The Relationship between Place Attachment and Socioscientific Reasoning among High School Students in Puerto Rico after Negotiation with Local and Foreign Socioscientific Issues

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A dissertation submitted to the College of Engineering and Science of Florida Institute of Technology in partial fulfillment of the requirements for the degree of Doctor of Philosophy in STEM Education

Melbourne, Florida
May 2020
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Abstract

Title: The Relationship between Place Attachment and Socioscientific Reasoning among High School Students in Puerto Rico after Negotiation with Local and Foreign Socioscientific Issues

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The purpose of this mixed-method study was to explore the relationship between place attachment and socioscientific reasoning (SSR) of Puerto Rican high school students through debate and discourse of local and foreign socioscientific issues (SSI). The specific research questions were, (1) what is the extent of the participants’ place attachment to the island of Puerto Rico, (2) are there differences in SSR between groups working with local and foreign SSI, (3) is there a correlation between place attachment and SSR, (4) are there differences in SSR between scenarios after SSI negotiation, and (5) do negotiation and discourse improve after SSI negotiation with local and foreign SSI? The sample consisted of 124 high school students, granted parental consent, divided into one treatment group evaluating foreign SSI, and one comparison group working with local SSI.

The Identification with Place scale (Burdge & Ludtke, 1972) measured place attachment of participants to their homeland, while the Quantitative Assessment of Socioscientific Reasoning (QuASSR) (Romine, Sadler, & Kinslow, 2017) addressed SSR through a pre-test and post-test method. Descriptive analyses provided the means and standard deviations to determine the levels of participants’ place attachment. Independent samples t-tests assessed differences between the pre-test and post-test for each group after SSI negotiation, while an analysis of covariance measured differences between scenarios.
controlling for pre-test scores. A Spearman ρ correlation analyzed a possible relationship between place attachment and SSR.

Results indicated that participants shared a moderate to high place attachment to the island of Puerto Rico. Mean scores for SSR, though showing an increase in the post-test, did not display high SSR application nor revealed significant differences between groups or scenarios after SSI negotiation. However, the Spearman ρ analysis illustrated a negative correlation between SSR and place attachment from the treatment group translating into an inverse relationship between these two variables. The comparison group depicted no correlation.

Audio transcriptions of the debate and the semi-structured interviews, and entries from a reflective journal comprised the qualitative data. A rubric based on Sadler and Fowler (2006), coded the number of evidence-based justifications used on the journal entries and the debates to evaluate changes in their lines of reasoning and decision-making skills. Both groups displayed improvement after SSI negotiation supporting the higher SSR mean scores from the QuASSR. However, findings depicted gains in the number of evidence-based justifications used after intervention in journal entries by the comparison group on local SSI versus the treatment group. Whereas in the debates, the treatment group showed a higher increase in the use of evidence-based justifications between scenarios than the comparison group. Finally, the semi-structured interviews supported results on place attachment to the island of Puerto Rico. Though quantitative data did not detect significant changes in SSR, qualitative data reflected SSI negotiation allowed participants to create emotional connections and environmental awareness of local and global scenarios affecting the planet, which are vital qualities needed in the formation of informed and environmentally-literate citizens.
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Acknowledgments

Thank you to Dr. Samantha R. Fowler, advisor, for encouraging me to move forward and step out of my comfort zone. You not only allowed me to learn from my mistakes but convinced me to trust in my capabilities whenever my self-confidence faltered.

I would like to thank my committee members, Dr. Saida Caballero-Nieves, Dr. Kastro Hamed, and Dr. Ken Lindemman, for their time, support, and expertise.

I would like to acknowledge all the professors that contributed their time and wisdom to validate the survey instruments used in this study. Thanks to Prof. Jaime Galarza, Prof. Janine Haderthauer, Dr. Graciela Tesan, and Dr. Ramón Fernández from the Inter American University in Puerto Rico; Dr. Warner Ithier-Guzmán from the University of Puerto Rico; Dr. Regina Suriel from Valdosta State University; Dr. Saida Caballero-Nieves, Dr. Ken Lindemman, Dr. Kurt Winkelmann, Dr. Kevin B. Johnson, and Dr. John G. Windsor from Florida Tech. Special thanks to Dr. William Romine from Wright State University for the full validation of the modifications to the Quantitative Assessment of Socioscientific Reasoning.

A huge thank you to the administration, faculty, and students from Academia San Agustín y Espíritu Santo for their invaluable support toward this study. Special thanks to Mrs. Nydia Vargas, school founder; Mrs. Enid Cordero, school principal; and Mrs. Mara Carmona, high school general science and biology teacher.

I would like to express my gratitude to Nancy Garmer for not only being my library liaison but my good friend. You helped bring my ideas to fruition. Thanks for your guidance and motivation throughout my research journey.

Thanks to Dr. Kurt Winkelmann and Dr. Jessica Smeltz in the Chemistry Department for the opportunity to follow my passion as an educator. I truly appreciate being trusted with assisting in improving the students’ lab experience as an instructor and GSA mentor.
Dedication

God and my Virgin of the Well, thanks for guiding me on a new path and giving me the strength to strive forward.

To my family, for supporting my dreams and goals. These years have been easier with you behind me cheering me on. I could not have done it without you!

To my friends, I am grateful to have you in my life. Thanks for your motivation and positive energy.

To me, for proving that life is what I make of it. For learning that positive things always come from even the most unfavorable circumstances, testing my strength and resilience. These years have revealed the amazing woman I am, that one who can approach any challenge and be successful. As a teacher, I encouraged my students to embrace every opportunity and give it their all. I always told them, “the sky is the limit,” not realizing that it was within reach. I guess now I’ll have to aim for the galaxies.
Chapter 1

Introduction

Today’s technologically-driven generation is often unaware of the challenges faced as every action and decision taken today can impact the welfare of future generations. As citizens, the ability to analyze, synthesize, and evaluate information that leads to sound decisions regarding science and its relation to society is indispensable. Socioscientific issues (SSI) are brief narratives featuring complex real-world situations to exercise reflection and decision-making. The goal of SSI is to enable students to consider how these science-based scenarios and the decisions made reflect their virtues and moral principles as well as the physical and social world they live in (Driver, Leach & Millar, 1996; Driver, Newton & Osborne, 2000; Kolstø, 2001; Sadler, 2004). As students engage in discourse and debate with SSI, socioscientific reasoning (SSR) is enabled.

Science education research with SSI suggests these are excellent pedagogical tools to foster the development of higher-order thinking skills leading to SSR while educating about citizen science. However, since learning involves affective and motivational components, factors such as culture and sense of place can have significant effects on the way an individual thinks and acts. Informal reasoning might trigger a premature response or interfere with judgment when a student feels identified with a situation or setting. This combination of cognitive and emotional processes can benefit or hinder a student’s performance when solving a complex issue.
Background and Rationale

As a science teacher in Puerto Rico, some of my students displayed a negative demeanor toward the class. Their claims focused on the lack of relevance to real-world situations or their lives, thus finding the subject unappealing. Puerto Rico’s science curriculum is heavily content-based, with a deficit on the emphasis of local complex scenarios for students to reflect on. Most textbooks and educational resources are from U.S. based companies and do not feature topics specific to the island. A pilot study done by the primary investigator during January and February 2018 with several high school groups (Villarin & Fowler, 2019) incorporated a local environmental SSI to a biology and an environmental science class. Participants actively engaged in discourse and debate as they sympathized with a situation happening 15 miles away from their school.

Science education should not be just content-based but able to train responsible citizens that can make thorough decisions about scientifically-based personal and societal issues that might affect them in the future. In the 1980s, science-technology-society (STS) education was introduced to the curricula to reflect on the influence between these three areas. Aikenhead (1994) described this teaching approach as a student-centered one on which science content integrated social and technological contexts that make it meaningful for students. Its purpose was to increase students’ interest in science content learning through a societal context (Zeidler, Sadler, Simmons & Howes, 2005). Later, the science-technology-society-environment (STSE) approach was implemented to validate the importance of the latter. However, these methods did not seem to consider the personal or
individual moral, cultural, and ethical development of students (Zeidler et al., 2005). The SSI movement derived from this need of not just pinpointing controversial issues, but being able to create affective and epistemological connections that would promote awareness of the interdependence between science and society.

