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# Linking environmental knowledge, attitude, and behavior with place: a case study for strategic environmental education planning in Saint Lucia

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**ABSTRACT**

This case study investigated whether and how urban/rural differences may impact environmental knowledge, attitude, and action levels of the youth to better understand the linkage between place and environmental behavior. A nation-wide survey was conducted in Saint Lucia, targeting secondary school students. A total of 1,349 self-reported questionnaire samples were collected and the results were compared between sex (male/female), age (younger/older), and location (urban/rural) groups using three-way ANOVA tests. Significant urban–rural differences as well as interactions between location and age, and location and sex factors, were found. A path analysis further confirmed that location had a significant direct impact on students' knowledge, and indirect impacts on attitude and action levels via age factor. We discuss the impact of living place on students' environmental characteristics, and how environmental education (EE) can incorporate such perspective in its design. We believe that the obtained insights are useful for making EE more effective.

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Environmental education; place; knowledge-attitude-behavior (KAB) model; student; Saint Lucia; GIS

## Introduction

The increasing signs of global environmental degradation and ecological collapse are urging us to shift from our current wasteful, consumption-heavy economy and lifestyle to a sustainable one in which the interrelatedness of the Web of life and the preciousness of finite resources are appreciated (Tilbury 1995).

As early as the 1960s, Stapp (1969) proposed environmental education (EE) as a vital means for every citizen to develop a clear understanding that humans are an integral part of a living system and how we live both positively and negatively affects this system. He explained that EE must help individuals form a broad understanding of the biophysical environment and human–nature interaction, as well as the problems arising from it, ways to solve those problems, and, most importantly, the motivation to solve them.

While the importance of EE is crystal clear, how effective it has been is an ever-more critical question. Hungerford and Volk (1990) urged educators to contemplate how EE could become more successful in promoting responsible environmental behavior. More recently, Hume and

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Barry (2015) pointed out that the state of the planet has gone from bad to worse and there is a lack of an educational framework that could take the lead in radically altering our economy, production systems, and ways of living. Although steady progress has been made in mainstreaming EE and Education for Sustainable Development at the global level, a recent UNESCO study indicates insufficient integration of environmental issues in many countries' education systems (UNESCO 2021). Incoherent discourse and practice are causing confusion and a loss of effectiveness of EE (Barraza, Duque-Aristizábal, and Rebolledo 2003), and there are methodological flaws, including a lack of reflection on the part of practitioners (Carvalho de Sousa, Sevilla-Pavón, and Seiz-Ortiz 2012). The approach to EE is still largely fragmented, and better accumulation of research and practice will be essential to reach the goal of EE.

Kasimov, Malkhazova, and Romanova (2002) pointed out that guiding people from knowledge to attitude to action is inherently difficult. Many studies, including the comprehensive discussion developed by Kollmuss and Agyeman (2002), confirmed that EE cannot simply assume the linear relationship shown in the knowledge-attitude-behavior (KAB) model. In reality, human behavior is much more complex.

Another major challenge in implementing EE is the evaluation of its impact (Crohn and Birnbaum 2010; Heimlich 2010). While, at a project level, there is ample evidence around the world of the positive effects of EE, our knowledge about its broader effectiveness is limited due to the lack of a common framework or instrument that would allow measurement of the impact of interventions (Steg and Vlek 2009; Monroe 2010; Pauw 2014) on a geographically and temporally collective scale. Such evaluation is especially challenging because it involves intangible value changes that are difficult to quantify (Harder et al. 2014); the attribution is also complicated due to said complexity of the behavioral mechanism. Thus, the two challenges, behavioral complexity and evaluation, are closely linked.

The ultimate goal of EE is to change people's behavior in ways that improve the physical environment (Tilbury 1995; Short 2009; Heimlich 2010). This is becoming an urgent mission for all global citizens. Hence, EE must focus more on emotional, action-oriented outcomes (UNESCO 2021). Ardoin, Bowers, and Gaillard (2020) conducted a timely review of the existing studies and provided recommendations for future EE research and practices: to better demonstrate direct impacts of EE, focus on locally relevant topics, and develop a thorough approach for measuring and reporting EE outcomes. Their discussion highlights the significance of careful EE design and planning prior to implementation.

There is an expanding line of research into the role of place in one's environmental behavior. Outdoor EE has long been shown to effectively raise the environmental consciousness of both youth and adults (Tilbury 1995; Hungerford and Volk 1990). Otto and Pensini (2017) argue that nature-based EE is a holistic approach that enhances both knowledge and intrinsic drivers, leading to increased environmental behavior. Such studies provide important insights into how one's environmental behavior is driven by a sense of connectedness to a 'place' and how EE can effectively incorporate this in its design to promote 'durable behavior change' (van der Linden 2015). Integrating spatial perspectives into EE seems to be key for advancing our knowledge of behavioral mechanisms (Klaniecki, Leventon, and Abson 2018) and accelerating behavioral change through EE. Nevertheless, the impact of place on one's environmental behavior is still largely underexplored (Kudryavtsev, Stedman, and Krasny 2012).

This paper attempts to provide insights useful for overcoming the challenges of strengthening EE design and understanding the linkage between place and behavior. We believe that the analytical step during the EE planning stage is crucial, as discussed in Demnati, Allache, and Ernoul (2015). We demonstrate this point through a case study. In doing so, our goal is to investigate how people's living place may affect their environmental knowledge, attitude, and behavior and take this into account in strategizing EE. In the next sections, we review relevant studies and set out our objective and methods. Discussions on the role of place and future EE approaches are provided based on the findings.

## Understanding environmental behavior

The KAB model is one of the oldest and simplest to explain an individual's environmental behavior (Hungerford and Volk 1990; Kollmuss and Agyeman 2002). It shows that gaining knowledge influences an individual's attitudes, which then causes a change in behavior (Yi and Hohashi 2018). Though this is an overly simplistic picture of the behavioral mechanism (Kollmuss and Agyeman 2002; Heimlich 2010; Wals et al. 2014), it describes a fundamental relationship between environmental knowledge, attitude, and action-taking (Akintunde 2017; Iyer 2018). Additional models have been proposed further characterizing the mechanisms that lead to environmental behavior (e.g. Hines, Hungerford, and Tomera 1987; Stern 2000); these are constantly developing (e.g. Bamberg and Möser 2007; Varela-Candamio, Novo-Corti, and García-Álvarez 2018; Thiermann and Sheate 2020).

Studies investigating why some people take more environmental actions than others identified key mechanisms and factors influencing environmental behaviors. For example, Barr (2007) argued that recycling is a fundamentally normative behavior that is very different from reduce and reuse behaviors. Relatedly, Gould et al. (2016) found that those practicing recycling may not necessarily connect this concrete action with more systemic actions such as modifying a consumption-heavy lifestyle.

Studies conducted worldwide collectively help us to understand what influences individual environmental attitudes and behaviors. Gender/sex, age, and educational attainment are among the known factors associated with these constructs, though to varying degrees (Chawla and Cushing 2007; Gifford and Nilsson 2014). In general, women seem to be more emotionally engaged (Kollmuss and Agyeman 2002; Barr 2007; Hassan, Noordin, and Sulaiman 2010; OECD 2020). More highly educated people seem to be more pro-environmental, possibly because they understand the benefits more clearly and thoroughly (Meyer 2015). Culture and socio-economic status also seem to be influential factors (Valeria and Maria 2013; Litina, Moriconi, and Zanaj 2016; Grúňová et al. 2019), though these results are less conclusive (Gifford and Nilsson 2014). Hungerford and Volk (1990) identified three categories of variables, Entry, Ownership, and Empowerment, that lead to environmentally responsible behavior; they argued that, although the categories likely operate in a linear fashion, variables within each category react synergistically. These studies indicate how complex human behavior mechanisms are.

