareness of these issues through education is crucial to fostering sustainable urban development and environmental responsibility.

This study focuses on the impact of educational interventions designed to increase awareness and understanding of remote sensing and urban heat islands among teachers and students in Pafos, Cyprus. In this respect, this study investigates the effects of a structured educational intervention on students' awareness and creativity concerning UHI and applications of Remote Sensing. The research aims to determine whether the intervention leads to measurable improvements in students' proposed solutions for addressing UHI the Applications of Remote Sensing and to examine the perspectives of both students and teachers before and after the intervention. The sample comprises students from A and B classes of a Lyceum in Pafos, enrolled in both Elective and Core Physics courses, as well as their Physics teachers. A pre- and post-intervention research design was employed, utilizing a structured questionnaire administered to both students and teachers. The questionnaire included items measured on a five-point Likert scale to evaluate shifts in understanding, creativity, and environmental awareness. Data collection focused on capturing both cognitive and attitudinal changes, while the analysis involved comparative evaluation of pre- and post-intervention responses, quantitative assessment of the ideas expressed, and statistical processing using the SPSS© (version 26) software. The study anticipates that the intervention will contribute to an increased understanding of the local environmental challenges, stimulate more innovative thinking among students, and enhance overall environmental awareness. It is anticipated that the intervention will lead to a deeper understanding of the local environment, foster students' creativity in proposing sustainable solutions, and promote greater environmental awareness.

Remote sensing involves the use of satellite or aerial sensor technologies to detect and monitor physical characteristics of the Earth's surface without direct contact. These technologies capture data by sensing the reflected and emitted radiation from the surface, which can then be used to generate detailed images or datasets [1]. Remote sensing has become a vital tool in environmental monitoring because it provides comprehensive and continuous coverage over large areas, allowing the analysis of patterns and changes over time. For example, remote sensing is widely used to monitor deforestation, urban expansion, and the impacts of climate change on ecosystems and biodiversity [2]. In the context of urban environments, remote sensing can be used to detect changes in land use, surface temperatures, and vegetation cover, all of which are closely linked to the urban heat island effect [3–13]. By offering an accurate, large-scale perspective on environmental conditions, remote sensing helps policymakers, scientists, and urban planners make informed decisions about resource management and urban development.

Urban heat islands refer to the localized warming that occurs in urban areas as a result of human activities, such as industrial processes, transportation, and the replacement of natural land surfaces with impervious materials like asphalt and concrete. These materials absorb and retain heat more effectively than natural surfaces, causing urban areas to become warmer than their rural surroundings, especially at night. The UHI effect can lead to higher energy consumption due to increased demand for air conditioning, exacerbate air pollution, and contribute to health problems such as heat stress and respiratory issues.

Moreover, urban heat islands can intensify the effects of climate change by increasing local temperatures and altering weather patterns. The phenomenon is especially prevalent in rapidly growing cities where green spaces are limited, and urban infrastructure dominates the landscape [14–17]. Research has shown that green spaces, vegetation, and water bodies can mitigate the UHI effect by providing cooling through evapotranspiration and shade, making urban planning and green infrastructure key strategies in addressing this issue.

While education is widely recognized as a key tool for promoting environmental awareness, little research has explored interventions that integrate both Remote Sensing and the Urban Heat Island (UHI) phenomenon within formal education. Existing studies often focus on climate change in general or on isolated technological applications, without linking scientific knowledge to local urban impacts or assessing their effectiveness across different educational groups.

Asimakopoulou et al. [18] identify technical and motivational reasons for a limited inclusion of Earth observation subjects in school curricula; their study confirms that there is a knowledge gap and proposes educational approaches, aiming at enhancing the interest of both teachers and students in the discipline.

Having identified a knowledge weakness on UHI among students in Indonesia, Susilawati et al. [19] stress that it is critical to research young people's knowledge gaps about climate change in the effort to engage youth in the endeavor to understand and mitigate climate change impacts. In their study, they aim to ascertain whether or not the UHI module is necessary for enhancing students' understanding of climate change but also to identify possible reasons for their knowledge gap. Their research showed that educators teaching UHI had exhibited below-average knowledge in the discipline, revealing the need to provide appropriate training to them. The need to train teachers in European countries to use Remote Sensing was a focal point of the research project by Schulman et al. [20], too; they also stress that their project results suggest that "promising approaches from one country cannot simply be transplanted to another—even neighboring—country, but more research is needed".

Adaktylou [21] delineates how the introduction of geospatial technologies aiming at educating teachers and students can become a powerful tool for the enhancement of teaching and learning, thus bridging the knowledge gap in the discipline.

The objective of this research is to evaluate the effectiveness of educational interventions in increasing awareness and understanding of Remote Sensing and urban heat islands among Lyceum teachers and students in Pafos, Cyprus. The study seeks to measure the participants' baseline knowledge of these topics before the intervention and assess the effect of the educational program on their post-intervention understanding. By comparing the pre- and post-intervention survey results, this research aspires to determine whether the intervention successfully increased knowledge and shifted attitudes towards the practical applications of Remote Sensing and the significance of urban heat islands. Additionally, the study seeks to explore how these educational interventions could influence perceptions of local environmental issues and lead to the adoption of sustainable urban policies. The findings of this research have implications for future educational programs in Cyprus and other regions facing similar environmental challenges, highlighting the need for ongoing initiatives to raise public awareness about the critical role of science and technology in addressing urbanization and climate change. The present study addresses also the knowledge gap between teachers and students and demonstrates how a targeted intervention can bridge knowledge disparities, while fostering both technical understanding and environmental responsibility.

Following this introductory section, details of the participating groups are given in Section 2 and the methodology adopted is outlined in Section 3. The results of the analysis of the surveys are presented in Section 4, followed by a discussion of the findings in Section 5. Lastly, Section 6 presents some conclusions and recommendations.

2. Materials

In recent years, Pafos region has experienced substantial demographic growth, both at the municipal and district levels. Pafos Municipality the main municipality in Pafos distinct which is one of the five administrative districts of Cyprus, had a population of 37,991, according to the 2021 Population Census [22]. Pafos Municipality, which serves as the administrative and economic hub of the region, recorded a population of 32,892 in 2011 [23]. This stands for a growth rate of nearly 15.5% between 2011 and 2021. These figures underscore the region's rapid urbanization and demographic dynamism, making it a relevant context for studying environmental issues such as the Urban Heat Island phenomenon.

Given this context, the research sample—comprising students from the A and B classes of a Lyceum in Pafos, along with their Physics teachers—represents a substantial portion of the upper secondary student population in the urban municipality. The school was selected based on its size, location, and demographic diversity, which reflect the characteristics of the broader urban student body. Although the sampling was purposive rather than random, it is considered reasonably representative of urban youth in Pafos, particularly in relation to environmental education and awareness in the context of rapid urban development.

The sample for this research consisted of two distinct groups: teachers and students, who participated in the surveys conducted before and after an educational intervention on Remote Sensing and urban heat islands. Both groups were drawn from the region of Pafos, Cyprus, with the objective of assessing changes in their knowledge and attitudes toward environmental issues.

The teachers sample consisted of 36 participants who responded to both the pre- and post-intervention surveys. The gender distribution of the teacher sample was skewed slightly toward male participants, with 23 males (63.9%) and 13 females (36.1%). This distribution remained relatively consistent across the pre- and post-surveys. Regarding their area of residence, a significant majority of the teachers (55.6%) were residents of the Municipality of Pafos, while the remaining 44.4% lived in the broader Pafos District. This demographic split allowed for a comparison of urban and rural perspectives on the environmental issues addressed in the surveys. Table 1 provides an overview of the teacher sample's demographic characteristics.

Table 1. Demographics of the Teachers Sample.

Demographic Variable	Category	Frequency (N)	Percentage (%)
Gender	Male	23	63.9
	Female	13	36.1
	Total	36	100.0
Area of Residence	Municipality of Pafos	20	55.6
	Pafos District	16	44.4
	Total	36	100.0

The educational intervention was designed to enhance teachers' knowledge about Remote Sensing technologies and urban heat islands, and the pre-intervention survey revealed baseline knowledge levels, which were used as a benchmark for post-intervention comparisons.