Research regarding the effects of SSI towards the understanding of the nature of science (NOS), decision-making abilities, the use of argumentation, and changes in scientific reasoning is extensive. Bell and Lederman (2003) studied the role of NOS in decision making on science and technology-based issues with university professors from diverse fields. There were no significant differences in the decisions made by participants. Their reactions and responses to SSI appeared unaffected despite divergent views of the NOS. These results contrast with studies on which high school and college students reported interactions between NOS conceptions and socioscientific decision making (Sadler, Chambers & Zeidler, 2004; Zeidler, 2002). However, all these studies suggested that participants centered their decisions primarily on personal values, ethics, and social concerns. Zeidler, Walker, Acket, & Simmons (2002) claim that to achieve scientific literacy, it is necessary to include moral and ethical issues in an interdisciplinary curriculum.

Roberts (2007) proposed two broad visions of scientific literacy. Vision I emphasized the importance of understanding science content and competencies in the scientific community. On the other hand, Vision II referred to the application of that content or how a student engages with science ideas and practices embedded in the context of societal issues. SSI provides the means to assess understanding of science content while
allowing the flexibility of customizing the context to assert students’ interests and needs. Since scientific literacy aids in the development of SSR, Romine, Sadler, and Kinslow (2017) supported SSR as a useful construct for science research and learning as it fostered Vision II on scientific literacy.

While students’ cultural experiences will influence their decisions, personal identities shaped through students’ particular social, intellectual, and moral growth (Hughes, 2000; Kozoll & Osborne, 2004) may lead to divergent views of reasoning and reflection. Puerto Ricans’ family-oriented upbringing has led to individuals having special appreciation and respect for their island and everything that happens therein, nurturing its unique culturally-rich personal identities. Research performed by Patronis, Potari, and Spiliotopoulou (1999) with middle school students reflected remarkable patterns of argumentation due to personal connections of participants with local issues and the solutions they presented. Halpenny’s (2010) findings supported environmental behaviorists’ claim on how emotions and knowledge of a place can impact an individual’s environmentally-responsible behavior toward that location. Sobel (2004), a precursor of place-based education (PBE), believed this pedagogy allowed for immersive experiences that encouraged an appreciation for the natural and environmental engagement leading to responsible citizens. Therefore, SSI applicable to an individual’s community may trigger intrinsic factors that could motivate the individual to reflect on a situation differently.

Society should be aware of the relationship that exists between them and the issues included in SSI as to how they correlate with their lives. Exploring how students negotiate and solve SSI will aid in the development of new socioscientific curricula that could foster
SSR. However, knowing whether a local or foreign SSI produces different lines of reasoning about related issues can reveal a different perspective on SSR assessment, which prior studies have lacked to investigate. Therefore, the purpose of this study is to assess a relationship between place attachment and SSR as some students negotiated with local environmental dilemmas and others with foreign environmental scenarios through the incorporation of SSI in Puerto Rican high school science courses, which included earth science, biology, and environmental studies.

**Context and Place Attachment**

The context of a particular SSI can influence decision-making skills or the way a situation is interpreted, which in turn can impact SSR. Zeidler and Newton (2017) agree that affect plays a “mediating role” (p. 61) in the way individuals reflect and respond to an environmental issue. These responses may be different when individuals are emotionally attached to a place or situation, making them more compelled to take action (Halpenny, 2010; Kaltenborn, 1998). That positive emotional bond towards a setting or environment is known as place attachment. Physical settings are “centers of value” (Tuan, 1977, p. 18), which shape everyday experiences and behaviors (Proshansky, 1978). Since Puerto Rico is the participants’ place of origin and residence, it is what they call home. Thus, place attachment scores could reflect this special connection to the island.

As an educational reformer, John Dewey (1916) promoted the inclusion of real-world tasks and challenges to instigate thought in students. It is impossible to conceive that something so meaningful is not the primordial focus when educating the future generation
of well-rounded citizens. Tal, Kali, Magid, and Madhok (2011) claimed that value-laden SSI support students in becoming active citizens as it combines the relationships between science and economical, health, environmental, and social issues which Hodson (as cited in Tal et al., 2011) argued are still missing from traditional teaching in most schools. There is a lack of environmental education resources that feature real-world scenarios and prepares students to be contributing members of society (Marcinkowski, 2009, as cited by Zeidler & Newton, 2017). Science content knowledge and application are tested through SSI negotiation and discourse as students realize its relevance to the real world or, in this case, their island. Socioscientific issues display controversial situations that might not have a definitive answer but from which students can reflect and debate upon alternatives to reach decisions. This constructivist type of learning allows a transition from a teacher-centered classroom into a student-centered one. The teacher turns into a facilitator and a neutral entity that becomes sensitive to diverse values and beliefs while encouraging critical thinking and purposeful action (Pedretti, 2003).

In a society where equity and social justice movements are more palpable than ever, addressing circumstances that neglect to allow inclusiveness in science education research is fitting. There is still a lack of minority groups, such as Latinos, rarely featured in studies. The island needs a new generation of well-rounded citizens that can restore financial stability and make smart decisions. Through an SSI-infused curriculum, this Spanish-speaking population of Americans exercised scientific understanding and decision-making skills through negotiation and discourse of local and foreign environmental scenarios. Using topics regarding environmental justice and sociopolitical
issues, SSR analysis and assessment after proper discourse and debate should expose differences between the lines of reasoning in high school students.

**Definition of Terms**

1. Socioscientific issues (SSI) are complex, open-ended societal issues with applicable connections to science ideas and principles which are subject to multiple perspectives and solutions (Zeidler, 2014; Sadler & Zeidler, 2005). When teaching SSI, there are four areas of pedagogical importance: the nature of science issues, classroom discourse issues, cultural issues, and case-based issues (Zeidler et al., 2005).

**Areas of pedagogical importance.**

a. Nature of science (NOS) issues relates to the influence epistemological views have on the evaluation of SSI. Personal beliefs compete against factual evidence, as students have a hard time finding the meaning of data when exercising decision-making skills (Sadler et al., 2004).

b. Classroom discourse issues refer to the way students construct arguments to defend a stance. Fallacious reasoning or emotional responses to prior convictions could support these thoughts. Although discourse plays a crucial role in peer interaction and its impact on thinking (Zeidler et al., 2005), Sadler (2004) suggests that personal experiences consistently influenced the informal reasoning of participants while negotiating with SSI.
c. Cultural issues promote mutual respect and acceptance of diverging views (Zeidler et al., 2005). Cultural background and environment determine acquired values and how individuals think. Zeidler and colleagues (2005) indicate that “by explicitly attending to cultural issues, science educators recognize, acknowledge, and maximize opportunities afforded by diverse assemblies of learners” (p.366).

d. Case-based issues foster the exercise of issue resolution while considering ethical implications and examining complex situations related to the scientific enterprise. Sadler and Zeidler (2005) stress how the SSI context can trigger emotive informal reasoning patterns based on empathy and “gut-level” (p.123) reactions that persuade decision-making in students when negotiating with controversial dilemmas.

2. Sosioscientific issues negotiation pertains to students’ engagement with SSI through discourse and debate. Participants reflect on the implications of the issue and its connections with the social, economic, and scientific aspects. They research and scrutinize information before exercising decision-making, supported by evidence-based justifications.