## The role of place in environmental behavior

To ultimately achieve improvements in environmental quality through changes in people's behavior, the changes must endure. While environmental knowledge contributes to this to a certain degree (Kollmuss and Agyeman 2002), emotional engagement seems to be key (Hungerford and Volk 1990; Chawla and Cushing 2007; van der Linden 2015). Intrinsic motivation and contextual factors are interwoven in the causation of environmental behavior (Pauw 2014). Hungerford and Volk (1990) assumed that EE learners require instructional reinforcement over time to maintain positive environmental behavior. Steg, Lindenberg, and Keizer (2016) discuss the motivational dynamics behind environmental behaviors and emphasize that intrinsic motivation is essential for sustained behavior and that strategies to nurture or support biospheric values are crucial. Darner (2009) discusses a similar point through the Self-Determination Theory.

The impact of place on one's environmental attitude and behavior has been increasingly highlighted in recent EE and behavioral research. For example, nature-based EE seems to be effective for nurturing children's intrinsic motivation (Otto and Pensini 2017), and younger children seem to retain nature connectedness longer (Liefländer et al. 2013). One's love or trust for community driving him/her to act environmentally (Pei 2019) support the idea that people act responsibly towards their immediate environment if they have a sense of rootedness (Kudryavtsev, Stedman, and Krasny 2012). Kudryavtsev, Stedman, and Krasny (2012) provide a thorough review of the linkage between EE and sense of place, focusing on why and how place attachment and place meaning are important for one's environmental behavior. According to the authors, place attachment generally implies a positive bond between people and places, but a broader relationship between places and people exists; this includes negative or ambivalent feelings around places (Manzo and Perkins 2006).

'Place' is a broad term, encompassing not just geographic but also cultural, political, economic, and esthetic meanings that have become attached to it (Kudryavtsev, Stedman, and Krasny 2012). It is more recently that studies have actively explored the role of place in fostering environmental behavior via emotional attachment to nature (e.g. Liefländer et al. 2013; Otto and Pensini 2017; Thiermann and Sheate 2020) or to a specific place (e.g. Manzo and Perkins 2006; Pei 2019), yet those investigating how one's living place positively or negatively influences one's environmental attitude and associated behavior are scarce. As pointed out by Kudryavtsev, Stedman, and Krasny (2012), more studies focused on urbanized settings, i.e. environments away from nature, are therefore needed. In fact, the negative impact of urban living on a student's environmental perception (Ferguson 2020) is a vital point of investigation.

In Malaysia, Hassan, Noordin, and Sulaiman (2010) compared and found significant differences in students' environmental awareness between urban and suburban samples without clear explanation, prompting a deeper examination of this difference. A recent study in Mexico investigated the difference in children's environmental behavior between urban and rural place of residence and found that rural children report more environmental behavior, mediated by their connection to nature (Duron-Ramos et al. 2020). Other studies arguing urban–rural differences point to the need to recognize learning opportunities uniquely provided in urban areas (Duhn, Malone, and Tesar 2017) and highlight successful examples (Crosley 2013). Furthermore, urban–rural inequality seems to exist in an educational context (Agrawal 2014; van Maarseveen 2021), and a close linkage between environment-specific and general knowledge is suggested (Geiger, Geiger, and Wilhelm 2019), but the overall relationship between knowledge, attitudes, and behavior and place of residence remains unclear. Thus, a more comprehensive investigation of the urban–rural difference is necessary as a first step to understand the role of place and consequently strengthen EE planning. Collecting new empirical evidence regarding the young population in developing countries is especially valuable given the general lack of data in the current literature.

## Objective

The objective of this study is to investigate the urban–rural difference and its implications for students' environmental knowledge, attitude, and behavior as an initial effort to understand the impact of living place on individual environmental behaviors.

We chose Saint Lucia, an Eastern Caribbean island nation, as our case study for the reasons described below. We conducted a nation-wide secondary school environmental survey and converted the responses into individual's overall environmental attitude, knowledge, and action scores. We first compare the scores by sex (male/female), age (younger/older), and location (urban/rural). We then examine the relationship of these three factors and how they influence the knowledge, attitude, and action scores.

## Case study selection

Saint Lucia is an upper-middle-income country and one of the Small Island Developing States (SIDSs). A case study in a middle-income country is important because countries in this group are generally experiencing drastic economic development and accompanying negative environmental impacts; EE is therefore especially valued. We focus on teenagers in a developing country context, as they are ecologically and socio-economically fragile to local and global environmental change. A case study in Saint Lucia should provide unique information about the youth population in a Caribbean country, which is largely underreported.

## General description of Saint Lucia

Saint Lucia is part of the Lesser Antilles, located south of Martinique and northwest of Barbados, with a land area of 616 $km^2$. The total population of the country grew from 166,526 in 2010 (Central Statistics Office 2011) to 178,696 in 2018 (Government of Saint Lucia 2020). The capital city, Castries, is located on the northern part of the island, where the population density is the highest (826 persons/$km^2$); according to the 2010 census, the national average is 307 persons/$km^2$ (Central Statistics Office 2011). Over 80% of the country's GDP comprises services (82.8%), primarily tourism (65%), and the rest is industry (14.2%) and agriculture (2.9%) (2017 estimate, Central Intelligence Agency 2021).

The case study in Saint Lucia is unique due to its geographic, environmental, and socio-economic characteristics. First, due to the island's relatively small areal extent, conducting a nationwide analysis is feasible, which ensures a highly comprehensive case study. Second, the country is abundant in natural resources, particularly characterized by its dense forest coverage that supports rich wildlife. Being one of the most mountainous islands in the Caribbean, it is home to many endemic species that are of global importance. Biodiversity conservation is positioned high on the nation's agenda (Myers et al. 2000) and EE is one of the government's main pillars of its biological conservation effort (Government of Saint Lucia 2004). Third, being one of the SIDSs and an upper-middle-income country (United Nations 2015; World Bank 2017), its economic and geographic vulnerability is high, even though the nation's economy and infrastructure level are relatively high compared to other developing nations; this is primarily due to its high dependency on tourism and exposure to high natural disaster risks. Rapid urban growth accompanied by a deterioration of the living environment is a common phenomenon in developing countries (Cohen 2006; Cobbinah, Erdiaw-Kwasie, and Amoateng 2015). Saint Lucia is no exception, as rural to urban migration and a continued trend of former overseas migrants returning to urban areas, are causing various issues including environmental degradation and regional disparity (Ishmael 1991; Walters 2016).

## Environmental agenda and environmental education policy in Saint Lucia

In 2008, the national government initiated the development of a policy framework for implementing effective EE and raising public awareness (Government of Saint Lucia 2011). This framework highlighted sustainability perspectives and the government's intention to strengthen its focus on raising awareness in the public sector. The initiative was based on a situational analysis conducted for the country (King-Joseph 2008, unpublished report) that identified several policy recommendations, including wider stakeholder engagement and broadening channels to reach a wider population. Despite the numerous challenges discussed in the report, including the lack of 1) coordination, 2) stable implementation, and 3) evaluation, EE has been a major pillar of the government's environmental agenda and a diverse set of programs have been implemented, led by the government, NGOs, and local groups.