The student sample was much larger, consisting of 422 participants. The gender distribution was somewhat balanced, with 245 males (58.1%) and 177 females (41.9%) participating in the surveys. As with the teacher sample, the student respondents came from both the Municipality of Pafos and the broader district. In this case, the split was almost even, with 50.2% of students residing in the Municipality of Pafos and 49.8% in the Pafos District. The student sample represented a range of grade levels, adding further diversity to the group. The highest proportion of students (28%) were from the B Elective (i.e., Grade B Elective Subjects), with other significant groups being the B Core (i.e., Grade B Core subjects, 24.9%), A Core (i.e., Grade A Core subjects, 23.7%), and A Elective (i.e., Grade A Elective subjects, 23.5%). This diversity in class levels was significant in analyzing how the intervention affected students across different educational stages. Table 2 summarizes the demographic characteristics of the student sample.

Table 2. Demographics of the Students sample.

Demographic Variable	Category	Frequency (N)	Percentage (%)
Gender	Male	245	58.1
	Female	177	41.9
	Total	422	100.0
Area of Residence	Municipality of Pafos	212	50.2
	Pafos District	210	49.8
	Total	422	100.0
Class Level	A Core	100	23.7
	A Elective	99	23.5
	B Core	105	24.9
	B Elective	118	28.0
	Total	422	100.0

Both the teacher and student samples provided a diverse demographic range for the study. The male-dominant teacher sample and the balanced gender distribution among students, along with the range of residence and class levels, allowed for a comprehensive analysis of how the intervention impacted different demographic groups. These demographics were significant because they enabled meaningful comparisons, examining gender differences in student responses, assessing the influence of a male-dominant teaching body, and identifying variations across residence and class levels.

3. Methodology

Two surveys were conducted: one with a group of teachers and the other with a group of students. The first set of surveys was conducted prior to an educational intervention designed to enhance understanding of environmental concepts, specifically Remote Sensing and urban heat islands. After the intervention, a second set of surveys was conducted to evaluate changes in knowledge, perceptions, and attitudes among the participants. In the pre- and post-surveys, the same questionnaire was handed over to both the teachers and students. The questionnaire comprises seventeen questions (see Table A1).

The educational intervention consisted of three main components: educational materials, a team-based approach, and post-presentation discussion. First, PowerPoint© presentations provided participants with a comprehensive overview of Urban Heat Islands (UHI), including causes, effects, and remote sensing applications, using visuals, graphs, and case studies. Second, participants were divided into teams to encourage collaboration and active engagement, allowing for peer-to-peer learning among students and professional exchange among teachers. Finally, post-presentation discussions enabled participants to reflect, deepen understanding, and consider the integration of environmental education into teaching. Together, these elements created an interactive and comprehensive learning experience.

The intervention involved a series of informative PowerPoint© presentations designed to increase awareness of the Urban Heat Island (UHI) effect and its impact on human health. The questionnaire also included examples of how Remote Sensing can be applied.

These sessions were tailored specifically for two distinct groups: students and teachers. To ensure focus and relevance, the groups were kept separate—students and teachers did not mix during the intervention. Furthermore, different classes were not combined, and the sessions were delivered within each group based on their specific needs and prior knowledge.

The intervention was structured as follows:

1 PowerPoint© Presentations: The core component of the intervention was a series of PowerPoint presentations made by the same person, which provided a comprehensive overview of UHI, its causes, and its significant effects on both the urban environment and human health. These presentations aimed to familiarize participants with key concepts, scientific data, and real-world examples of UHI phenomena and applications of Remote Sensing. The material included visual representations, graphs, and case studies to engage the audience and ease understanding.

2 Team-Based Approach: To encourage collaboration and active participation, the students and teachers were divided into separate teams. Each team worked together during the presentation, discussing the topics presented and exchanging ideas. This approach allowed for a more interactive learning environment and helped participants process the information through group discussions. For students, this method encouraged peer-to-peer learning, while for teachers, it fostered professional exchange and the opportunity to reflect on the integration of environmental education into their teaching.

3 Content Focus: The content of the presentations focused on the following key areas:

   i. Introduction to UHI: An explanation of the UHI phenomenon, its causes (e.g., urbanization impact, heat-absorbing materials), and its effects on local climates.
   ii. Impacts on Human Health: The specific consequences of UHI on human health, such as heat-related illnesses, respiratory issues, and the exacerbation of pre-existing conditions.
   iii. Mitigation Strategies: Practical solutions to reduce UHI effects, including urban green spaces, reflective materials, and improved urban planning.
   iv. Applications of Remote Sensing: Environmental monitoring plays a crucial role in tracking changes in natural and urban environments. This includes observing deforestation and forest degradation, monitoring air and water pollution levels, and assessing land use and land cover changes. Additionally, it involves monitoring urban heat islands to better understand the impacts of urbanization on local climates. In the field of climate and weather studies, environmental monitoring is used to track sea surface temperatures and other key indicators that influence global and regional climate patterns.

4 Educational Materials: In addition to the PowerPoint presentations, other materials were provided, including printed handouts summarizing key points and offering additional resources for further reading. These materials were designed to reinforce the content covered during the presentations and give participants a reference to review the information at their own pace.

5 Post-Presentation Discussions: After the presentations, participants were invited to engage in group discussions. These discussions allowed them to reflect on the information presented, share their thoughts on the impacts of UHI in their local context, and brainstorm potential solutions. These post-presentation sessions were crucial for fostering deeper understanding and helping participants to connect the theoretical knowledge to real-world applications.

Overall, the intervention was designed to be interactive, informative, and relevant to both students and teachers. By tailoring the content to the specific needs and backgrounds of each group and providing opportunities for collaboration, the intervention aimed to not only increase awareness of UHI and applications of Remote Sensing, but also to inspire action and creative thinking on how to mitigate its effects.

The analysis of questionnaire responses employed descriptive statistics, particularly the mean and standard deviation, which are commonly used to interpret Likert scale data in educational and behavioral research [24]. A Likert scale is a psychometric scale used to measure participants' attitudes, knowledge, or perceptions. In this study, a 5-point scale was used, where 1 = Strongly Disagree and 5 = Strongly Agree.

The teacher sample consisted of 36 participants, while the student sample was significantly larger, comprising 422 respondents. In both cases, demographic data such as gender and area of residence (urban vs. rural) were collected to ensure a comprehensive understanding of the groups.

The identical pre- and post-intervention design of the questionnaire allowed for a direct comparison of participants' responses before and after the educational experience. The purpose was to measure the effectiveness of the intervention in increasing awareness and understanding of Remote Sensing technologies and their role in urban environmental phenomena.

The primary tool for data collection was a structured questionnaire, with different sets tailored for teachers and students. Most questions were designed to be closed utilizing a 5-Point Likert Scale ranging from 1 (strongly disagree/low awareness) to 5 (strongly agree/high awareness). A small number of questions utilized binary positive/negative responses.

The questions were structured around key environmental topics, including:

- Awareness of Remote Sensing;
- Knowledge of urban heat island effects;
- Perceptions of the role of Remote Sensing in environmental protection;
- Opinions on the local urban environment and green spaces.

These questions aimed to capture both subjective opinions and objective knowledge.

To analyze the data, descriptive statistical variables were employed, specifically the mean and standard deviation, to measure central tendency and variability across participants' responses. These are commonly used tools in educational research for summarizing Likert-scale data [24].

The mean ($\overline{x}$) represents the average score for each item and was calculated using the formula:

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

where x_i is the score of each respondent and n is the total number of respondents.

The standard deviation (s) quantifies the degree of variation or dispersion from the mean and was calculated as:

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})^2}$$

These computations were conducted using the SPSS© statistical software, which also generated visual representations such as bar charts and histograms to support the interpretation of findings. By using these descriptive statistics, the analysis aimed to highlight patterns of change in awareness and perception before and after the intervention, allowing for a clearer understanding of its educational impact.

4. Results

4.1. Teachers' and Students' Responses Before and After the Intervention

The following presents a comparative overview of selected questionnaire responses from teachers and students regarding Remote Sensing and the Urban Heat Island (UHI) phenomenon. The answers were collected before and after an educational intervention designed to raise awareness and understanding of environmental issues. Each question is paired with the corresponding figure that visually illustrates the data. The responses reflect how perceptions and knowledge changed as a result of the intervention.