3. Socioscientific reasoning (SSR) refers to how citizens engage through multiple SSI. There are four aspects of SSR related to negotiation and resolution of SSI: recognizing the complexity of SSI, analyzing them through various perspectives, maintaining ongoing inquiry, and employing skepticism when reviewing information (Sadler, Klosterman & Topcu, 2011). Effective measures of SSR enable individuals to distinguish between understanding of the issue and reasoning practices in the context of the issue (Romine et al., 2017).
4. Quantitative Assessment of Socioscientific Reasoning (QuASSR) (Appendices B – E) is the newest valid quantitative instrument for assessing socioscientific reasoning. Developed by Romine et al. (2017), it presents students with a particular SSI in a two-tiered ordered multiple-choice that relates to one of the four dimensions of socioscientific reasoning (SSR): complexity, perspective-taking, inquiry, and skepticism.

5. Place attachment or sense of place relates to the affective bond and behavior towards a place (Shamai, 1991; Williams, Patterson, Roggenbuck & Watson, 1992). Fournier (1991) and Giuliani & Feldman (1993) (as cited by Vaske & Kobrin, 2001) suggest that this emotional aspect correlates with the depth of attachment a person has for a setting. Jorgensen & Stedman (2001) agree but integrate the cognitive and functional components to the definition of place attachment.

6. Identification with Place measurement scale (Appendix A), designed by Burdge & Ludtke (1972), determines the extent to which an individual maintains any emotional attachment to their place of residence. This instrument consists of a Likert-type twelve-item summated rating scale with five response categories: strongly agree, agree, neutral, disagree, and strongly disagree. There are eight positive place identification questions and four negative ones. The values of responses waver between strongly agree with four points and strongly disagree with zero points.
Research Questions and Hypotheses

This study aimed to address if place attachment enabled changes in SSR through negotiation with SSI on local and foreign environmental issues. High school students enrolled in earth science, biology, and environmental science courses reflected on environmental dilemmas that were either affecting their community or an extraneous one. The research focused on possible impacts to the SSR construct through local or foreign SSI negotiation and how they compared across assessment scenarios. Factors like culture and emotions due to place attachment may likely play a role in SSR changes aligned with the relevance of an issue to this population. Better understanding and SSR were expected from the local environmental scenario than the others since participants were more familiar and personally identified with what was happening within their community. Therefore, the questions this study addressed were:

1. What is the extent of students’ place attachment to Puerto Rico?

2. Is there a significant difference in overall SSR between pre-test and post-test responses after local and foreign SSI negotiations?

3. Is there a positive correlation between place attachment and SSR changes between local and foreign SSI scenarios?

4. Are there significant differences in SSR between pre-test and post-test responses after negotiation across local SSI and foreign SSI scenarios?
5. Do negotiation and discourse improve with SSI implementation of local and foreign scenarios?

Due to culture and the fact that it is the participants’ place of residence, a positive connection with Puerto Rico may be possible. Therefore, changes in SSR and its dimensions are probable across students working with local SSI versus foreign SSI. Higher competencies in SSR are likely for those debating about local scenarios since they can relate to issues affecting their community. Correlations between changes in SSR and place attachment may indicate fluctuations between these two factors. However, SSR should increase in all participants as they exercise debate and discourse of SSI. The hypotheses are as follows:

RQ #1: $H_0^1$: Students reflect no significant place attachment to Puerto Rico.

$H_1^1$: Students reflect significant place attachment to Puerto Rico.

RQ #2: $H_0^2$: SSR does not improve significantly between pre-test and post-test after local and foreign SSI negotiations between groups.

$H_2^2$: SSR improves significantly between pre-test and post-test after local and foreign SSI negotiations between groups.

RQ #3: $H_0^3$: There is no positive correlation between place attachment and changes in SSR across scenarios.
H3: There is a positive correlation between place attachment and changes in SSR across scenarios.

RQ #4: H04: There are no significant differences in SSR after SSI negotiation between students working with local scenarios and those working with foreign ones.

H4: There are significant differences in SSR after SSI negotiation between students working with local scenarios and those working with foreign ones.

RQ #5: H05: No improvement is observable in negotiation and discourse after SSI implementation of local and foreign scenarios.

H5: Improvement is observable in negotiation and discourse after SSI implementation of local and foreign scenarios.

**Significance of the Study**

Traditional approaches to science learning revolve around a teacher-centered environment where students learn in an autocratic fashion, which may limit the opportunities for reflection. Changes in teaching dynamics have led to more active methodologies where experiential and autonomous learning are taking place. Zeidler, Applebaum, and Sadler (2011) supported pragmatic views by Friedrich Froebel and John Dewey, who perceived education as a student-centered environment where learning is a social and interactive process that can lead to social reform and change as the student realizes its full potential based on personal experiences.
According to Sadler (2011), the primary goal of science education should be promoting citizenship. STS education tried to address the impact of decisions in science and technology on society but lacked to consider external factors like emotions, place, and culture, which fuel SSR. SSI displaced STS education. Socially relevant and controversial contexts are to be considered for learners to experience science and debate about divergent views. Under the SSI framework, students can build character as they engage in the discourse of various moral problems linked to science (Zeidler & Sadler, 2007). However, personal identities, “embedded in [the] implicit understanding of their lifeworld, identity, and self” (Kozoll & Osborne, 2004, p. 160), need to be also recognized as culture and setting may play an important role in informal reasoning and decision-making skills. Therefore, SSI negotiation between culturally different scenarios could illustrate this influence.

Kaltenborn (1998) believes that people conceive relationships with places to make sense and give purpose to their lives as he measured pro-environmental behavior regarding place attachment. The evolution of education supported this circumstance as place-based instruction, experiential learning, and situated learning originated, providing context-dependent curricula shaped by students’ personal experiences and the communities that surround them. Some studies have focused on promoting this kind of instruction as findings contribute to that positive gain in science learning and understanding. Sternberg’s (2003) results suggest a greater diversity of success and learning transfer in students who engaged in real tasks rather than those taught through conventional instruction. P. Chinn (2012) has been an active advocate of PBE through the inclusion of indigenous knowledge
and underrepresented population and minorities. She believes that this kind of instruction “holds promise of a path toward educational equity and transdisciplinary science literacy for all learners” (Chinn, 2012, p. 331). Sadler and colleagues (Sadler & Donelly, 2006; Sadler, 2009; Romine et al. 2017) suggest that knowing and learning are context-dependent. Context can impact an individual’s SSR concerning the understanding of an issue. More recently, Kinslow, Sadler & Nguyen’s (2018) findings support the development of SSR competencies with experiences in a field-based ecology course through local SSI negotiation as a new path in SSI research. Therefore, this study’s findings can potentially lead to the inclusion of place attachment in SSR assessment.

Some students around the world have had the opportunity to work with SSI and further their SSR. However, the lack of access to the underrepresented Spanish-speaking population of Puerto Ricans presents a wasted opportunity for inclusiveness in science education and the promotion of decision-making skills. Puerto Rico’s financial, educational, and political outlooks are in negative disarray. The lack of funding prevents access to the latest trends in science education, more less, translated educational resources. Allowing Puerto Rican students to explore SSI would enable them to become aware of what goes on in and outside their community. Fostering their SSR will make them feel capable when making decisions about other dilemmas upsetting their welfare.

**Study Design**

Five intact classrooms totaling around 130 participants of a small private high school in the southwestern part of Puerto Rico enrolled in earth science, biology, and
environmental science courses comprised this mixed-methods study. Parental consent was granted to 124 students. The primary investigator gathered quantitative and qualitative data related to place attachment and SSR through SSI negotiation to support gaps not addressed in the pilot study. Before treatment, every participant completed a Likert-type measurement scale (Burdge & Ludtke, 1972) to assess the place attachment of students towards Puerto Rico (Appendix A). As for SSR, a pre-test post-test design survey instrument measured changes before and after the intervention, and between local and foreign assessments. Groups debated on two SSI focusing on parallel local or foreign environmental dilemmas. Puerto Ricans worked with a validated Spanish version of the SSI and the instruments (Appendices B – E).

Incorporated into the regular science activities, the SSI on local scenarios featured issues related to a coal power generation plant (Appendix B) and a coastal environmental controversy related to possible threats to bioluminescent life (Appendix D). Two out of the five groups negotiated using these local SSI. The SSI on foreign scenarios, parallel to the local situations, presented the pollution caused by coal power generation companies in two municipalities in Chile (Appendix C) and the deterioration of the Indian River Lagoon (IRL) in Florida along with its conservation efforts (Appendix E). Three out of the five groups negotiated with these foreign SSI.