## Materials and methods

### *Developing the environmental survey*

In this study, a survey questionnaire was developed to assess students' general level of environmental attitude, knowledge, and action. We targeted secondary school students for two reasons.

First, young people are active agents for developing more sustainable futures (Percy-Smith and Burns 2013) and their attitudes toward the environment are an important indicator of long-term social change (Wray-Lake, Flanagan, and Osgood 2010), and for this reason, children and teenagers are the primary target of current EE activities in the country. Second, responses from teenagers provide more reliable information than those from primary school children. In addition, the teenage population accounts for 18% of the total population in Saint Lucia (Central Statistics Office 2011), so their responses represent the views of roughly one-fifth of the general public.

A two-page questionnaire was designed comprising three sections to ask questions related to: 1) concern about various environmental problems (Part 1-1) and attitude towards the environment (awareness and motivation) (Part 1-2); 2) knowledge of basic environmental science (Part 2-1) and recognition of ongoing environmental activities at school or in the community (Part 2-2); and 3) daily environmental actions (Part 3). As the scope of this study was to measure environmental attitude, knowledge, and action, only the results of Part 1-2, Part 2-1, and Part 3 were used.

In developing the questionnaire, existing scales were carefully reviewed. Special care was taken to ensure that questions and statements are well-contextualized and are as simple and concise as possible. This was important so that students of different education levels could understand the content easily and answer without feeling confused or distracted. We conducted several trials with adults (environmental professionals, educators, and other) and a college student prior to launching the survey, seeking their opinions and feedback with regards to contents and wording. Through this process, we modified the existing scales and developed an original questionnaire designed to measure the overall attitude, knowledge, and action levels of students. The questionnaire items and references are summarized in Table 1. The full survey form is provided as supplemental material S1.

### Conducting the survey

The survey was conducted between April 2013 and January 2014, targeting all public secondary schools on the island (24 at the time of the survey). The lead author announced the survey via an official communication letter and followed up with each of the 24 schools either in person or by phone to explain the purpose, procedure, and timeline of the survey and to receive permission from the principal or vice-principal to proceed. Informed consent to conduct the survey was received from all school representatives (no individual consent was obtained from students). A set of survey sheets was either directly handed over or distributed using a governmental courier service. Package receipt was confirmed via phone communication. In conducting the survey, only a small explanation was given for some of the nine topics under Part 1-1 to specify the scope; otherwise, the survey assumed that students were familiar with the terms used in the survey. Participation was voluntary and respondents were asked to indicate age, grade, and gender on the form. Given the differences in school size, school characteristics, and other factors, the exact methodology to conduct the survey was left to the school representatives' and teachers' judgment. Some were conducted during class and others after school. Completed surveys were usually returned within three weeks. A total of 2,000 survey sheets were sent out, and 1,349 sheets were returned from all 24 schools (response rate: 67.5%). A summary of respondents is shown in Table 2. Samples with no male/female or age indication were omitted, and 1,285 samples out of 1,349 responses were used for the analysis.

### Group definition

To allow comparison of age, sex, and location, we divided the samples according to the following group definitions: for sex, male and female groups according to respondent's self-indication; for age, the samples (ranged from 11 to 19) were divided into younger (11–14) and older (15–19). Only two samples were of age 19.

**Table 1.** Survey contents.

| | Question | Items | Reference |
|---|---|---|---|
| Part 1-1 (concern) | *'In your opinion, how important is it to address the following environmental issues in your living area?'* | Omitted | Omitted |
| Part 1-2 (attitude) | *'To what extent do you agree or disagree with the following statements?'* 5-point Likert scale ('strongly agree' to 'strongly disagree') or 'don't know' | a) *Our lifestyles greatly affect the condition of the nature.* | Dunlap et al. (2000); Milfont and Duckitt (2010) |
| | | *b) It is important to minimize negative impacts on the environment.* | Dunlap et al. (2000); Milfont and Duckitt (2010) |
| | | *c) Energy and resource-saving practices will help save costs.* | Milfont and Duckitt (2010) |
| | | *d) Education is an important part of conserving nature.* | Kuhn and Jackson (1989); National Environmental Education & Training Foundation (2001) |
| | | *e) Economic growth must be achieved in harmony with environmental protection.* | Milfont and Duckitt (2010); Kuhn and Jackson (1989); La Trobe and Acott (2000) |
| | | *f) I want to take part in maintaining a healthy and beautiful environment.* | Bohlen, Schlegelmilch, and Diamantopoulos (1993); Erdogan and Marcinkowski (2015) |
| Part 2-1 (knowledge) | *'Please select the right answer to the following questions.'* | *a) Which items won't break down naturally?* | Leeming, Dwyer, and Bracken (1995) |
| | | *b) Which is the main cause of global warming?* | Leeming, Dwyer, and Bracken (1995) |
| | | *c) Which products would be harmful to the ozone layer?* | Ivy et al. (1998) |
| | | *d) Which of the following is considered renewable energy?* | Leeming, Dwyer, and Bracken (1995) |
| | | *e) Of all species on earth, what percentage of species is considered threatened with extinction?* | Leeming, Dwyer, and Bracken (1995) |
| Part 2-2 (recognition) | *'Please select the right answer to the following questions.'* | omitted | omitted |
| Part 3 (action) | *'Have you done any of the following during the past month?'* | *1) Turn off the water while brushing your teeth* | Leeming, Dwyer, and Bracken (1995) |
| | | *2) Chose environmentally friendly products when shopping* | Leeming, Dwyer, and Bracken (1995) |
| | | *3) Reuse or recycle something in order to reduce waste generation* | Leeming, Dwyer, and Bracken (1995) |
| | | *4) Turn off the light, air conditioner, etc. to save energy* | Leeming, Dwyer, and Bracken (1995) |
| | | *5) Clean or improve your living area (trash pickup, tree planting, etc.)* | New item[a] |
| | | *6) Think or talk about environmental issues and solutions* | Leeming, Dwyer, and Bracken (1995) |

[a]This item was added as these activities are popularly practiced at school and community levels locally.

**Table 2.** Summary of survey respondents.

| | | Enrolled[a] | | | Sample *n* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group | Dist. | Total | M | F | | Ratio % | M (%) | F (%) | Age (%) | | Grade (%) | |
| North | 1 | 1,661 | 872 | 789 | 201 | 12.1 | 82 | 111 | ≤ 13 | 299 | ≤ 7 | 197 |
| | 2 | 2,704 | 1,510 | 1,194 | 281 | 10.4 | 141 | 135 | 14 | 174 | 8 | 127 |
| | 3 | 2,502 | 806 | 1,696 | 219 | 8.8 | 44 | 165 | 15 | 142 | 9 | 180 |
| | 4 | 1,301 | 750 | 551 | 124 | 9.5 | 59 | 56 | ≥ 16 | 178 | 10 | 141 |
| | | | | | | | | | | | ≥ 11 | 143 |
| Sub-total | | 8,168 | 3,938 | 4,230 | 825 | 10.1 | 326 (41.1) | 467 (58.9) | 793 (61.7) | | | 788 (62.0) |
| South | 5 | 1,941 | 1,088 | 853 | 180 | 9.3 | 89 | 72 | ≤ 13 | 115 | ≤ 7 | 21 |
| | 6 | 1,697 | 758 | 939 | 163 | 9.6 | 54 | 103 | 14 | 86 | 8 | 115 |
| | 7 | 1,247 | 634 | 613 | 133 | 10.7 | 51 | 77 | 15 | 124 | 9 | 64 |
| | 8 | 653 | 332 | 321 | 48 | 7.4 | 18 | 28 | ≥ 16 | 124 | 10 | 155 |
| | | | | | | | | | | | ≥ 11 | 129 |
| Sub-total | | 5,538 | 2,812 | 2,726 | 524 | 9.5 | 212 (43.1) | 280 (56.9) | 492 (38.3) | | | 484 (38.1) |
| **Total** | | **13,706** | **6,750** | **6,956** | **1,349** | **9.8** | **538 (41.9)** | **747 (58.1)** | **1,285** | | | 1,272 |

[a]Source: Ministry of Education, Human Resource Development and Labour (2013).
Note: The North/South grouping is defined by this study. The total and sub-total for age and grade may not agree as some respondents only answered either.