Graphical representations of selected interview questions and answers for teachers and students (before and after the intervention) are provided and discussed below.

4.1.1. Teachers' Responses

Before the intervention, teachers showed moderate awareness of Remote Sensing. The average response was 3.69 with a standard deviation of 1.01, indicating some agreement but also variability (Figure 1). After the intervention, this average increased significantly to 4.78, with a much lower standard deviation of 0.42, showing a strong consensus and improved understanding.

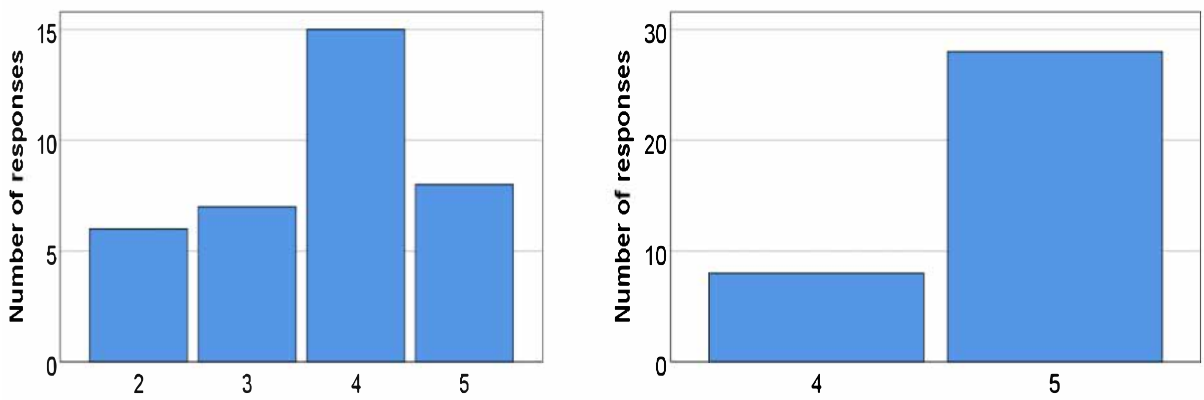

Figure 1. Answers to the question "Do you know what Remote Sensing is?"; Before the intervention (**left**) and After the Intervention (**right**). The x-axis refers to the responses on the Likert scale, from 1 to 5 (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

Regarding how well the school informed them about Remote Sensing, teachers initially had a neutral to slightly positive stance (Figure 2). The responses averaged at 4.67 after the intervention, indicating clear agreement among the participants.

On the question of how Remote Sensing affects our understanding of environmental evolution and protection, the average score before the intervention was 3.72 (Figure 3), which improved substantially to 4.78 afterward, showing increased appreciation for its environmental relevance.

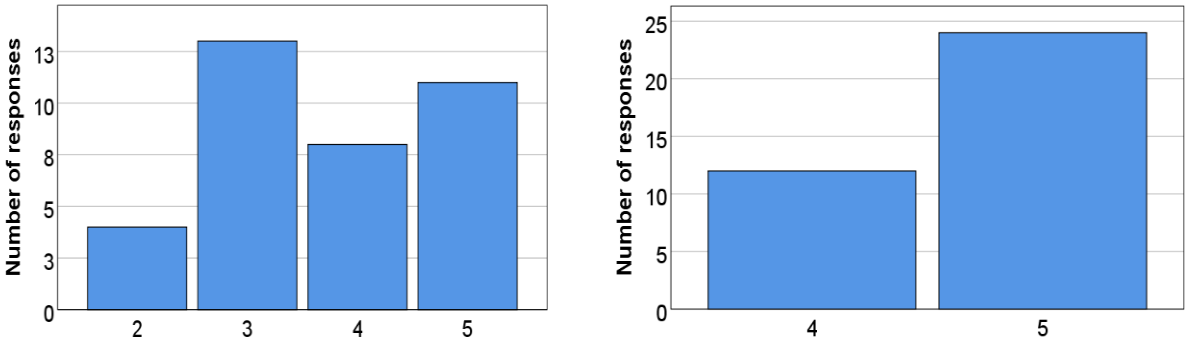

Figure 2. Same as Figure 1, but for the question: "To what extent do you think your school informed you about Remote Sensing?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

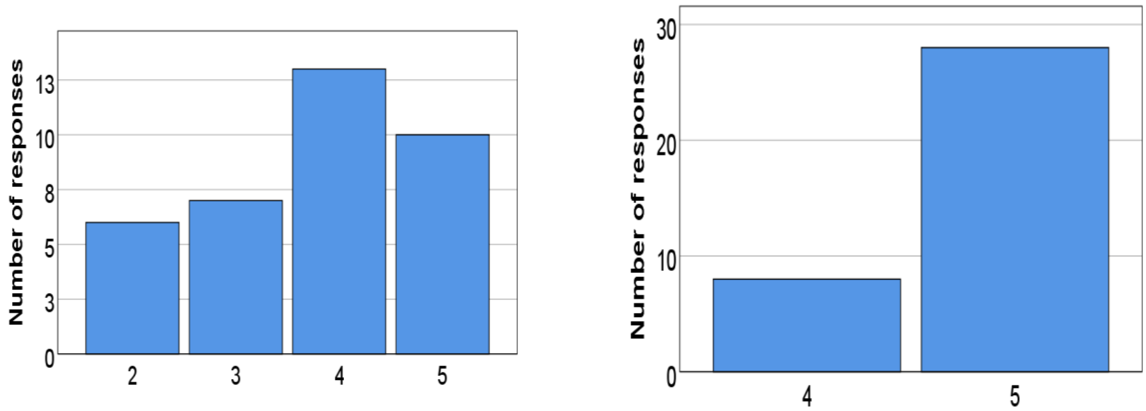

Figure 3. Same as Figure 1, but for the question "How do you think Remote Sensing affects our understanding of environmental evolution and protection?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

When asked whether Remote Sensing can help in developing new technologies, the average score was 3.78 before and increased to 4.78 after the intervention, demonstrating a shift toward recognizing its innovative potential (Figure 4).

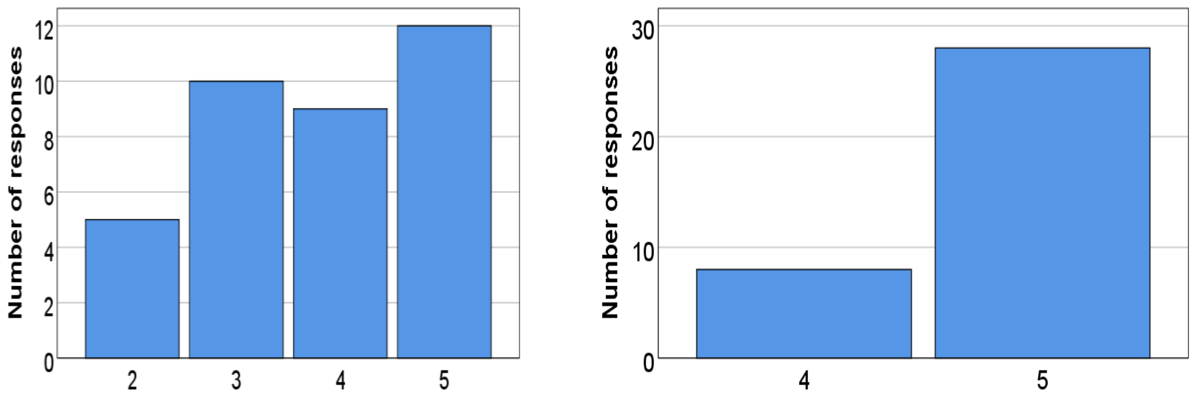

Figure 4. Same as Figure 1, but for the question "To what extent do you believe Remote Sensing can help in developing new technologies?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

Teachers' knowledge of the Urban Heat Island (UHI) phenomenon also improved. Initially, the average score was 3.72, which rose to 4.61 after the intervention (Figure 5, continued for UHI question).