Through the process of discourse and debate, teacher-centered instruction became a student-centered one. Students made in-depth explorations on the topics to exercise their decision-making skills through SSR as they understood the complexity of the problem, relied on ongoing inquiry, evaluated multiple perspectives, and challenged skepticism to
defend a posture. The reputable resources used included videos, newspaper and scientific articles, and websites. (Appendix G).

To assess SSR, students completed the Quantitative Assessment of Socio-Scientific Reasoning (QuASSR) (Romine et al., 2017) (Appendices B – E), which encompasses an SSI and a series of multiple-choice questions using a two-tiered ordered multiple-choice format. In the first tier, participants choose from yes or no. In the second tier, students select the best assertion based on the responses from the first tier. Answers will be compared before and after SSI negotiation and between groups to evaluate changes in overall SSR and throughout scenarios.

The qualitative part of the study involved evaluating audio transcriptions from the debates, random students’ reflective journals, and answers to a semi-structured interview (Appendix F) on their experiences with SSI and the reasoning behind some of their responses. Questions were related to culture, emotions, and personal relevance and how these aspects influenced the decision-making factor. Figure 1 illustrates a flowchart of the overall study design.
Figure 1

Flowchart of the Study’s Design

**Phase I: Pilot Study**
- Selected valid survey instrument: QuASSR
- Developed SSI
- Performed pilot study
- Administered QuASSR with SSI on local environmental issue
- Analyzed data for SSR

**Phase II: Formal Study**
- Added variables
  - More SSI on local and foreign environmental issues
  - English validated Spanish
- Place attachment “Identification with place scale”
- Translated and validated
- Treatment group (Foreign)
- Selected more participants and trained teacher
- Comparison group (Local)
- Administered survey instruments
  - QuASSR (pre/post)
  - Place attachment (pre)

**Phase III: Data Analysis**
- Analyzed data
  - Quantitative
    - Place attachment
    - SSR
    - Research Question 1: Extent of place attachment
    - Research Question 2: Changes in SSR between groups
    - Research Question 3: Correlation of SSR and place attachment
  - Qualitative
    - Interviews
    - Debates
    - Journal Entries
    - Rubric
    - Research Question 4: Changes in SSR by scenarios
    - Research Question 5: Negotiation and discourse after treatment
Summary

Factors such as culture, political and moral postures, and the impact from the media influence the way people think and reflect. To promote citizenship and decision-making skills in science education, SSI provides an alternative way to foster knowledge and science application through SSR. This study assessed variations in SSR between local and foreign environmental SSI discourse in Puerto Rican high school students enrolled in earth science, biology, and an environmental science course. Cultural differences and place-attachment might trigger divergent views and responses toward SSI. Changes in SSR were assessed quantitatively through the QuASSR (Appendices B – E). This instrument measures variations in SSR by scenarios and across dimensions. Semi-structured interviews qualitatively gathered information on whether personal relevance, culture, and sense of place influenced when reflecting on SSI. Allowing students to explore SSI would enable them to become aware of what goes on in and outside their community. They will also feel capable of engaging in decisions about imminent changes to their local environment and society’s well-being.
Chapter 2
Review of Related Literature

Introduction

Classic and contemporary theorists have led the way to bring about changes in how learning and instruction should transpire. They have managed to set standards for which to abide by looking for consistency and quality of education. They have examined how students learn and the processes behind this. However, all students are not alike. Diversity has required certain modifications in teaching and learning activities to meet students’ needs and promote inclusiveness. Classrooms with a heterogeneous mix of cultures, ethnicities, and languages can be challenging when these factors do not play an active role in instruction. In a world where so much depends on the decisions we make, the future generation should master proper decision-making and problem-solving skills that will shape them into educated citizens. For a while now, research has provided an opportunity to address these gaps, making it more feasible for students to gain resourceful skills and more structured for educators to promote citizenship while stimulating scientific literacy.

However, there are still certain aspects that need to be studied further. The fact that context can appeal to the emotional and moral character of individuals (Fowler, Zeidler & Sadler, 2009) means that outside factors may influence reasoning and decision-making, and it is not necessarily based solely on content knowledge. The relationship between place attachment and socioscientific reasoning is absent from research. While place attachment
may influence other actions, this chapter will also explain how previous studies have been able to implement a framework that comprises the interdependence between science and society while accounting for the emotional, ethical, economic, and political elements that have brought context and relevance to science education and could certainly consider place to enhance the learning experience. Finally, a summary of the literature and the implications this might bring to the transforming realm of education will close the chapter.

**Underlying Theory**

As educators, our primary focus lies on finding ways to promote students’ thinking and reasoning. However, misconceptions on how just a few can acquire these higher-order thinking skills may come from an established cumulative hierarchy of abilities, which seems unattainable for some. Benjamin Bloom (1956) created a framework from which educators and researchers could agree on as they measured educational objectives. Looking to describe these essential educational properties and their interrelationship, an arranged set of skills were aligned from necessary to complex as prerequisites to attain higher levels of thinking and reasoning. Bloom’s original taxonomy included knowledge, comprehension, application, analysis, synthesis, and evaluation as ascending categories in a hierarchy (Bloom, 1956). A revision modified the taxonomy to add a second dimension: knowledge and cognitive processes. Also, hierarchical statements changed from nouns to verbs, and the highest categories switched appearing as remember, understand, apply, analyze, evaluate, and create (Krathwohl, 2002). Nonetheless, it became a useful tool to measure the depth and breadth of curricular activities and assessments among educators worldwide.
Based on the original taxonomy, remembering, understanding, and low-level application were part of the necessary thinking skills, whereas synthesis and evaluation comprised the higher-order thinking skills. Hence, students performed better when tested on recalling information or understanding a topic than when doing analysis or synthesis. However, Zohar and Dori (2003) believe that the knowledge category has shifted to “usable knowledge” (p. 148) since modern students are not only able to repeat information but know how to use it effectively. To use it effectively, they should be able to understand this knowledge. Findings revealed that even though overall high-achieving students had higher gains in high order reasoning than the low-achievers, some low-achievers scored higher than the high-achievers in the knowledge and understanding categories. Therefore, by fostering the development of thinking skills in students of all academic levels, literacy should improve from an individual starting point. Although teachers expressed frustration as they realized some students, especially low-achieving ones, might not be able to reach up to a high thinking level, the researchers insisted that “the traditional view that the basics can be taught as routine skills, with thinking and reasoning to follow later as an optional activity that may or may not take place, cannot longer guide the educational practice” (p.148).

Sternberg (2003) also encouraged schools to teach “wisdom.” He defined wisdom as “the use of successful intelligence and experience towards the attainment of a common good” (Sternberg, 1999, p. 7). Expertise in wisdom involved being able to make crucial decisions and fair judgments on behalf of the community’s welfare. Traditional instruction lacked to prepare experts for real-world thinking. Therefore, to enable creative thinking, all students needed to engage in role-playing with tasks that experts do. Expertise teaching
implicated, making students realize how necessary knowledge is and how to apply it (Sternberg, 2003). Expert students would be more prepared to handle situations that require responsible decision-making skills needed for a fulfilling professional career and life.