For the location factor, we split the samples for urban/rural comparison using the existing eight educational district boundaries (Ministry of Education, Human Resource Development and Labour 2012). Urban/rural is a clear concept in that they are contrary to each other. However, there is no standard definition as it varies by country. The criteria used by countries to decide whether to define a place as 'urban' include population size, population density, type of economic activity, physical characteristics, level of infrastructure, or a combination of these or other criteria; moreover, in reality, administrative boundaries may not align with the physical or economic extents of the urban area (Deuskar 2015).

According to the government of Saint Lucia, the North-West Quadrant, which includes the Gros Islet and Castries area, is the primary destination of rural and urban migration and home to 55% of Saint Lucian residents (Government of Saint Lucia 2018). The 2010 Census reported that Castries, the most densely populated area, has been experiencing a dynamic population transition with substantial movement away from the city to the rural areas of Castries and Gros Islet. Thus, this North-West Quadrant, which approximately corresponds to Education Districts 1–4 (supplemental material S2), is the developed and rapidly developing side of the island. In contrast, Education Districts 5–8 correspond to the more rural side of the country. The two groups have a clear contrast in terms of forest density (supplemental material S3) as well as demographic and infrastructural features based on the 2010 census data (supplemental material S4). As shown in S4, the Castries and Gros Islet area represents a highly populated and generally advanced infrastructure (including internet connectivity) level. Accordingly, for this study we defined the north group (Districts 1–4) as representative of urban areas and the south group (Districts 5–8) as representative of rural areas. The 24 public schools were divided into north (14 schools) and south (10 schools) based on the district to which they belong.

## *Computing attitude, knowledge, and action scores*

Responses to Part 1-2 (attitude), Part 2-1 (knowledge), and Part 3 (action) were each converted to scores by summing the 5-scale Likert answers to represent the individual's overall attitude, knowledge, and action level, respectively. The reliability of these scores was tested using Cronbach's alpha statistic. A Cronbach's alpha value of 0.6–0.7 is generally acceptable (Taber 2018; Mohamad et al. 2015; Ursachi, Horodnic, and Zait 2015). Thus, we set a Cronbach's alpha of 0.60 or higher as an acceptable level of reliability. For example, in computing the score, the response to '*I want to take part in maintaining a healthy and beautiful environment*' under Part 1-2 was converted to +2 if 'strongly agree,' to +1 if 'agree,' to −1 if 'disagree' and to −2 if 'strongly disagree.' 'Don't know' and 'Neither agree nor disagree' were converted to zero. Scores for the six attitude-related statements were then summed to obtain the individual's environmental attitude score, which ranged from +12 to −12 (Cronbach's alpha = 0.69). In this case, higher score indicates more positive environmental attitude. For the knowledge variable, the answers were converted to a binary value (1 = correct; 0 = incorrect) and the percentage of correct answers was computed for the total of five quizzes (ranging from 0 – 100 by increments of 20). The action variable was similarly computed as an attitude score by summing the responses to the six statements (Always = 3, Often = 2, Sometimes = 1, Never and Don't Know = 0). Score ranged from 0 to +18 (Cronbach's alpha = 0.68), with higher scores indicating higher level of daily environmental actions. To ensure that the three constructs capture different elements, a Spearman's rho was performed. The result showed weak correlations (0.089-0.277, $n = 1{,}285$, all significant at 0.01 level) between the scores indicating that they are appropriately independent.

### *Analysis 1: attitude, knowledge, and action comparison by sex, age, and location*

To compare the overall attitude, knowledge, and action scores among the three defined groups (Male/Female, Young/Old, North/South) and examine the interactions among these variables, we performed three 3-way ANOVA tests (sex * age * location) on attitude, knowledge, and action, respectively. The analysis was done using IBM SPSS 27.

To further examine and identify unique patterns in the survey responses, we grouped the respondent populations into four categories, as follows, and compared the compositions of Male/Female, Young/Old, and North/South. The four categories were students with: 1) low knowledge/low attitude scores (KNL-ATL); 2) low knowledge/high attitude scores (KNL-ATH); 3) high knowledge/low attitude scores (KNH-ATL); and 4) high knowledge/high attitude scores (KNH-ATH). We did this between attitude and knowledge, knowledge and action, and attitude and action. The division was done at 50 percentiles of each dataset. The difference was compared by performing chi-square tests of homogeneity.

### *Analysis 2: attitude-knowledge-action and sex-age-location relationship modeling*

We performed a path analysis to characterize the structural relationship between attitude, knowledge, and action, and the defined three groups, i.e. sex, age, and location. To obtain an initial insight into their relationships, we employed the KAB model.

In addition, based on the existing conclusions about urban–rural difference (Hassan, Noordin, and Sulaiman 2010; Gifford and Nilsson 2014), we hypothesized that sex, age, and location impact all three of the KAB aspects of an individual (Figure 1). We performed the analysis using the structural equation modeling (SEM) software IBM SPSS Amos 27.

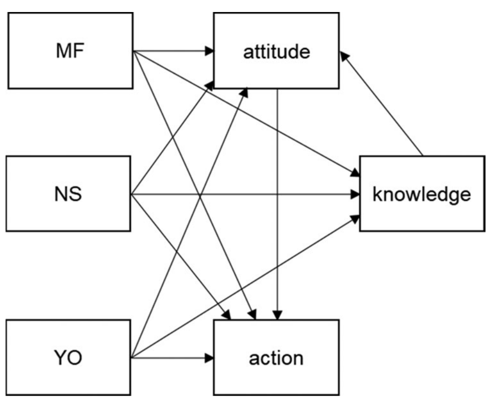


**Figure 1.** Conceptual relationships between the six variables.
Note: MF, Male/Female; NS, North/South; YO, Young/Old.

## Results

### *Analysis 1: attitude, knowledge, and action comparison by sex, age, and location*

The mean values of the environmental attitude, knowledge, and action scores sorted by sex, age, and location groups are presented in Table 3, and the results of 3 three-way ANOVA tests performed for each of the three scores are presented in Table 4.