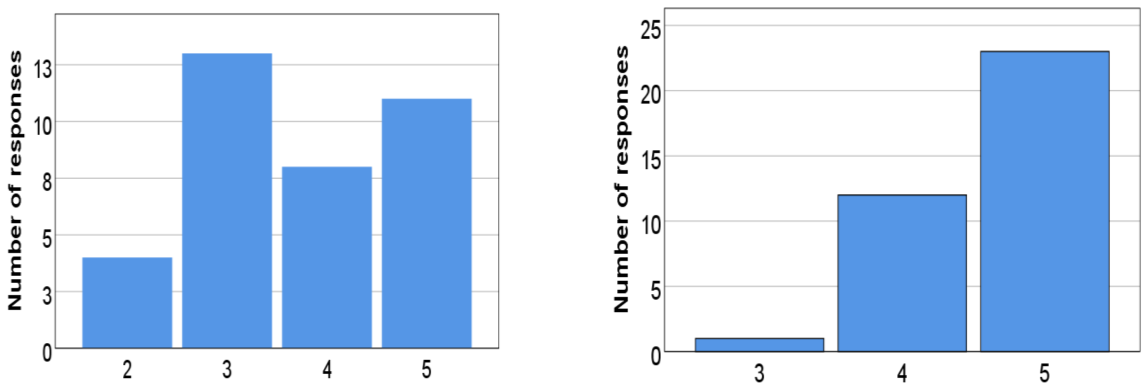

Figure 5. Same as Figure 1, but for the question "Do you know what the Urban Heat Island effect is (UHI)?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

Regarding the impact of residential development on the UHI effect, responses improved from an average of 3.69 before to 4.61 after the intervention, showing better understanding (Figure 6).

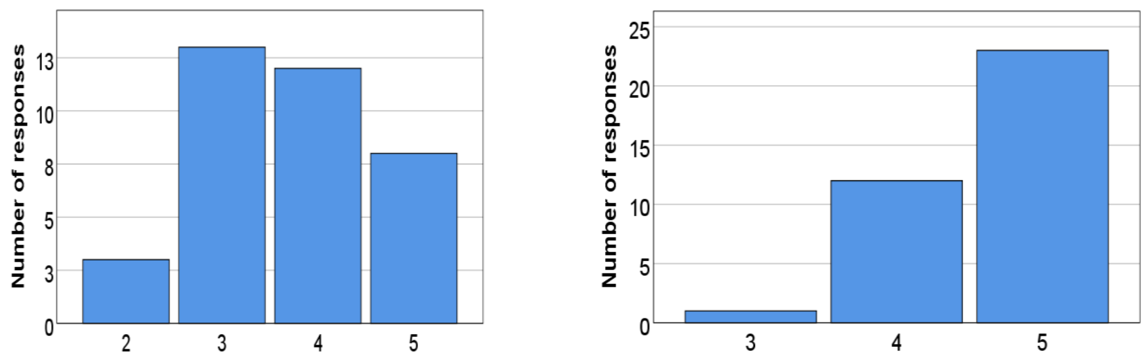

Figure 6. Same as Figure 1, but for the question "How does the urban heat island change with increasing residential development?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

In terms of climate awareness, 61.1% of teachers initially reported having noticed temperature changes in their city (Figure 7). After the intervention, this rose to 88.9%, indicating greater sensitivity to climate-related changes.

Figure 7. Answers to the question "Have you noticed changes in the temperature of your city in recent years?". In the pie chart, positive responses are given as blue, while negative responses are given as green.

When asked whether education about the UHI is important, 75% responded positively before the intervention (Figure 8), which increased to 97.2% after the intervention.

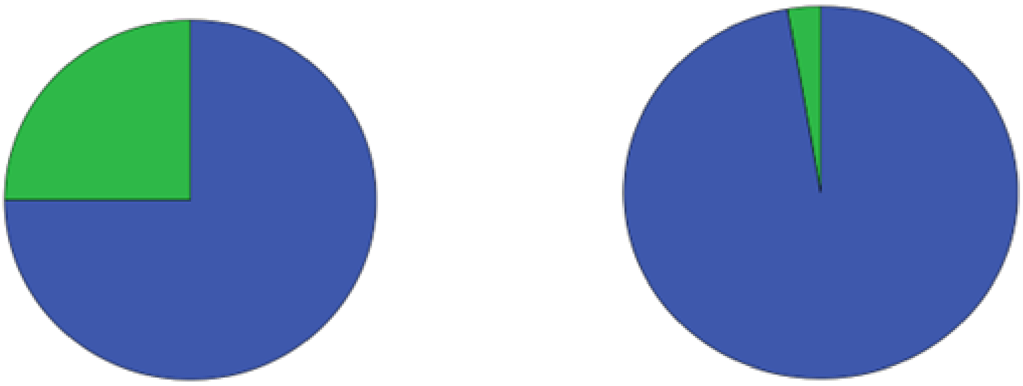

Figure 8. Same as Figure 7, but for the question "Do you believe that awareness and education about the urban heat island is important?".

Support for local policies to address the UHI effect also rose, from 69.4% of teachers agreeing before to 91.7% afterward (Figure 9).

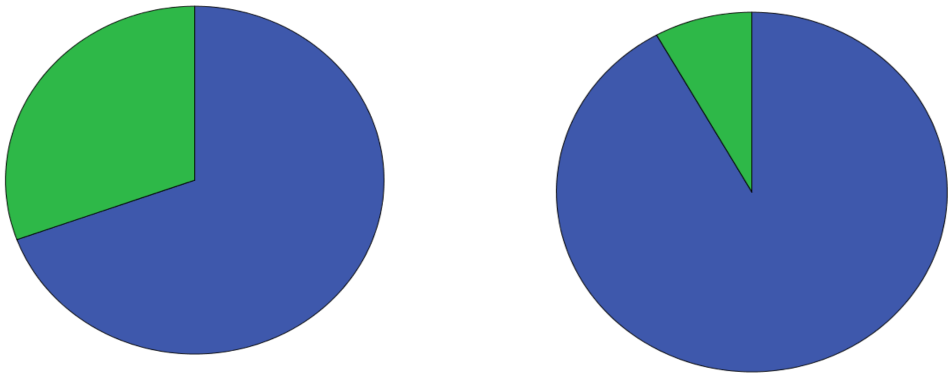

Figure 9. Same as Figure 7, but for the question "Would you prefer there to be a local policy to address the urban heat island?".

4.1.2. Students' Responses

Before the intervention, students showed limited knowledge of Remote Sensing. The average score was 2.55 with a standard deviation of 1.43 (Figure 10). This improved to an average of 3.42 and a slightly lower deviation of 1.33 after the intervention.

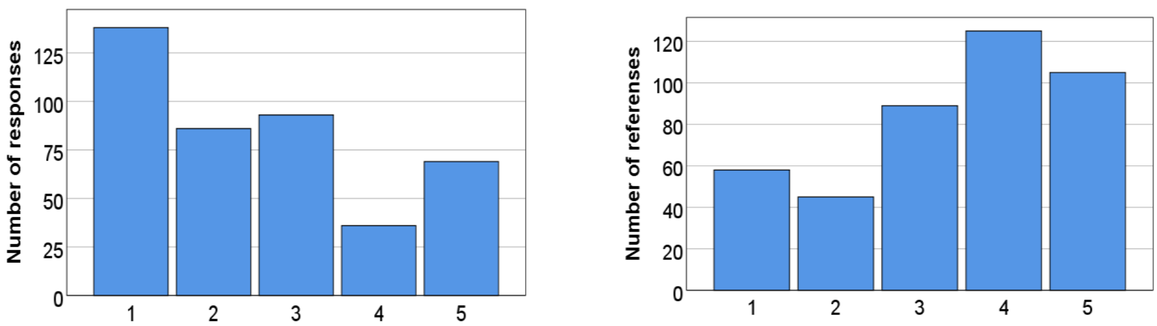

Figure 10. Answers to the question "Do you know what Remote Sensing is?"; Before the intervention (**left**) and After the Intervention (**right**). The *x*-axis refers to the responses on the Likert scale, from 1 to 5 (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

When asked whether the school informed them about Remote Sensing, students initially gave an average score of 2.32 (Figure 11). After the intervention, this increased to 3.21, showing some improvement in perceived school communication.