Dewey (1916) suggested thinking was finding continuity between experience and what results from it. Meaningful experiences were not possible without some element of thought. Therefore, he asserted that if we fostered students to hypothesize on consequences and scrutinize implications related to something that happened or it is about to happen, we would trigger reasoning. Dewey criticized instruction that involved absorbing knowledge directly rather than becoming engaged in fruitful action. Thus, paying attention to the action that would connect the mind with the body, especially coming from interests outside of school in daily life, was vital. This is when personal experiences can become part of the learning process. The lack of activity and relevance would steer students’ interest away, forcing the teacher to focus on discipline rather than the material. Bransford and Donovan (2005) followed Dewey’s philosophy. They believed that by merely lecturing a student about a theory or following the steps of the scientific method would not be enough to acquire knowledge and understanding of science. Their book *How Students Learn: Science in the Classroom* (2005) encouraged teachers to tend to students’ mistaken preconceptions of science to further comprehension. Based on everyday experiences, they claimed students might have a hard time coming to terms with new evidence that does not fit their beliefs. Understanding scientific knowledge involved changing one’s epistemological perspective. Therefore, Dewey (1916) recommended engaging students in exciting and “unscholastic” relevant context as the first approach to any subject in school.
**Socioscientific issues.** Adding relevance in context and affixing a detachment between science education and matters of social importance led to the introduction of the STS approach. Its goal was to aid students in making sense of everyday experiences while integrating a personal understanding of the social, technological, and natural aspects (Aikenhead, 1994). This student-oriented instruction wanted to increase the general interest of students towards the science curriculum, encourage research, and foster citizenship through the interrelationship of science, technology, and society. However, this approach neglected to focus on the ethical issues embedded within these three realms (Sadler & Zeidler, 2004; Zeidler, Sadler, Simmons & Howes, 2005). Years later, the environmental aspect gave way to the science, technology, society, and environment (STSE) approach. Although STSE seemed to be an improvement by pointing out ethical dilemmas, the lack of open discourse, epistemological connections, nature of science considerations, and emotional attachment to the issues reflected no significant changes from STS instruction (Zeidler et al., 2005).

The SSI movement originated to fill the gap from STSE instruction by incorporating moral aspects regarding personal experience and the physical and social world. This conceptual framework combined the moral and epistemological orientations of students as well as their emotions and character and made them critical aspects in science education (Sadler & Zeidler, 2005; Zeidler et al., 2005). Zeidler (2014) described that to promote functional scientific literacy, four “entry points” (p. 697) of pedagogical importance are to be considered in SSI instruction: NOS issues, classroom discourse issues, cultural issues, and case-based issues. These issues attended to epistemological
preconceptions, peer interaction, and its impact on reasoning, moral agency of diverse learners, and students’ engagement through context, respectively.

Roberts (2007) described two visions on scientific literacy that framed contemporary science education. Vision I encompassed the building and understanding of content knowledge to create a foundation and introduce students to the scientific enterprise. Opposite to Vision I, which had a more inward view of scientific literacy, Vision II focused on the outside aspect related to science application and citizenship. It accounted for student engagement with social issues embedded in the science context, which may include political, economic, and ethical considerations to ponder on, negotiate, and argue (Roberts & Bybee, 2014). The SSI approach better aligns with Vision II on scientific literacy as it provides open-ended situations on which individuals will be challenged to exercise decision-making skills while considering other influential factors from the interrelationship between the social, political, and scientific perspective (Presley et al., 2013). These thinking practices that stem from Vision II and trigger reflective judgment when negotiating with SSI enables SSR (Romine, Sadler, Kinslow, 2017). This construct was initially proposed by Sadler and Zeidler (2009) “to better understand how SSI-based learning experiences can affect students’ thinking and development of scientific literacy” (p.700).

Socioscientific reasoning comprises four dimensions: understanding the complexity of the SSI, assessing it from multiple perspectives, practicing ongoing inquiry, and exercising skepticism from potentially biased information (Romine et al., 2017). Providing students with a chance to enable SSR will raise a generation of informed citizens
ready to face future societal problems. Mueller and Zeidler (2010) connected SSR with Dewey’s views of pragmatism. Dewey (1938, 1963) (as cited by Mueller & Zeidler, 2010) was concerned about the disconnect between thought and action revolving around the social sphere and encouraged educators to instruct about making the right choices for the welfare of society. However, this pragmatic philosophy has not been included as part of traditional science teaching practices since reasoning did not involve the inclusion of the moral-ethical characteristics, personal beliefs or values, and sociopolitical judgments until now, through SSI negotiation. Nonetheless, questions on whether the context of the issue can influence SSR, have brought about studies with disparate conclusions (Fowler et al., 2009; Sadler & Donelly, 2006; Sadler & Fowler, 2006; Romine et al., 2017).

Theory suggests that engaging students in active learning where personal experiences and surroundings can embed within the science content would promote scientific literacy and proper decision-making skills. Negotiating with local and foreign environmental SSI as part of the science activities should trigger SSR in all participants, no matter their academic performance level. Allowing active discourse related to the ethical, economic, and political aspects revolving an environmental issue will challenge students to scrutinize evidence and examine multiple perspectives, which are qualities needed to become well-rounded citizens.

**Place attachment.** Harold Proshansky was one of the first advocates of environmental psychology. In his “City and Self-Identity” (1976) article, he explained that although self-identity is a blend of specific dimensions like gender, social class, ethnicity, and religion, place identity played an essential role. The connection between the physical environment
and self, which defined personal identity, can be divided into three sub-dimensions that explained who the person was and how he or she will behave. The day-to-day experiences with the physical settings, our feelings or preferences toward places, and the roles we played in the society described the cognitive-descriptive dimension, the affective-evaluative dimension, and the setting and object dimension, respectively. Proshansky also referred to how physical settings could play a part in the social and cultural context of our everyday experiences and behaviors as they inadvertently intervened with our socialization process.

Tuan (1977), a geographer, coincided with Proshansky by suggesting that culture supported the meanings of places and could accentuate or alter human dispositions. He acknowledged that “objects and places are centers of value” (p. 18). However, these do not achieve a concrete reality until our senses and mind combine to shape our experiences. Therefore, living in a place does not necessarily translate into attachment until experiences are processed from the outside. Both theorists agree that experiences can influence place identity and attachment. Experiences are fundamental for learning as they help shape individuals’ social environments. Proshansky (1973) advised, “that no body of knowledge about human behavior and experience can be complete or fully meaningful without the inclusion of concepts and principles relevant to the influence of physical settings regardless of how much or little it contributes to the variance in such behavior and experience” (p. 105). Despite this, it took a long time for environmental psychology to obtain a vital role in science education research and practices.
Place-based education came about in the ’90s from the need to spark awareness on a highly globalized and ecologically deteriorated world and how to guide us to steer it back onto a sustainable path. Through PBE the local community and the environment shaped the foundations of a hands-on, real-world learning experience which featured an appreciation for the natural world, a sense of commitment as responsible citizens, and an improvement in community and environmental quality through active engagement (Sobel, 2004). Socioscientific issues share similarities with PBE in the formation of responsible citizens through the discourse of complex real-world scenarios, while considering ethical, political, and economic aspects to incite reasoning.

Bourdieu and Passeron’s (1977) sociocultural theory on how instruction and interpersonal interactions within cultural frameworks cannot be separated, and Dewey’s (1916) philosophy on active learning, which connected mind and body by way of experience, supported Chinn’s ideas on what science education was missing in her island of Hawaii. Chinn (2007) condemned text-based science and favored instruction that connected science, society, and culture. As an active advocate of PBE, Pauline Chinn (2012) stated that as part of the social learning system, two standards could determine the competence of science teachers: knowledge of content and their knowledge of student’s lives and communities. Inclusion of culture and familiar context could end the detachment between student and “foreign” science that Dewey (1897) constantly criticized to improve motivation. Chinn (2012) suggested three reasons why culture-based and PBE should play a role in professional development in science. These approaches were intended to (1) aim towards scientific progress and scientific literacy (2) to promote equity and social justice,
especially for underrepresented populations, and leading towards a (3) sustainable world. Chinn’s (2007) efforts to incorporate indigenous knowledge to the science curriculum led to a study where Asian and American teachers and school administrators who mostly availed its exclusion, were convinced differently. After a short presentation with examples from her work with Hawaiian natives, criticism towards the omission of local issues and indigenous knowledge from the national science curriculum was evident as it interfered with “intergenerational transmission of knowledge” (p.330). Her hard work toward educational equity and transdisciplinary scientific literacy for all learners, including native ones, have also inspired this study.