### *Validity of the three-way ANOVA test results*

Because the distribution of the attitude score ($n = 1{,}285$) was highly skewed and the results of both the Shapiro–Wilk and Levene's tests were significant at the 0.05 level, the normality and equality of variance could not be assumed (in Table 3, the results of the assumption tests are omitted). The White Test for Heteroskedasticity was not significant at the 0.05 level ($X^2$ = 13.19, $df = 7$, $p = 0.07$). When the normality assumption is violated but independence and linearity are assumed, and residuals are approximately normally distributed, the result of the ANOVA test can be considered robust, especially given a large sample size (Ernst and Albers 2017; Blanca et al. 2017). We therefore visually examined the P–P plot for normality of the residuals and considered our sample size (73+) to be large enough to interpret the result of the three-way ANOVA tests.

### *Interpretation of the interactions and main effects*

The between-subjects effects of sex, age, and location groups on environmental attitude, knowledge, and action scores are shown in Table 4. No significant three-way interaction was found for any test of the three dependent variables.

For the attitude score, the three-way ANOVA (sex, age, location) test showed a significant interaction between age and location ($F(1, 1277) = 13.687$, $p < .000$). A pair-wise comparison of the Bonferroni-adjusted simple main effect of age performed for north and south showed that attitude levels among those aged 14 and younger were significantly higher than among those aged 15 and older in the south group ($F(1, 1277) = 13.557$, $p < .000$). When the simple main effect of location was examined, the north group showed significantly higher attitude levels than the south in the age 15 and older group ($F(1, 1277)$ = 16.342, $p < .000$). These show that: 1) environmental attitude levels change by age, and the younger, rural students possess higher attitude level than the younger urban students, and 2) when older, the attitude level becomes higher among students in the urban area, suggesting that there is an effect of living place on one's environmental attitude development.

In terms of knowledge, significant interactions were observed between age and location ($F(1, 1277) = 11.252$, $p = .001$) as well as sex and location ($F(1, 1277) = 4.053$, $p = .044$). Pair-wise comparisons of the Bonferroni-adjusted simple main effect of age performed for north and south showed that the older age group scored significantly higher than the younger age group ($F(1, 1277) = 25.340$, $p < .000$) within the northern population. When the simple main effect of location was examined, the north group scored significantly higher than the south for age 15 and older ($F(1, 1277) = 31.359$, $p < .000$). When examined by sex, the north group was significantly higher than the south among the male population ($F(1, 1277) = 16.925$, $p < .000$). The difference was not significant for the female population ($F(1, 1277) = 3.216$, $p = .073$). No significant difference was found for the knowledge score between male and female participants when compared within the same location group. These indicate that environmental knowledge level is higher in the north than south, and the level increases as students get older. However, this tendency was not observed in the south. In other words, the urban–rural difference was clear in the knowledge level.

For the action score, no significant interaction existed. The interaction between age and sex was not significant ($F(1, 1277) = 3.363$, $p = .067$). Considering the simple main effect of age,

**Table 3.** Descriptive statistics.

| | | *n* | | | Attitude Statistic | Attitude *SE* | Knowledge Statistic | Knowledge *SE* | Action Statistic | Action *SE* |
|---|---|---|---|---|---|---|---|---|---|---|
| North | Young (<15) | Male (193) | Mean | | 6.98 | 0.27 | 47.98 | 1.88 | 8.86 | 0.27 |
| | | | 95% CI for Mean | Lower | 6.45 | | 44.28 | | 8.33 | |
| | | | | Upper | 7.51 | | 51.68 | | 9.39 | |
| | | | Variance | | 13.80 | | 679.75 | | 14.17 | |
| | | | *SD* | | 3.72 | | 26.07 | | 3.76 | |
| | | | Skewness | | −0.83 | 0.17 | −0.13 | 0.17 | −0.02 | 0.17 |
| | | | Kurtosis | | 0.13 | 0.35 | −0.60 | 0.35 | 0.03 | 0.35 |
| | | Female (280) | Mean | | 6.93 | 0.22 | 44.21 | 1.51 | 8.86 | 0.22 |
| | | | 95% CI for Mean | Lower | 6.49 | | 41.24 | | 8.43 | |
| | | | | Upper | 7.37 | | 47.19 | | 9.29 | |
| | | | Variance | | 13.88 | | 640.24 | | 13.63 | |
| | | | *SD* | | 3.73 | | 25.30 | | 3.69 | |
| | | | Skewness | | −1.44 | 0.15 | 0.03 | 0.15 | 0.28 | 0.15 |
| | | | Kurtosis | | 3.76 | 0.29 | −0.57 | 0.29 | −0.02 | 0.29 |
| | Old (>=15) | Male (133) | Mean | | 6.76 | 0.40 | 56.84 | 2.16 | 8.25 | 0.33 |
| | | | 95% CI for Mean | Lower | 5.97 | | 52.56 | | 7.60 | |
| | | | | Upper | 7.55 | | 61.12 | | 8.90 | |
| | | | Variance | | 21.28 | | 623.29 | | 14.31 | |
| | | | *SD* | | 4.61 | | 24.97 | | 3.78 | |
| | | | Skewness | | −1.33 | 0.21 | −0.45 | 0.21 | 0.24 | 0.21 |
| | | | Kurtosis | | 1.93 | 0.42 | −0.37 | 0.42 | −0.20 | 0.42 |
| | | Female (187) | Mean | | 7.89 | 0.24 | 54.65 | 1.91 | 8.74 | 0.29 |
| | | | 95% CI for Mean | Lower | 7.42 | | 50.88 | | 8.17 | |
| | | | | Upper | 8.37 | | 58.43 | | 9.30 | |
| | | | Variance | | 10.89 | | 685.23 | | 15.32 | |
| | | | *SD* | | 3.30 | | 26.18 | | 3.91 | |
| | | | Skewness | | −1.81 | 0.18 | −0.31 | 0.18 | 0.34 | 0.18 |
| | | | Kurtosis | | 5.43 | 0.35 | −0.49 | 0.35 | −0.29 | 0.35 |
| South | Young (<15) | Male (73) | Mean | | 7.32 | 0.41 | 43.29 | 3.17 | 9.66 | 0.49 |
| | | | 95% CI for Mean | Lower | 6.50 | | 36.97 | | 8.68 | |
| | | | | Upper | 8.13 | | 49.61 | | 10.63 | |
| | | | Variance | | 12.08 | | 733.49 | | 17.53 | |
| | | | *SD* | | 3.48 | | 27.08 | | 4.19 | |
| | | | Skewness | | −1.44 | 0.28 | −0.07 | 0.28 | −0.01 | 0.28 |
| | | | Kurtosis | | 3.50 | 0.56 | −1.03 | 0.56 | −0.36 | 0.56 |
| | | Female (128) | Mean | | 7.46 | 0.34 | 45.94 | 2.52 | 9.07 | 0.33 |
| | | | 95% CI for Mean | Lower | 6.79 | | 40.94 | | 8.42 | |
| | | | | Upper | 8.13 | | 50.93 | | 9.72 | |
| | | | Variance | | 14.52 | | 814.86 | | 13.77 | |
| | | | *SD* | | 3.81 | | 28.55 | | 3.71 | |
| | | | Skewness | | −1.56 | 0.21 | −0.04 | 0.21 | 0.04 | 0.21 |
| | | | Kurtosis | | 3.34 | 0.42 | −0.91 | 0.42 | 0.02 | 0.42 |
| | Old (>=15) | Male (139) | Mean | | 5.83 | 0.37 | 41.87 | 2.26 | 8.08 | 0.35 |
| | | | 95% CI for Mean | Lower | 5.09 | | 37.39 | | 7.39 | |
| | | | | Upper | 6.58 | | 46.35 | | 8.76 | |
| | | | Variance | | 19.50 | | 712.42 | | 16.65 | |
| | | | *SD* | | 4.42 | | 26.69 | | 4.08 | |
| | | | Skewness | | −0.63 | 0.21 | −0.01 | 0.21 | −0.37 | 0.21 |
| | | | Kurtosis | | −0.45 | 0.41 | −1.05 | 0.41 | −0.44 | 0.41 |
| | | Female (152) | Mean | | 6.26 | 0.33 | 45.79 | 2.03 | 8.68 | 0.31 |
| | | | 95% CI for Mean | Lower | 5.61 | | 41.77 | | 8.07 | |
| | | | | Upper | 6.91 | | 49.81 | | 9.28 | |
| | | | Variance | | 16.44 | | 628.51 | | 14.23 | |
| | | | *SD* | | 4.06 | | 25.07 | | 3.77 | |
| | | | Skewness | | −1.25 | 0.20 | −0.09 | 0.20 | 0.01 | 0.20 |
| | | | Kurtosis | | 2.49 | 0.39 | −1.03 | 0.39 | −0.47 | 0.39 |