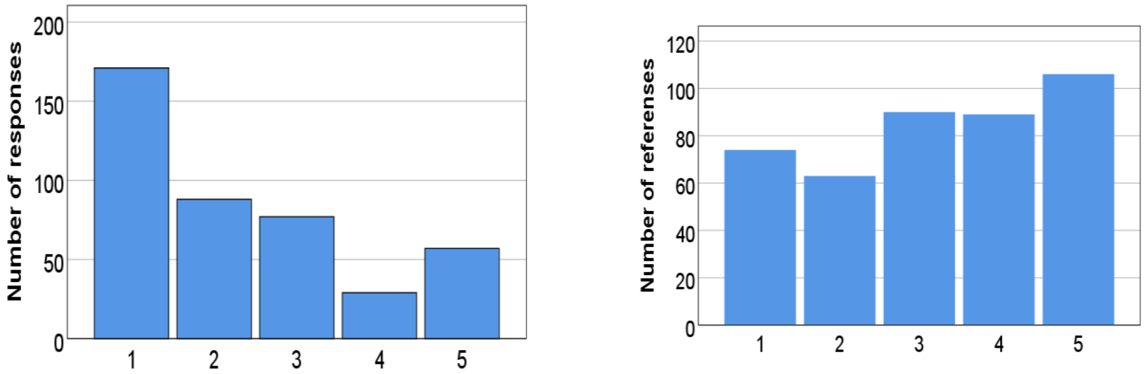

Figure 11. Same as Figure 10, but for the question "To what extent do you think the school informed you about Remote Sensing?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

On the question of how Remote Sensing contributes to understanding environmental evolution and protection, students' responses improved from an average of 2.70 to 3.52 (Figure 12).

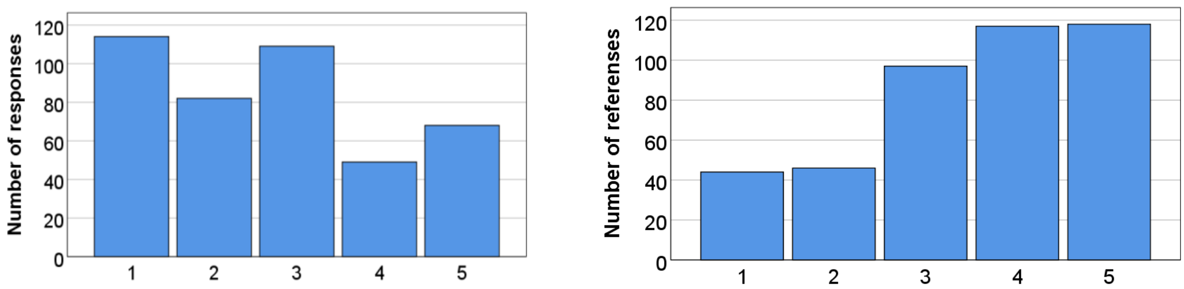

Figure 12. Same as Figure 10, but for the question "How do you think Remote Sensing affects our understanding of environmental evolution and protection?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

Regarding whether Remote Sensing can help in developing new technologies, the pre-intervention score was 2.90 and increased to 3.60 after the intervention, indicating increased awareness of its potential (Figure 13).

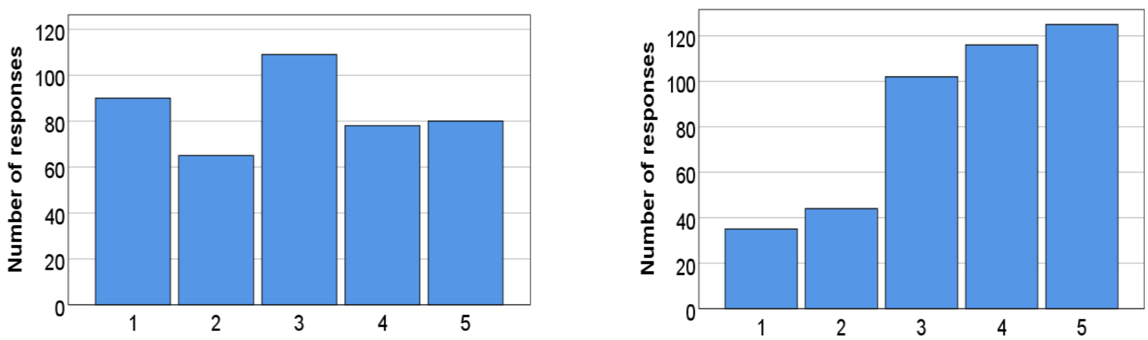

Figure 13. Same as Figure 10, but for the question "To what extent do you believe Remote Sensing can help in developing new technologies?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

Knowledge of the Urban Heat Island (UHI) was also low at first, with an average of 2.34 (Figure 14), but increased to 3.51 after the intervention, showing notable improvement.

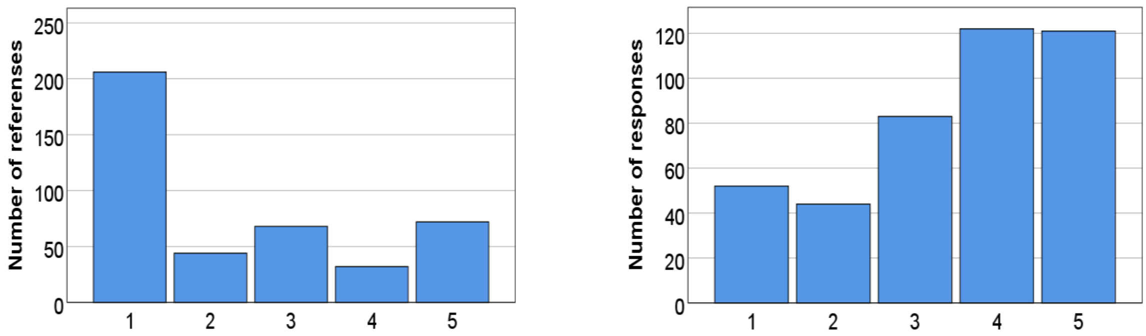

Figure 14. Same as Figure 10, but for the question "Do you know what the Urban Heat Island (UHI) effect is?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

When asked how residential development affects the UHI effect, students' responses rose from 2.61 before the intervention to 3.55 afterward (Figure 15).

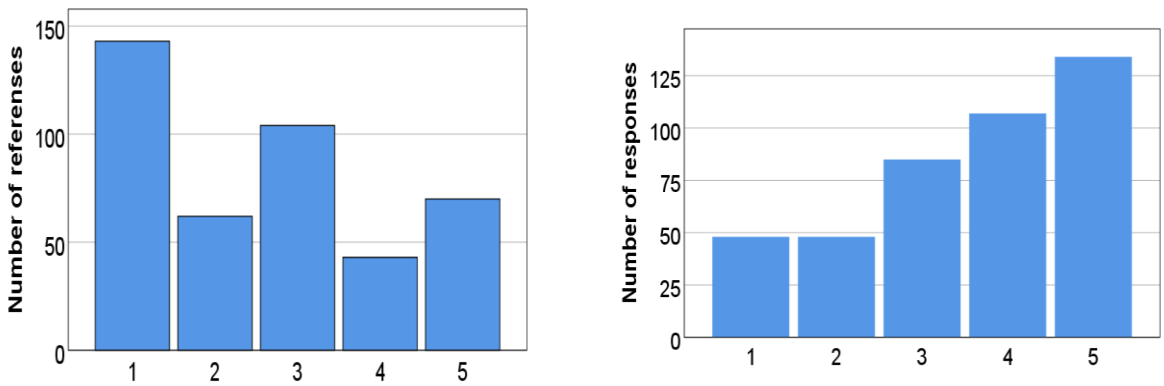

Figure 15. Same as Figure 10, but for the question "How does the urban heat island change with increasing residential development?" (1 = not at all, 2 = a little, 3 = quite a lot, 4 = a lot, and 5 = very much).

Regarding perceived temperature changes in their city, 76.1% of students initially responded positively (Figure 16), and this rose to 86.5% after the intervention.