Scientific literacy for all learners is difficult but possible. Heterogeneous groups can include a diversity of learners that come from different backgrounds, ethnicities, cultures, economic status, and even academic performance. When educators get to know more about their students and where they come from, classes can be modified to assess individual needs. Neither underrepresented populations of students nor minorities should pay the consequences of an established curriculum or standard. To encourage a better future, we need to engage students with context relevant to their everyday experiences and surroundings. Place attachment should impact reasoning as emotions will weigh decisions. Sadler and Zeidler’s (2004) study revealed that emotions considerably influenced during the consideration and resolution of SSI negotiation.
Review of Past Research Studies

Socioscientific reasoning. Patronis, Potari, and Spiliotopoulou’s (1999) experimental study addressed changes in decision-making through students’ argumentation of an SSI. Fourteen-year-olds from a mathematics classroom in a suburb of Patras, Greece, were featured as participants. The study displayed a real situation involving the design of a road in the area. The controversy began since plans to build a major road would be too close to the school. Students explored the topic looking for options to come up with a proposal that would be voted on by themselves and sent to the City Council. At first, the teacher asked each student to reflect on the situation and write their opinions on the issue. Two weeks later, students split into groups and took on a particular role to develop a proposal that could elucidate the controversy. Two weeks after that, participants presented their proposals to the class, and choices were justified. A proposal on transferring the road to a different area was voted the best one and sent to the City Council. The runner-up proposed the construction of a bridge to minimize the impact on the school and the community.

Months later, the topic was retaken as students had to come up with a bridge design. Previous activities measured arguments according to the effort given by students to justify their proposals and not on finding the best solution to the scenario. There were two categories of arguments: defense and pragmatic. Defense arguments related to the impulsive informal reasoning students used to justify a claim; whereas, pragmatic arguments, classified as qualitative, semi-quantitative, and quantitative, encompassed the consideration of social, ecological, economic, or practical aspects of the issue, common
sense reasoning about the real world, and the application of science content knowledge, respectively.

Patronis and colleagues (1999) stressed the need to develop analytical citizens through pedagogical approaches where scientific knowledge would emerge from a real-world issue or need that society is facing. The exchange of different arguments offered students a chance to understand the complexity of an issue. This experimental study empowered students as they acquired critical competencies in decision-making and policy in order to justify their proposals as being the very best ones.

Zeidler, Walker, Acket, and Simmons’s (2002) mixed-methods study focused on how the NOS beliefs of high school and undergraduate college students influenced responses to socioscientific dilemmas. They suggested that students who have an adequate conception of NOS should be able to “recognize the implications of science as a culturally-based social endeavor” (p.345) as it is subject to human bias. NOS relates to the epistemological view that may prompt an individual to ponder information and evidence in a certain way (Zeidler et al., 2005).

The focus of inquiry in this study was on how students’ view of NOS reflected on their reactions to SSI when challenged with information contradictory to their initial beliefs. The first two phases of the study consisted of pairing a sample of 82 participants, 54 high school students, and 28 undergraduate college students according to responses from a questionnaire and after SSI negotiation. Pairings matched individuals with opposite views on animal rights and their use for medical research after the four authors
independently read the responses to the open-ended NOS questionnaire and the SSI
scenario. Subsequent data analysis resulted from the third phase.

Gee and Green’s (1998) convergence, agreement, and coverage, established by all
four authors, as well as, Lincoln and Guba’s (1985) general criteria for the credibility of
qualitative data (as cited by Zeidler et al., 2002) ascertained validity for discourse analysis.
The paired students answered questions by an investigator, not a teacher. These questions
elicited participants’ epistemological reasoning and challenged discourse between students
with opposite views of a situation. The semi-structured protocol allowed an investigator to
instigate debate through questions that would serve as justification, clarification, or
evidence probes while others focused on the alternative views, epistemological, personal,
or sociological aspects. Once interviews became redundant, participants received false
information from “authoritative sources” contrary to their personal views. Each student in a
pair was unaware that they were getting the same information on medical research protocol
with slight changes in the title and some key phrases to challenge their beliefs. Once done
reading, students completed an ordinal scale ranging from 0 for strongly agree to 10 for
strongly disagree. Responses aligned with their confidence level about the veracity of the
information and how they felt about switching their viewpoints.

This portion of data was analyzed using quantitative nonparametric statistical
procedures to know the extent of how anomalous data would sway someone’s convictions.
A Wilcoxon rank test was performed with the entire sample (n = 82) to assess whether
changes in their preliminary convictions occurred following the interview discourse and
the review of anomalous information. The alternative hypothesis (p = 0.0001) suggested
changes in student’s beliefs after SSI negotiation and exposure to the fictitious article. A Wilcoxon rank sums test addressed differences in the confidence level groups displayed towards the veracity of the “authoritative source.” There were significant differences between high school (n = 53) and college students (n = 28) as more mature participants exercised skepticism, which lacked from the younger group (p = 0.06) who believed the information or were easily influenced by others.

Interview questions triggered an interplay between NOS views and the ethical implications of science, while others probed epistemological interpretations. Responses revealed how NOS attributes like the cultural and social influence affected students’ view of the scientific enterprise.

Another study featured the SSR construct, which emerged from SSI negotiation and discourse. Four dimensions comprised this construct: complexity, inquiry, ongoing inquiry, and skepticism (Sadler, Barab & Scott, 2007; Sadler & Zeidler, 2009; Sadler, Klosterman, Topcu, 2011). Initially, SSR was only able to be measured qualitatively; however, a study by Romine and colleagues (2017) brought about the creation of a quantitative tool that assessed overall SSR and each of the four dimensions: the Quantitative Assessment of Socioscientific Reasoning (QuASSR). This validated assessment consisted of a brief scenario describing an SSI and 11 multiple choice questions that encompassed each dimension. Two items weighed complexity, perspective-taking also had two, while inquiry and skepticism had three items each. An additional unscored item asked students to take a position on the issue. The two-tiered ordered multiple-choice format (Briggs, Alonzo, Schwab, & Wilson, 2006) enabled participants to select between a
yes or no response on the first tier. The second tier provided three options from which to choose the best reason based on the first tier’s response. The QuASSR was performed online using Qualtrics software.

The sample consisted of one hundred thirty-two students from five environmental classes in a small private liberal arts college. The study consisted of two parts, which included completing assessments of understanding about fracking and then responding to the QuASSR, both as pre and post-test assessments. Two weeks before the intervention, students learned about the formation, extraction, and the use of coal and petroleum through lecture-based instruction, as well as the economic and environmental perspectives on fossil fuel dependence. The intervention carried on for three days. Students examined multiple viewpoints on fracking and reflected upon them using their journals.

The first day, students were separated into groups and watched three 5-10 minute videos on positive and negative aspects of fracking, the possibility of water pollution, and the option of energy by combustion of natural gas. After each video, students would respond to questions made by the instructor, as well as, make a judgment to deny or affirm the information provided and the risks and benefits of fracking. The second day, students would search for information on the Internet about fracking. Participants visited five websites with information on fracking. The instructor suggested three websites; students chose the other two. Using their journals, each student summarized their positions on fracking, described the data that helped support their stance, and assessed the trustworthiness of the information. The third day included group discussions on the
websites and the reflections made in the journals, as well as if any additional information was needed to understand the issue further.

Pearson partial correlations at the 95% confidence level to control for testing instances were used to assess relationships between SSR, knowledge of fracking, and identification of views. The generalizability theory and Rasch modeling measured validation of the QuASSR. Since the SSR assessment is three-faceted, Osterlind (2006) (as cited by Romine et al., 2017) indicated that the generalizability theory would ascertain test reliability by allowing simultaneous evaluation of multiple sources of error. This generalizability theory study included a generalizability study to understand how variance partitions across facets and a decision study to investigate test reliability and find the ideal test structure that would yield the desired measurement precision. The ten SSR items, the two scenarios, and the two testing instances (pre and post-test) would comprise the three-facets. The first two would become random effects, and the testing instances would be the fixed effects. The generalizability coefficient and the dependability coefficients were also quantified to explore how changes to several items or scenarios would impact the precision measurement of the instrument in future studies on SSR.