the younger group stated a higher environmental action level than the older age group ($F(1, 1277) = 8.777$, $p = .003$). The difference between young male (mean = 9.08) and older male (mean = 8.16) was significant ($F(1, 536) = 7.389$, $p = .007$).

**Table 4.** Comparison of between-subjects effects.

| | | Attitude | | | Knowledge | | | Action | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Source | *Df* | Type III Sum of Squares | *F* | Sig. | Type III Sum of Squares | *F* | Sig. | Type III Sum of Squares | *F* | Sig. |
| Corrected Model | 7 | 460.359 | 4.364 | .000 | 30666.797 | 6.442 | .000 | 175.763 | 1.713 | .102 |
| $R^2$ | | .023 | | | .034 | | | .009 | | |
| Adjusted $R^2$ | | .018 | | | .029 | | | .004 | | |
| Intercept | 1 | 53996.579 | 3583.210 | .000 | 2545291.690 | 3742.979 | .000 | 86582.559 | 5906.330 | .000 |
| NS | 1 | 50.594 | 3.357 | .067 | 12624.827 | **18.565** | **.000** | 10.629 | .725 | .395 |
| YO | 1 | 66.404 | **4.407** | **.036** | 5527.905 | **8.129** | **.004** | 128.663 | **8.777** | **.003** |
| MF | 1 | 48.102 | 3.192 | .074 | 6.628 | .010 | .921 | 4.424 | .302 | .583 |
| NS * YO | 1 | 206.261 | **13.687** | **.000** | 7651.482 | **11.252** | **.001** | 26.862 | 1.832 | .176 |
| North | 1 | | 1.686 | .194 | | **25.340** | **.000** | | | |
| South | 1 | | **13.557** | **.000** | | .102 | .749 | | | |
| Young | 1 | | 1.639 | .201 | | .428 | .513 | | | |
| Old | 1 | | **16.342** | **.000** | | **31.359** | **.000** | | | |
| NS * MF | 1 | 4.726 | .314 | .576 | 2756.206 | **4.053** | **.044** | 4.035 | .275 | .600 |
| Male | | | | | | **16.925** | **.000** | | | |
| Female | | | | | | 3.216 | .073 | | | |
| North | | | | | | 2.412 | .121 | | | |
| South | | | | | | 1.798 | .180 | | | |
| YO * MF | 1 | 37.304 | 2.475 | .116 | 142.184 | .209 | .648 | 49.302 | 3.363 | .067 |
| NS * YO * MF | 1 | 14.381 | .954 | .329 | 1.647 | .002 | .961 | 8.525 | .582 | .446 |
| Error | 1277 | 19243.535 | | | 868382.542 | | | 18719.902 | | |
| Total | 1285 | 81540.000 | | | 3817600.000 | | | 117038.000 | | |
| Corrected Total | 1284 | 19703.894 | | | 899049.339 | | | 18895.665 | | |

Note: NS, North/South; YO, Young/Old; MF, Male/Female. $p < 0.05$ shown in bold.

### *Comparison of composition according to students' environmental levels*

The composition of students with low-level and high-level environmental attitude, knowledge, and action scores are compared in Figure 2. While there was no significant difference between male and female in any of these comparisons (results for the sex comparison not shown), there was a significant difference between north and south in the number of students who showed low attitude and low knowledge based on the survey scores ($X^2$ = 9.286, $p$ = .002).

In the action–knowledge comparison, differences were found for students with low knowledge and high action; such students were found significantly more in the south ($X^2$ = 4.574, $p$ = .032), while the student population of high knowledge and low action was higher in the north ($X^2$ = 4.776, $p$ = .029).

### *Analysis 2: the relationship between attitude-knowledge-action and sex, age, and location*

Given the findings of Analysis 1, we modified the initial conceptual model shown in Figure 1. Analysis 1 indicated that the location factor not only has a direct effect on knowledge but also interacts with the age factor on attitude and with both age and sex on knowledge. On the other hand, no significant impact of sex on knowledge and action was found. The age factor, however, was found to have significant effects on all three scores. Based on these, we further hypothesized that the location factor indirectly influences attitude and knowledge through the age path. The modified conceptual relationship among the variables (illustrated in Figure 3) was tested and the achieved path model showed a very good fit ($X^2$ = 9.980, $df$=7, $p$ = .19; GFI = .997, AGFI = .992, CFI = .988, RMSEA = .018). All the coefficients shown in the figure are significant ($p$ < .05). Based on this model, we confirmed that: 1) age influences attitude, knowledge, and action levels; 2) location directly influences knowledge level (i.e. rural