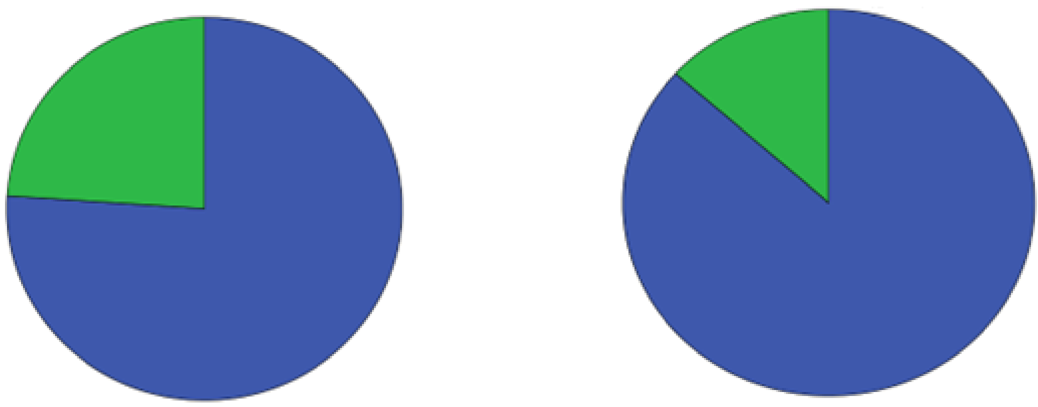

Figure 16. Answers to the question "Have you noticed changes in the temperature of your city in recent years?". In the pie chart, positive responses are given as blue, while negative responses are given as green.

The importance of education about the UHI was acknowledged by 67.8% of students before (Figure 17), which increased to 80.6% afterward.

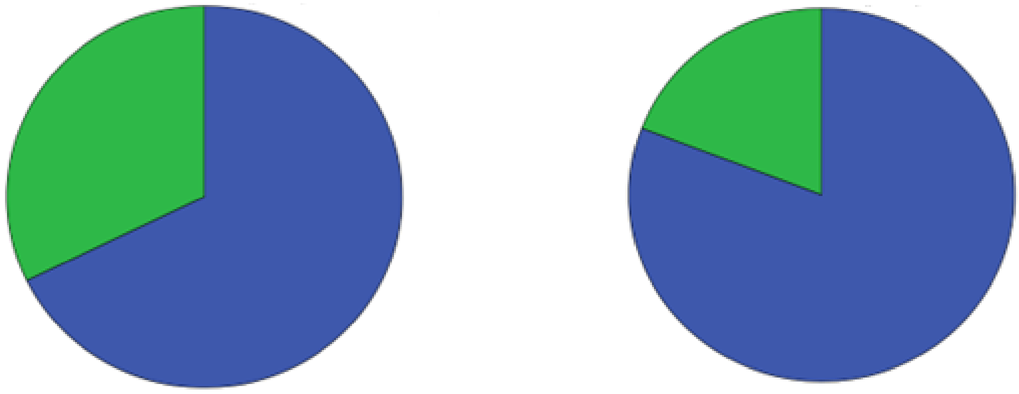

Figure 17. Same as Figure 16, but for the question "Do you believe that awareness and education about the urban island is important?".

Finally, when asked whether they would prefer a local policy to address the UHI, 66.1% responded positively before the intervention, rising to 80.3% afterward (Figure 18).

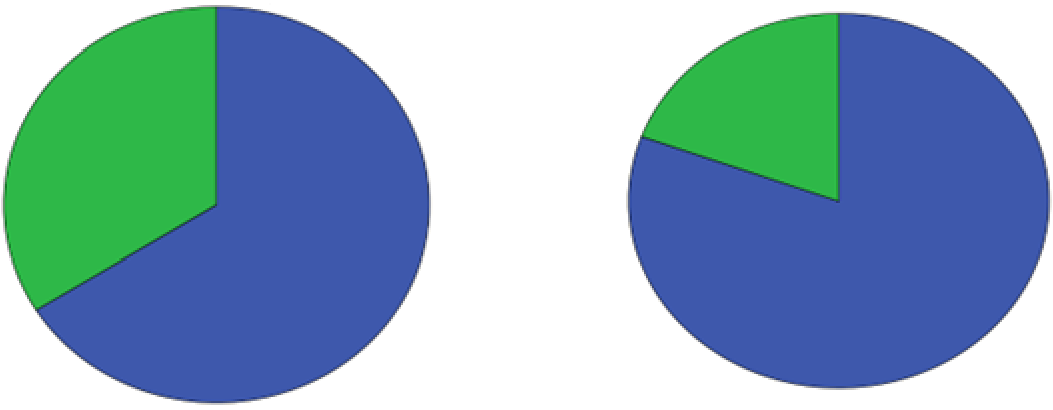

Figure 18. Same as Figure 16, but for the question "Would you prefer there to be a local policy to address the urban heat island?".

5. Discussion

Despite the importance of remote sensing and urban heat islands in understanding and mitigating the effects of urbanization and climate change, public awareness of these topics remains limited. Educational interventions have proven to be effective in raising awareness and building capacity among various demographic groups, including students and teachers. Studies have shown that integrating environmental topics into school curricula and professional development programs can significantly enhance knowledge and foster environmentally responsible behaviors [25–27]. For instance, interventions that include hands-on activities, simulations, and real-world data analysis have been shown to improve students' understanding of complex environmental systems, such as the relationship between land use and temperature changes in urban environments [28,29]. Teachers, who play a crucial role in shaping students' environmental awareness, can also benefit from targeted training programs that equip them with the tools and knowledge necessary to teach these topics effectively [30,31]. By increasing awareness of Remote Sensing technologies, teachers can help students appreciate the role of science and technology in addressing environmental challenges. Such structured educational programs have been shown to improve students' knowledge, self-efficacy, and communication skills [31]. Similarly, educating both teachers and students about the causes and effects of urban heat islands can promote sustainable urban practices and increase public support for policies aimed at reducing their impact. Also, recent studies demonstrate advancements in remote sensing technologies for urban climate change assessment [5,32,33].

In the context of Cyprus, an island nation, and specifically Pafos a region experiencing rapid urbanization and rising temperatures, the relevance of these educational interventions becomes particularly pressing. Cyprus is highly vulnerable to climate change due to its Mediterranean climate, which is characterized by hot, dry summers and mild winters. In recent years, the country has experienced increasing temperatures, with urban areas like Pafos being particularly affected by the urban heat island effect. It is essential to raise awareness among local populations, particularly educators and students, about the impact of urbanization on local climates and the potential of Remote Sensing to monitor and mitigate these effects. Educational programs that focus on these issues can help build a foundation of knowledge and inspire action at both the individual and community levels [32,34,35].

There has been a growing body of research over the past decade that highlights the importance of environmental education in fostering sustainable development and climate-related action. For example, a study by Li et al. [36] emphasizes the role of environmental education in promoting pro-environmental behaviors and increasing public understanding of climate change. Similarly, research by Sukma et al. [37] found that integrating climate science into school curricula not only increased students' knowledge but also influenced their attitudes toward climate policies. In the case of urban heat islands, research has shown that awareness programs focusing on the environmental and health impacts of UHIs can lead to increased support for urban greening initiatives and sustainable urban planning [38]. These studies underscore the critical role that education plays in shaping public attitudes and behaviors toward environmental issues, making targeted educational interventions a valuable tool in the fight against the adverse ramifications of climate change.

5.1. Comparative Analysis of Key Areas of Knowledge

Table 3 shows the pre- and post-intervention results for both groups focusing on selected key areas of knowledge and awareness. A comparative analysis of the two participant's groups, namely teachers and students, reveals both parallels and distinctions in how the educational intervention impacted their understanding of environmental issues.

Table 3. Key areas of knowledge and awareness before and after the intervention.

Question	Pre-Intervention Mean (Teachers)	Post-Intervention Mean (Teachers)	Pre-Intervention Mean (Students)	Post-Intervention Mean (Students)
Knowledge of Remote Sensing	3.69	4.78	2.55	3.42
Remote Sensing Contribution to Environmental Protection	3.75	4.78	2.70	3.52
Knowledge of Urban Heat Islands	3.72	4.62	2.33	3.51
Observed Temperature Changes in the City	61.1%	89.2%	76.1%	86.5%
Need for Local Policies to Address Urban Heat Islands	69.4%	91.9%	66.1%	80.3%

Both groups demonstrated substantial improvements in their knowledge of Remote Sensing and urban heat islands, with similarly significant increases in mean scores. Recent studies support the use of remote sensing to evaluate urban heat islands and urban climate dynamics [5,33,39–42]. However, teachers began with a higher baseline level of knowledge. For instance, prior to the intervention, the average score for teachers' knowledge of Remote Sensing was 3.69, whereas students averaged 2.55. This disparity likely reflects teachers' greater exposure to scientific content through their professional experience. Nevertheless, it is noteworthy to underline that the intervention proved effective in bridging this gap, as both groups achieved comparable post-intervention scores, indicating similar levels of comprehension by the end of the program. These results align with broader findings that remote sensing education can effectively improve climate literacy across groups with differing prior knowledge [32,43].