Rasch modeling compared the data gathered by the QuASSR to an already “accepted” data-independent standard, which is similar to “calibrating” an apparatus to make sure it is generating the proper values. The Rasch model was fit to responses from each scenario, as well as both altogether. A person-item map was also created along a Rasch scale to measure the hierarchy of items, difficulty distribution between student and item, and difficulty when shifting scenarios. Items were spread across the Rasch scale resulting in gradual levels of difficulty in addressing the various measures of SSR.
Different schemes tested scale-level reliability. A one-week SSI based scenario on fracking as a pre-post design model resulted in a Cronbach alpha average reliability of around 0.6 (Romine et al., 2017). However, adding one more scenario increased reliability to a Cronbach’s alpha of 0.79 across pre and post-tests, making it an acceptable measure (DeVellis, 2012). Nonetheless, the authors recommended no more than three scenarios for an experimental study due to the time it takes to answer the instrument. Despite these efforts, the QuASSR did not reflect significant changes in SSR between pre-test and post-test measures.

The most recent study by Kinslow, Sadler, and Nguyen (2018) utilized field-based learning to enable SSR and foster environmental literacy. Due to the lack of contextualization and “meaning-making opportunities” (p.2) for students in environmental education, the researchers provided two SSI on land and water quality related to the construction of an ethanol plant and a hydroelectric dam with scientific and social implications. They wanted not only a hands-on activity but a “minds-on” (p. 2) one.

This mixed-methods approach involved 19 participants enrolled on a field ecology course throughout two consecutive summers. These high school students from diverse academic backgrounds were predominantly white (94.1%), and a third of them qualified for free or reduced lunches. This six-week course, already taught for 18 years, in a small, rural district in the Midwest region in the United States would begin at sunrise and end around mid-afternoon. Students worked banding birds and performing water quality analyses. Although significant gains in relevant content knowledge domains were apparent, interviews with students revealed the lack of contextualization and meaning behind their
work. Therefore, the course was redesigned to achieve Vision II on scientific literacy. An SSI on a controversial local issue related to the construction of a groundwater ethanol plant connected water quality and avian ecology as part of the summer course. The QuASSR assessed SSR (Romine et al., 2017). Students completed two QuASSR on related scenarios before instruction, immediately after the class topic was done, and six months after the course ended. Personal reflection learning logs completed after each class session, PowerPoint and Keynote presentations on bird and water quality research, and a summative position paper on their stance about the ethanol plant were activities included as part of the course to gather qualitative data.

For the quantitative part of the study, a Friedman test revealed no significant differences across scenarios while measuring the four SSR dimensions at pre, post, and extended time frames nor while examining the combined scenario at all time frames. However, a Wilcoxon rank test indicated a statistically significant increase in three of the four SSR dimensions in time points between the pre and post-class assessments. Noticeable gains ($p < 0.001$) were associated with reasoning about the complexities of an issue, understanding the multiple perspectives, and the need for ongoing inquiry. There were no significant results on skepticism.

As for the qualitative part, an analysis of the students’ learning logs gave insight on environmental literacy and SSR development for triangulation with the QuASSR data. Evaluation of the learning logs would measure SSR competencies. Students’ writings featured the complexity dimension at 92%, followed by inquiry at 90% in their position statements. Perspective-taking was present in 75% of student position statements, and
skepticism in only 11%. Also, on completion of the summative position papers, the post-class QuASSR was completed and allowed convergent data analysis to examine changes and potential growth of SSR and environmental literacy. Two significant themes regarding student learning arose after reviewing qualitative data: the importance of conservation and stewardship of the environment, and the affective components of the class.

Once quantitative and qualitative data came together, researchers noticed that this SSI approach towards environmental education increased environmental literacy as students’ writings evidenced strong emotional connections with learning, and a desire to care for the environment while helping others. However, Kinslow and colleagues (2018) encourage other environmental educators to capitalize on the local place-based context of environmental SSI as students’ personal connections and interests should be stronger.

**Place attachment.** As part of a study on the forced migration of rural people faced with an unexpected event as a natural disaster, Burdge and Ludtke (1972) created an *Identification with Place Scale* to measure the extent of attachment with their place of residence. This Likert-type scale, with a reliability coefficient of 0.99, consists of twelve items and five response categories from completely agree to completely disagree. Although it tested nine variables, this scale focused on the emotional attachment to a region or home. Findings suggested that the higher the attachment to a place, the more apprehension there was toward moving. Therefore, place attachment might impact students’ SSR when dealing with local issues versus foreign ones.
Driven by the lack of studies relating pro-environmental behavior with place attachment and the rapid changes occurring in polar regions, Kaltenborn (1998) explored if resource exploitation and human development in the Arctic affected place-related values and meaning through the administration of environmental impact assessments. This cross-sectional case study wanted to probe if a sense of place affected probable behavior responses to potential environmental problems and changes, among other things. Norwegian residents in Longyearbyen, Svalbard, aged 15 or older, listed in the local census (n = 988), made up the sample. Three hundred completed questionnaires were obtained, resulting in a 29.8% response rate. This sense of place scale included the concepts of meaning and prominence of place. The original scale, based on the construct developed by Shamai (1991), involved an ordinal scale ranging from complete unawareness of place, through knowledge of a place, belonging to a place, place attachment, involvement in a place, and sacrifice for a place as the highest level. The modified scale portrayed the Svalbard archipelago as one place. Responses ranged from 1 to 5 from absolutely agree to absolutely disagree.

Though those with a stronger sense of place seemed more rooted and eager to make decisions for the welfare and conservation of the area, overall findings on behavioral responses to potential environmental problems showed that sense of place was not a good predictor of environmental sensitivity. Inspired by Kaltenborn’s (1998) work, Elizabeth Halpenny (2010) investigated whether an individual’s environmental intentions paralleled with the feelings towards a place. As previous studies had suggested (Relph, 1976; Schultz, 2000; Tuan, 1977; Walker & Chapman, 2003), positive attachments to place may influence
participation for the protection of a place (as cited by Halpenny, 2010). Therefore, the researcher set out to explore the relationship between place attachment and (a) place-specific pro-environmental behavior and (b) general pro-environmental behaviors.

The study sample (n = 355) consisted of visitors of Point Pelee National Park in Canada, a famous bird migratory site, and an ecological sanctuary. A questionnaire mailed to individuals, including one-time visitors, recurrent pass holders, and those who had visited this national park in the last four years, contained a place attachment scale, a pro-environmental intentions scale, and a park-specific pro-environmental behavioral intentions scale. It also provided information on age, education, frequency of visitation, place attachment, and satisfaction with the place. There were no significant differences between early responders, late responders, and non-responders contacted by telephone.

The 15-item place attachment scale, with a Cronbach alpha of 0.93, included three subscales. Place dependence had three items and presented a coefficient alpha of $\alpha = 0.82$. The two large six-item subscales included place identity ($\alpha = 0.86$) and place affect ($\alpha = 0.82$) with good reliability scores (DeVellis, 2012). Based on a scale of 1 for low place attachment and 5 for high place attachment, findings indicated a composite mean score of 3.6 for place attachment intensity (Standard deviation or SD = 0.64, n = 355). Place affect obtained a mean score of 3.8 (SD = 0.62, n = 355) and place identity (SD = 0.69, n = 354). Place dependence depicted a smaller mean of 2.9 (SD = 0.93, n = 351).