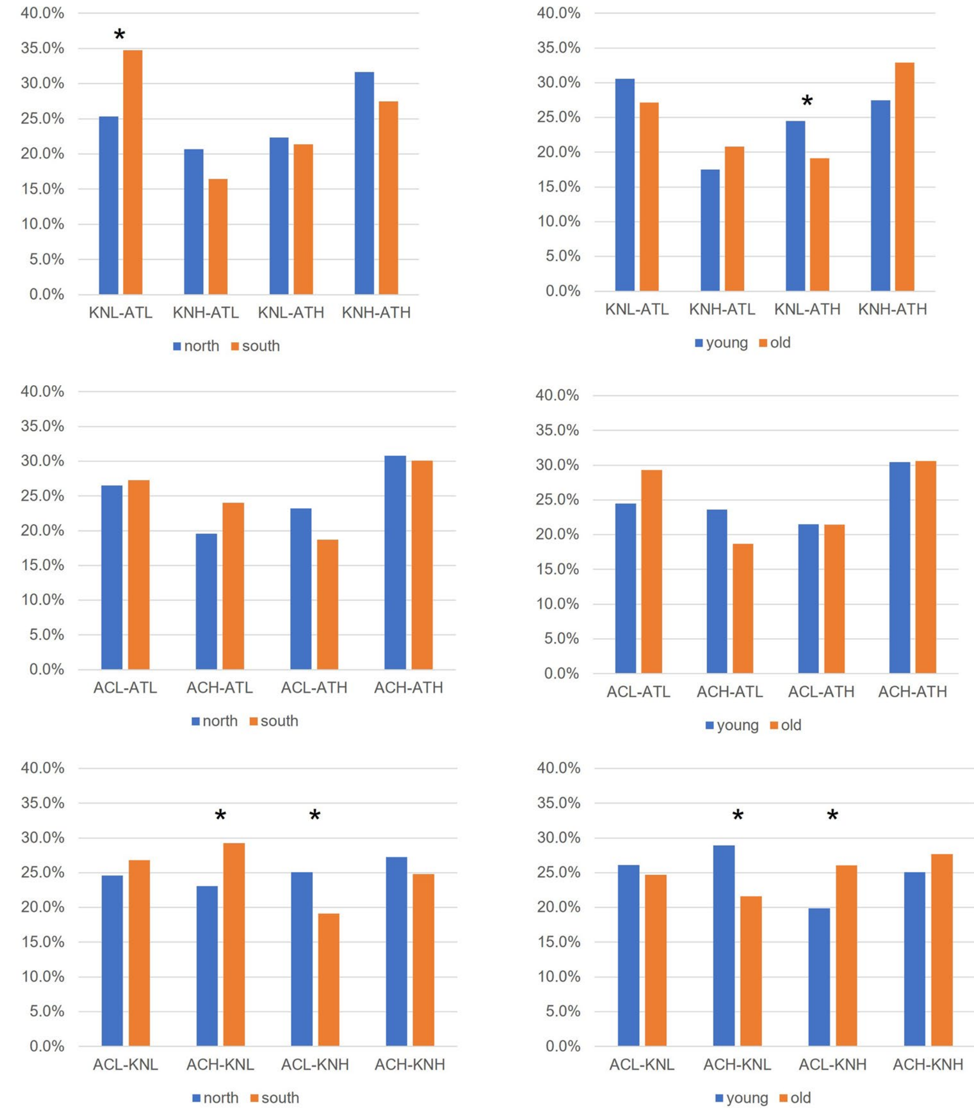


**Figure 2.** Different types of population according to knowledge, attitude, and action levels compared by age and location.
Note: ATL, low attitude; ATH, high attitude; KNL, low knowledge; KNH, high knowledge; ACL, low action; ACH, high action. The low/high was divided at 50 percentiles. The composition is the count of students that fall into a particular category and is shown in ratio to the total within each group (location or age). $^*p < 0.05$.

area is associated with a lower environmental knowledge score) and indirectly influences attitude and action levels through age; and 3) the knowledge level has a positive effect on the attitude level, and the attitude level has a positive effect on the action level.

## Discussion

### *Importance of place for students' environmental characteristics*

Based on our analysis of the survey data, there is a clear difference between urban and rural students. On the knowledge score, the difference was greater for the older students and especially

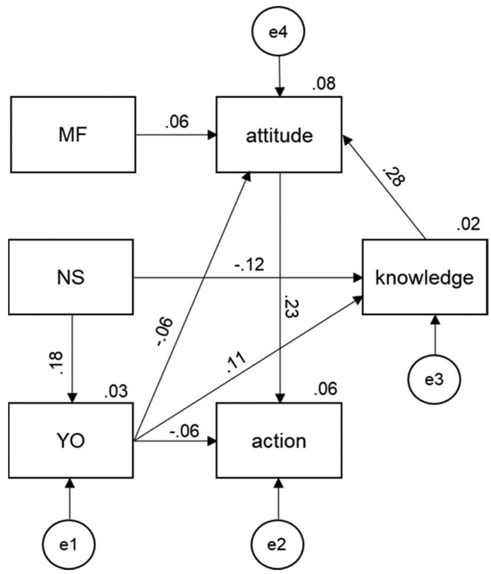


**Figure 3.** Established path model.
Note: Male/Female (MF) = 0.1; Young/Old (YO) = 0.1; North/South (NS) = 0.1. All standardized regression weights shown are significant at 0.05.

for the older male group, where northern students scored significantly higher than those in the south. This means that as students grow older, whether they live in an urban or rural area will impact their environmental knowledge level. As discussed earlier, the existing literature suggests that there is general education inequality between urban and rural areas (Agrawal 2014; van Maarseveen 2021), and environmental knowledge and general knowledge are strongly related (Geiger, Geiger, and Wilhelm 2019). We suspect that this may also be the case in Saint Lucia. Future studies could investigate the relationship between the level of environmental knowledge (such as the score developed in this study) and results from general student examinations, such as the Caribbean Secondary Education Certificate (CSEC). Such investigations should allow further understanding of how students obtain environment-related knowledge and how efforts to improve general education quality could have a synergistic effect of elevating students' environmental knowledge.

On attitude, our results suggest that the impact of the urban–rural difference may have a strong association with age. While the attitude scores are equally high between north and south for the younger age group (Table 3), they drop substantially among the older group in the south, and most prominently among males. This is in contrast to the northern female group, in which the older group scored higher than the younger group; this group scored the highest among all participants. This observation is also true in the comparison by population type (Figure 2), where the number of students who demonstrated a lower level of knowledge and attitude (KNL-ATL) was significantly higher in the rural group. While the reasons for this are inconclusive from our study, given the impact of knowledge on attitude, we speculate that the educational inequality discussed above may play a role in combination with age development.

The high level of environmental attitude observed across younger students, regardless of whether they were urban or rural, is noteworthy. If education inequality plays an important role in generating the urban–rural difference in environmental knowledge, there may be other specific factors, including socio-economic and cultural, affecting the formation of environmental attitudes among younger students. We provide more discussions on this point later in this section, but a deeper look into why younger students possess high environmental attitude is important, and understanding this along with geographic and temporal information about past and current EE activities in specific areas would be valuable. Such assessments, compiled at the national level over time, would facilitate educators and policymakers' broader understanding of the impact of EE in the country.

Regarding the action score, while our three-way ANOVA test did not find any significant effects of location, the comparison by student population type (Figure 2) suggests something curious. While there were significantly more students expressing a low level of knowledge but high level of action in the south, the opposite profile, i.e. high-knowledge but low-action students, was found more in the north. The interpretation of this could be twofold: on the one hand, this may be in line with past studies that suggest 'knowing does not simply translate into action' (Heimlich 2010). On the other hand, the reasons for southern students engaging in environmental and resource-saving practices may be driven by necessities, particular in rural areas, such as infrastructural or financial reasons (Chawla and Cushing 2007; Sweeney et al. 2013; Chen, Xu, and Day 2017). In this study, our urban–rural grouping highlighted not only a demographic difference but also environmental (forest density) and infrastructural differences (supplemental materials S3 and S4). Although we cannot offer any conclusive reasons behind these differences, how the different aspects characterizing rural life may drive ecological actions in the south, for example, is another important area of investigation. In doing so, adding action-related indicators to monitoring the impact of EE activities would help better understand the results obtained in this study.

### *How place impacts students' environmental characteristics*

Our analysis confirmed the impact of location on an individual's environmental attitude, knowledge, and action. The results of our path analysis suggest that where someone lives has both direct and indirect effects. The urban–rural difference indirectly affects a student's environmental characteristics through age development; specifically, living in the south seems to have an effect (0.18) on the older age group. No indirect effect via the sex path was found in our study. Based on this, we discuss policy implications below.