In terms of perceptions of Remote Sensing's role in environmental protection, both groups reported notable improvements. Initially, teachers were more inclined to recognize the potential benefits, with a pre-intervention mean score of 3.75 compared to students' more neutral 2.70. After the intervention, both groups expressed stronger agreement with the usefulness of Remote Sensing, with teachers averaging 4.78 and students 3.52. This aligns with broader research emphasizing remote sensing applications for environmental health monitoring and urban heat mitigation [43,44]. These results suggest that although students had further to progress, the intervention was successful in aligning their views more closely with those of the teachers.

The intervention also led to increased awareness of urban heat islands in both groups. Before the intervention, 61.1% of teachers and 76.1% of students reported noticing temperature changes in their city. Interestingly, students initially exhibited a higher level of environmental awareness, possibly due to their more direct and frequent exposure to outdoor settings. Following the intervention, awareness levels rose to 89.2% in both groups, indicating a convergence in environmental sensitivity and a high degree of post-intervention awareness. These findings are consistent with comprehensive reviews and case studies demonstrating remote sensing effectiveness for UHI monitoring in multiple cities [39–41].

Another key area of comparison is the participants' support for local policies aimed at mitigating urban heat island effects. Prior to the intervention, 69.4% of teachers and 66.1% of students expressed support for such policies. After the educational sessions, support increased markedly to 91.9% among teachers and 80.3% among students. This substantial rise in both groups reflects a stronger collective commitment to addressing local environmental issues through policy measures. These results echo studies highlighting the role of local climate data and heat maps for informing urban planning [44].

Overall, the educational intervention was highly effective in enhancing both teachers' and students' knowledge and awareness of Remote Sensing and urban heat islands. Although teachers entered the program with a somewhat higher level of background knowledge, both groups demonstrated significant improvements in understanding and perception by the conclusion of the intervention. The findings indicate that the program succeeded not only in increasing factual knowledge but also in fostering positive attitudes toward the use of technological tools and the importance of local environmental policy. These outcomes highlight the potential of targeted educational initiatives to build a shared foundation of environmental literacy across diverse participant groups.

5.2. Statistical Testing of Results

The statistical significance of the differences in the results of the analysis was further pursued through the application of a series of Student's *t*-tests carried out by using the

SPSS© package [24]. In this respect, the discussion here is limited to the testing of the differences in the pre- and post-intervention changes within the teachers and student groups. Table 4 displays the interpretation of the *t*-testing on each of the questions in the Survey for both the teachers and the students.

Table 4. Summary of statistical testing of pre- and post-intervention results for teachers and students.

Question Number	Respondent's Perception	Interpretation
Q1	Remote Sensing knowledge	Both teachers and students demonstrated significant improvements ($p < 0.001$). Although teachers reported higher baseline knowledge, post-intervention differences were no longer statistically significant, indicating knowledge equalization.
Q2	Awareness of Copernicus data	Teachers did not show a significant change ($p = 0.090$), whereas students exhibited a significant gain ($p < 0.001$). Despite progress, students remained at lower knowledge levels than teachers' post-intervention one.
Q3	School information on Remote Sensing	Both groups showed significant increases ($p < 0.001$). Post-intervention differences between teachers and students were not significant, suggesting comparable levels of perceived institutional support.
Q4	Remote Sensing and environmental protection	Teachers and students improved significantly ($p < 0.001$). Post-intervention results indicate similar recognition of the environmental relevance of Remote Sensing.
Q5	Remote Sensing and technological innovation	Both groups reported significant gains ($p < 0.001$), with no significant post-intervention differences, demonstrating a shared acknowledgment of technological applications.
Q6	Awareness of UHI	Teachers scored higher at baseline, yet both groups improved significantly ($p < 0.001$). Independent *t*-tests showed no significant post-intervention difference, reflecting convergence of understanding.
Q7	UHI and residential development	Significant gains were observed for both groups ($p < 0.001$). In post-intervention, group differences were not significant, suggesting similar awareness of urbanization effects.
Q8	Local warming	Teachers reported modest but significant changes ($p = 0.016$), while students showed stronger gains ($p < 0.001$). No significant differences remained between groups after the intervention.
Q9	Potential of Remote Sensing	Both teachers and students improved significantly ($p < 0.001$), with no significant between-group differences in post-intervention.
Q10	Community/authority sensitivity to UHI	Both groups reported significant improvements ($p < 0.001$). Students expressed greater skepticism, yet differences between groups were not significant in post-intervention.
Q11	Importance of UHI education	Teachers showed modest but significant gains ($p = 0.009$), while students' improvement was stronger ($p < 0.001$). In post-intervention, both groups expressed equally strong endorsement of UHI education.
Q12	Existence of UHI in Pafos.	Significant improvements were recorded in both groups ($p < 0.001$). No significant post-intervention differences were detected.

Table 4. *Cont.*

Question Number	Respondent's Perception	Interpretation
Q13	Awareness of municipal green spaces	Teachers showed no significant change ($p = 0.136$), whereas students reported a significant increase ($p = 0.004$). However, post-intervention group differences were not statistically significant.
Q14	Visiting green spaces	No significant changes were observed for either group, indicating that visiting behaviors were not affected by the intervention.
Q15	Value of green spaces	Both groups demonstrated significant increases ($p < 0.001$), converging in their recognition of the recreational and social value of green spaces.
Q16	Policy preferences regarding UHI	Teachers' responses showed modest but significant gains ($p = 0.030$), while students exhibited stronger support ($p < 0.001$). Post-intervention, both groups expressed comparable levels of policy preference.
Q17	Personal effects of temperature rise	Teachers ($p < 0.001$) and students ($p = 0.001$) both reported significant improvements. Between-group differences were non-significant post-intervention.

The results show that the program helped participants improve their knowledge and understanding of Remote Sensing and the Urban Heat Island (UHI) effect. After the intervention, participants better recognized how Remote Sensing can support environmental protection, modern technologies, and scientific discoveries. They also became more aware of the effects of rising temperatures, the reality of UHI in Paphos, and the need for local policies to deal with it. In general, teachers saw schools, communities, and authorities as more responsive to these important environmental issues.

However, not all areas indicated change. Knowledge about Copernicus data did not improve significantly, probably because the topic is very specialized and was not explained with enough practical examples. Similarly, awareness of green spaces in Paphos and the habit of visiting them remained the same. This is likely because participants already knew about the existence of green spaces and visiting them depends on personal lifestyle choices rather than a single educational activity. In short, the program was successful in raising awareness about key environmental issues.

Both students and teachers showed significant improvements in their understanding of Remote Sensing, the Urban Heat Island (UHI) effect, and the role of these concepts in environmental monitoring and sustainable development. After the intervention, both groups recognized the importance of Remote Sensing for technological progress and scientific discoveries, and they acknowledged the need for policies to mitigate UHI impacts. However, a difference emerged in how they perceived community and institutional responses: teachers tended to see schools, communities, and authorities as more responsive and sensitive to environmental issues, while students were more skeptical, often doubting the adequacy of local action. This suggests that teachers, due to their professional experience and closer contact with policy discussions, may have a more positive outlook, whereas students evaluate these issues from a more personal and experiential perspective.

Another difference concerned specialized knowledge and behavioral aspects. For students, awareness of Copernicus data increased significantly, while for teachers it did not show notable improvement—likely because the topic was too technical and not illustrated with enough classroom-ready examples. On the other hand, both groups showed slight change in relation to green spaces in Pafos and visiting habits. For teachers, this stability reflects pre-existing awareness and lifestyle routines, whereas for students, the limited change highlights that knowledge does not automatically lead to behavioral shifts. In both cases, the findings underline the importance of combining knowledge-based interventions with practical, experiential activities that can foster lasting behavioral engagement.