### *Reducing urban–rural educational inequality*

Our findings suggest that urban–rural education inequality may have an impact on individual's environmental knowledge, attitude, and, ultimately, behavior. The fact that having knowledge positively affects an individual's environmental attitude provides evidence of the effect of EE. It also means that, with limited environmental education, a student may eventually develop only limited environmental attitudes. However, environmental knowledge is not obtained through EE activities alone. It is obtained through science, ethical studies, and other subjects in combination (Nasibulina 2015). Therefore, policies to reduce the imbalance of educational quality between urban and rural areas could be beneficial not only from the general education perspective but also from the EE and sustainability perspectives. Tilbury (1995) argues that sustainability education is an evolved form of EE in the sense that it creates a more holistic outlook on problems, requiring a deeper integration between the study of environmental and developmental problems. Further, Hassan, Noordin, and Sulaiman (2010) discuss that there are some 'uniquely urban' factors that help nurture sustainability thinking. It is worth investigating this point further, as it may be associated with urban–rural differences in terms of the breadth of curriculum and/or the quality of learning experience.

### *Tailoring EE programs to make the experience more relevant*

An effective EE must make the best possible use of the unique settings in which the learners are located (Ardoin, Bowers, and Gaillard 2020).

In our study, age had significant effects on all three constructs: knowledge, attitude, and action. The exact reason why younger students tend to show a higher level of attitude than older students remains unclear (Gifford and Nilsson 2014), but it may be that younger people are more 'sensitive' to environmental problems (Szagun and Pavlov 1995). In our study, the younger population in the southern student group showed a higher attitude level. Whether or not this is unique to Saint Lucia or the entire Caribbean region is a topic for future research; it may be linked to an intrinsic value of the inhabitants of an island rich in natural resources. This result also strongly supports the importance of providing EE to students from an early age to nurture a strong intrinsic motivation, as discussed in Liefländer et al. (2013) and Hoang and Kato (2016).

Furthermore, the results shown in Figure 2 highlight how learners can be at different stages of learning. Some may be well-motivated and eager to learn about local and global environmental issues, while others may have acquired knowledge but are unable to assimilate it due to lack of personal experiences. It is important to remember that raising awareness begins with understanding the target population, such as identifying their current views on a particular issue and how they receive their information (Demnati, Allache, and Ernoul 2015). Moreover, EE can be provided in various forms—not only in the classroom but also through fieldwork, volunteering, and self-research projects. For those students with low motivation, it is important to understand what causes them not to care about the environment. There is not likely to be a straightforward answer, but there are often reasons. It may be that they cannot personally relate to the issues or that they associate them with negative feelings or experiences. Students may lack motivation due to a lack of knowledge or, more specifically, knowledge of the consequences of their own actions. Future studies should include efforts to identify the role of socio-economic status and cultural factors as well as what and how EE activities may help students to broaden their perspectives and develop their own views about the environment. For example, to support students' need for autonomy, curricular activities could include ample opportunities for students to actively solve environmental problems of their own choosing (Darner 2009; Percy-Smith and Burns 2013). Activities that seek to combine knowledge, education, and experience with nature could effectively foster durable behavior. It is also important to teach the interconnectedness of various issues and provide both global and local contexts in learning so that students and the public can envision or anticipate the impact of their actions. Such perspectives are important to enable the public to understand the underlying systemic issues (Gould et al. 2016; Rovira 2000). A planning-stage analysis such as the one demonstrated here may be helpful for educators to gain insights into tailoring EE, incorporating flexibility in the program, and identifying the most helpful activities for different populations.

### *Systematizing EE implementation*

The objective of this study—how to bring about more positive environmental outcomes—has been a particular challenge, and there is a strong need for education to enhance the transition towards sustainability (Barth and Michelsen 2013). Environmental education needs to be elevated in priority, with a stronger strategy that links the local and global contexts in order to nurture sustainability thinking. Strategically designed EE is more inclusive, and thus more effective, and place is an essential aspect of it. As Hume and Barry (2015) state, EE/ESD in Belfast will not necessarily be the same as EE/ESD in Boston, Berlin, or Beijing.

Environmental education involves learning as well as problem-solving and decision-making (Bogan 1973). It is not only multifaceted but also continually evolving (Monroe, Andrews, and Biedenweg 2008). Planning is a key step in this learning loop because it delimits the target, goal, and approach from a macro- to micro-level scope. Having a centralized information system describing ongoing efforts would help to evaluate the cumulative impact of local EE activities over time, which would then inform future planning. Given the importance of location found in this study, we suggest that geographic information systems (GIS) tools can be valuable in this process by serving not only as a database but also as an analysis platform to identify potential EE outcomes through spatial integration. For example, EE activities could be tracked together with indicators such as recycling rates or energy consumption levels in various areas of the country on a single GIS platform over time.

This study has some limitations. First, our approach of developing a simplified survey form comes with a limitation in that it does not fully capture the various dimensions of the three constructs we measured. However, we believe that the scores we compiled represent individuals' overall levels of environmental attitude, knowledge, and action. Second, bias may potentially exist in the sample collection scheme. Because the samples were collected by the schools, the respondents' profiles may not be completely random. Although it is not possible to track this, given the balanced composition of the overall sample population, we consider the bias to be minor. Third, it should be noted that a severe storm hit the island on December 24, 2013, within the survey period; this could have influenced the students' responses. Approximately 5% of the survey sample was compiled after this event. Fourth, because this study is based on a self-reported survey, the level of action considered may not be an accurate reflection of the actual action levels. Lastly, our approach to examine place difference was limited to an urban–rural comparison. While we believe that our results are a valuable initial step, the key next step would be to further investigate the underlying factors characterizing the urban–rural difference. Such effort would help to identify the role of place and make EE more effective.

## Conclusion

This study investigated the effects of sex, age, and location on environmental knowledge, attitude, and action levels using results from a secondary school survey in Saint Lucia.

Our conclusions can be summarized by three points. First, we confirmed that living place is an important factor affecting students' environmental knowledge, attitude, and action levels. The urban–rural difference directly and indirectly impacts these constructs. The difference in knowledge scores was prominent, and we suspect this may be associated with the difference in general education quality. Closing the urban–rural education gap is therefore imperative from the EE perspective. We also suspect that cultural and socio-economic differences influenced the results; further investigation of what shapes urban or rural life and what consitutes the different environmental characteristics observed in this study are essential. Second, our study identified dynamically different student profiles on the basis of which we argue that a tailored EE approach can be devised to motivate students to more effectively demonstrate the positive impacts of EE. Different levels and stages of the individuals' learning should be acknowledged when setting targets and designing activities. Various types of learning can be utilized for those who are not motivated so as to broaden their perspectives and encourage their engagement. A balanced combination of both global and local contexts is also important for students to understand the interconnectedness of the environment and how daily practices have regional and global consequences. Keeping in mind that children are naturally motivated, we scientists and practitioners should continue to work on nurturing their inquisitiveness and sensitivity to nature by providing flexible programs and activities that encourage spontaneous learning and initiative-taking. It would be wise to utilize both existing and new channels for providing educational activities, including community groups, library networks, and information and communications technology (ICT) tools. Providing sufficient training to teachers is of great importance as well (UNESCO 2021). Finally, we believe that EE can become more effective through a continuous cycle of planning, implementation, and evaluation by incorporating spatial perspectives and utilizing management tools like GIS. Such an approach would allow centralization of EE efforts and a better evaluation of the collective impacts. We have only partially demonstrated these points through our case study, but we believe that our findings have broad implications and can provide useful insights to guide future studies in the Caribbean and other regions.

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## Disclosure statement

No potential conflict of interest was reported by the authors.

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## Data availability statement

The datasets generated for this study are available upon request to the corresponding author.

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