The study investigated students' awareness and understanding of Remote Sensing, Copernicus data, and the Urban Heat Island (UHI) effect. Initial results revealed limited knowledge and low familiarity with these scientific concepts. Following the intervention, students demonstrated significant improvements in awareness, comprehension, and attitudes, acknowledging the importance of environmental monitoring, technological applications, and sustainable policy measures. The findings indicate that targeted educational programs can effectively enhance environmental literacy and foster responsibility toward local and global climate challenges.

The research also highlighted areas where knowledge gains did not directly translate into behavioral change. Specifically, no significant difference was observed in students' reported visits to local green spaces, a result likely influenced by external factors such as accessibility, leisure patterns, or family routines rather than awareness levels. This outcome suggests the need for future studies to explore complementary strategies that promote active engagement and behavioral shifts alongside cognitive development. Overall, the intervention proved educationally transformative, providing statistically robust results that support its readiness for academic dissemination and contribution to the field of environmental education.

6. Concluding Remarks

This study focuses on evaluating the effectiveness of an intervention for the Urban Heat Island and relevance of Remote Sensing and how it affects the emergence of ideas of students and teachers, as they were asked to answer a questionnaire, before and after the educational intervention on the Urban Heat Island phenomenon and Remote Sensing.

The educational intervention focused on Remote Sensing and urban heat islands proved highly effective in enhancing the knowledge and environmental awareness of both teachers and students. Pre-intervention survey results revealed a clear knowledge gap between the two groups, with students exhibiting significantly lower baseline understanding of both topics compared to teachers. However, post-intervention data showed marked improvements in both groups, with mean scores for knowledge and perceptions rising substantially. Notably, the post-intervention results demonstrated near-identical scores across teachers and students, indicating that the intervention successfully closed the initial knowledge gap and was equally impactful for both demographics.

One of the most compelling outcomes was the shift in attitudes regarding the practical applications of Remote Sensing—particularly its potential to support environmental protection and drive technological innovation. Both groups transitioned from neutral or mildly positive positions to strong agreement on the relevance of Remote Sensing in addressing contemporary environmental challenges. Similarly, awareness of the urban heat island (UHI) effect and its local consequences, such as temperature increases in areas like Pafos, improved significantly. Following the intervention, nearly all participants recognized these local climate shifts and expressed strong support for local policy measures to mitigate UHI effects [45,46].

These findings underscore the intervention's success not only in delivering technical knowledge but also in fostering a deeper sense of environmental responsibility and civic engagement. The consistency of post-intervention outcomes across both groups suggests the program was well-structured and inclusive, effectively engaging participants regardless of their initial familiarity with the subject matter. The intervention's ability to raise awareness and promote actionable understanding across diverse educational levels positions it as a promising model for future environmental education initiatives.

This study demonstrates that targeted educational programs can significantly enhance public understanding of complex environmental phenomena such as Remote Sensing and urban heat islands. By equipping both educators and students with the knowledge and tools needed to interpret and address environmental issues, such interventions can play a crucial role in promoting sustainable behaviors and preparing communities to confront pressing global challenges, including climate change.

As is widely acknowledged, education plays a pivotal role in raising awareness about the urban heat island phenomenon. To build on this foundation, the following educational activities are recommended:

- Research Projects: Students can explore the impact of urbanization on local temperatures, analyze data, and propose actionable solutions to reduce heat stress in cities.
- Use of Technology: Tools such as thermal imaging cameras can enable students to monitor temperature variations across different urban areas, providing direct insights into the UHI effect.
- Participation in Environmental Programs: Involvement in initiatives focused on climate change and urban resilience can deepen students' understanding and encourage active participation in mitigation strategies.

Through their engagement in the educational intervention, students not only acquire valuable theoretical and practical knowledge but also cultivate a stronger sense of environmental stewardship. This heightened awareness empowers them to contribute meaningfully to the development of sustainable solutions for urban environments [25,34,35,46]. As these students apply their learning to real-world challenges, they will form the foundation of a future generation of informed, proactive citizens—capable of advocating for and implementing strategies that enhance urban resilience and promote long-term environmental sustainability.

The findings indicate that the intervention was highly effective in raising knowledge and awareness of both Remote Sensing and UHI across teachers and students. Notable themes that emerge from this study are summarized in closing this article:

- Differential Baseline Knowledge: Teachers began with higher levels of knowledge, likely due to their professional exposure to scientific content. This aligns with findings from Hodam et al. [47] who reported that teachers often possess a moderate baseline understanding of environmental issues, which can be leveraged in professional development programs. Students, in contrast, entered with more limited knowledge, consistent with studies by Adaktylou [21], showing that students often lack prior exposure to Remote Sensing concepts but can engage meaningfully through phenomenon-based lessons on environmental issues such as the Urban Heat Island effect.
- Convergence of Awareness: Despite different starting points, the intervention effectively narrowed the gap between groups. By the conclusion, both teachers and students expressed greater appreciation for remote sensing's role in environmental protection and UHI awareness. Similar outcomes were reported by Lindner et al. [48] who demonstrated that structured STEM courses integrating remote sensing into geography and physics lessons can significantly elevate awareness across diverse audiences.
- Importance of Experiential Learning: An interesting finding was that students initially reported higher recognition of temperature changes in their city (76.1% vs. 61.1% for teachers). This suggests that students' more frequent outdoor exposure may heighten sensitivity to climate effects. Comparable observations have been noted

by Monroe [49], who highlighted the role of experiential learning in shaping youth climate awareness.

- Policy Support and Environmental Literacy: The intervention also fostered stronger support for local UHI policies. This outcome underscores the potential of targeted education to bridge the gap between scientific understanding and civic engagement. As Goldman & Alkaher [50] argue, educational initiatives play a crucial role in cultivating "environmental citizenship," where individuals not only understand ecological issues but also endorse policy actions.
- Implications: Overall, the results highlight the dual benefit of such interventions: improving factual knowledge and shaping attitudes toward sustainable urban planning. These findings support the argument that integrating Remote Sensing and UHI topics into formal education can enhance environmental literacy and policy support at both institutional and community levels.

The outcomes correspond to recent research demonstrating how remote sensing can be integrated into urban climate education and mitigation strategies [32,33,43].

In conclusion, this study demonstrates that well-structured educational interventions can play a transformative role in equipping educators and students with the knowledge, attitudes, and motivation needed to address pressing environmental challenges. As climate change continues to impact urban environments, such programs offer a scalable and impactful model for fostering informed, proactive, and environmentally responsible citizens.

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Appendix A

Questionnaire administered to Teachers and Students (Before and After the Intervention)

Table A1. Questionnaire.

Number	Question	Answer
Q1	Do you know what Remote Sensing is?	Likert (1, 2, 3, 4, 5)
Q2	Do you know what Copernicus data are?	Yes/No
Q3	Has your school informed you about Remote Sensing?	Likert (1, 2, 3, 4, 5)
Q4	How do you think Remote Sensing affects our understanding of environmental evolution and protection?	Likert (1, 2, 3, 4, 5)
Q5	To what extent can Remote Sensing help in developing new technologies?	Likert (1, 2, 3, 4, 5)
Q6	Do you know what the Urban Heat Island (UHI) effect is?	Likert (1, 2, 3, 4, 5)
Q7	How does UHI change with increased residential development?	Likert (1, 2, 3, 4, 5)
Q8	Have you noticed temperature changes in your city in recent years?	Yes/No
Q9	How do you assess the potential of Remote Sensing in revealing scientific discoveries?	Likert (1, 2, 3, 4, 5)
Q10	How would you describe the sensitivity of the local community and authorities on UHI matters?	Likert (1, 2, 3, 4, 5)
Q11	Do you believe that awareness and education about UHI are important?	Yes/No
Q12	Do you believe that UHI exists in Pafos?	Likert (1, 2, 3, 4, 5)
Q13	Are you aware that Pafos Municipality has green spaces?	Yes/No
Q14	If yes, have you visited them?	Yes/No
Q15	Evaluate green spaces as meeting and recreation places	Likert (1, 2, 3, 4, 5)
Q16	Would you prefer a local policy to address UHI?	Yes/No
Q17	How does temperature increase affect you?	Likert (1, 2, 3, 4, 5)

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