The 11-item general pro-environmental behavior scale achieved a Cronbach alpha value of $\alpha = 0.85$ while the 12-item park-specific pro-environmental behavior scale
obtained a Cronbach alpha value of $\alpha = 0.87$ considered good instruments (DeVellis, 2012). These Likert-type scales questioned participants about pro-environmental behavior intentions within the next 12 months. “Not probable” scored a one and “Highly probable” a five. General pro-environmental behavioral intentions accounted for a mean of 3.7 (SD = 0.68, n = 349), and the park-specific pro-environmental behavioral intentions scale obtained a mean of 3.8 (SD = 0.70, n = 344). A Pearson correlation between place attachment subscales, general, and specific pro-environmental behavioral intentions found significant positive relationships ($p < 0.001$) among constructs.

Although preliminary descriptive statistical analysis suggested that place identity and affect had stronger relationships with specific pro-environmental behavioral intentions, affect failed to predict pro-environmental behavior as it portrayed a more generalized role. Therefore, Halpenny (2010) suggested that “place identity plays in encouraging pro-environment attitudes and behaviors” (p.418).

**Summary**

The literature reveals how science education has slowly transitioned and become more engaging as it aids in the development of higher-order thinking skills that lead to reasoning. Changes in instruction have managed to convey a more active role in students as educators shift from being the providers of information to being the facilitators. Students could take charge of their education to feel empowered and responsible for what they learn and the extent of their learning.
Although content-based learning is essential and still a big part of science instruction, educators are welcoming the inclusion of socioscientific context to promote understanding and science literacy. As Zohar and Dori (2003) indicate, “understanding is seen as being constructed while learners engage in thinking and inquiry in contexts that make sense to them” (p.148). Therefore, the SSI approach has managed to provide educators with a way to bring relevance to content as students can relate the scenarios with real-life experiences, which may guide reasoning and decision making. Accounting for the ethical and emotional aspects embedded within the scientific enterprise, studies by Patronis et al. (1999), Kinslow et al. (2018), and Zeidler et al. (2002) demonstrated how these factors impact decision making and reasoning as students dealt with a local issue on the first two and evaluated information contrary to their beliefs on the last one. Discourse from peer interaction helped participants in these studies understand the complexity of an issue and the multiple perspectives conveyed. It also taught about the importance of ongoing inquiry and how to apply skepticism toward bias or contradictory evidence. These practices are the foundation of SSR.

Looking to measure SSR and variations in its dimensions, Romine et al. (2017) created a quantitative instrument that would assess SSR as one construct or a divided one, the QuASSR. Their study also involved a variation in the SSI contexts that were administered to participants which improved understanding of the issues, but unfortunately did not show changes in SSR. However, none of the SSI was related to local scenarios. Not only were water quality and fracking new topics for non-science majors, but SSI
negotiation was a novelty as well. Nonetheless, being a recently developed instrument, there are still other scenarios to explore.

In a study by Kinslow and colleagues (2018), the QuASSR with SSI on a local situation was integrated into a field-based learning summer course while engaging students in research and exploration. Students demonstrated improved SSR competencies over time as post-hoc analysis revealed statistically significant differences. Researchers also acknowledged that dealing with an immersive local environment increased motivation and interest. Emotional attachment or empathy towards the birds and the welfare of their environment might have inspired their lines of reasoning and eagerness to find a solution to the local controversy.

However, this begs the question of whether emotional attachment stems from dealing with a local scenario and a familiar setting. Williams and colleagues (1992) advocate that emotional bonds are associated with long-term relationships with a place like home and community. Kaltenborn (1999) and Halpenny (2010) explored whether pro-environmental behavior could relate to place attachment. Although there was no significant connection between these variables, findings did establish that sense of place helped participants become more aware of environmental conditions and possible impacts due to anthropogenic behavior. A strong sense of place became a good predictor of environmental impact since participants seemed more “rooted” and eager to solve the problems that directly affected them. In Halpenny’s (2010) study, place-specific pro-environmental behavior did seem to provide positive results, which the researcher advocated with place identity, whereas general pro-environmental behavior did not. Therefore, assessing the
place attachment of participants might help understand some of the influence behind reasoning and decision-making, which can reveal a different perspective on SSR assessment.
Chapter 3

Methods

Introduction

The focus of this study was to investigate whether place attachment influenced SSR of Puerto Rican high school students when negotiating with SSI depicting foreign or local real-world situations. The following research questions addressed the extent of place attachment of participants, SSR differences found pre and post-intervention, and those found between foreign and local SSI negotiation and discourse.

1. What is the extent of students’ place attachment to Puerto Rico?

2. Is there a significant difference in overall SSR between pre-test and post-test responses after local and foreign SSI negotiations?

3. Is there a positive correlation between place attachment and SSR changes between local and foreign SSI scenarios?

4. Are there significant differences in SSR between pre-test and post-test responses after negotiation across local and foreign SSI scenarios?

5. Do negotiation and discourse improve with SSI implementation of local and foreign scenarios?
This chapter gives an overview of the design of the study, a description of the target and accessible populations, instruments used in the study, and an explanation of data collection and analyses by research question.

Overview

A pilot study performed between January and February of 2018 (Villarin & Fowler, 2019) explored changes in relevant content knowledge, and SSR of Puerto Rican students enrolled in the tenth and twelfth grade in a small private school. Both the QuASSR and the SSI were introduced and tested. Although changes in relevant content knowledge were noticeable, SSR depicted no statistical significance after negotiation with SSI on a local coastal environmental situation. These results led to considering prolonging the intervention by adding a second SSI. The primary investigator’s observations suggested an emotional influence in the students’ lines of reasoning before and after the debate, especially in those familiar with the topic. Therefore, a second SSI on a local situation and two parallel SSI on a foreign scenario were added to ascertain any changes in SSR.

This mixed-method study used a pre-post-test design with five intact classrooms. All students enrolled in ninth-grade earth science, tenth-grade biology, and twelfth-grade environmental science participated in this study (Figure 2). The Identification with Place scale (Appendix A) provided information on place attachment of the students to their island. The QuASSR (Appendices B – E) measured SSR to compare any changes while students examined local or foreign environmental SSI. Considering that Puerto Rico is home to the participants, place attachment might influence decision-making as students
may feel more compassionate toward situations they are familiar with or those in their community. Therefore, correlation, independent sample t-tests, and analyses of covariance (ANCOVA) calculated quantitative differences between groups and scenarios before and after the intervention. Qualitative data would further inform changes in the lines of reasoning of participants and provide triangulation of results through reflective journals, debates, and interviews.

Figure 2

*Sample Population Allocated by Groups*

<table>
<thead>
<tr>
<th>Comparison Local</th>
<th>Grade - Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES Puerto Rico Parguera</td>
<td>9-1 9-2 10-1 10-2 12-2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment Foreign</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES Gener Indian River Lagoon</td>
</tr>
</tbody>
</table>

**Target Population**

The population of interest in this study was Puerto Rican high school students in Sabana Grande, a small town in the southwestern part of the island. High school students are typical participants of SSI research. However, there is still a lack of minority groups, such as Latinos, who are barely ever featured in science education research. This Spanish-speaking population of American citizens is unaware of the benefits of SSI. The financial
crisis and restoring of the island after a devastating hurricane should be motivation enough
to encourage the development of functional scientific literacy and the formation of
responsible future citizens.

**Participants**

The participants were from a small private high school in the town of Sabana
Grande, Puerto Rico. Due to over 200 school closings by the Department of Education on
the island (López Alicea, 2018), only one public high school was available in town. The
school chosen for this study is the best affordable private academic institution in Sabana
Grande. Enrollment increased as it accommodated students from middle to low social
status, thus fitting the demographics for the target population. Many of these students
would have been forced to a different, crowded school or one too far away from their
homes without the means of proper public transportation to get there. While other private
institutions can be found in surrounding vicinities, their cost is too high for financially-
disadvantaged families.

The accessible population consisted of 130 students. Parental consent was granted
to 124 students; 56 males and 68 females. The sample size following Cohen’s d table
(1992) referred to 64 as the least number of participants needed to run statistical analyses
in this study at the 0.80 power and a medium effect size with an alpha of 0.05.

There were no specific criteria assigned to the comparison and treatment groups. The
choice was randomly assigned (See Figure 2). The comparison group negotiated with SSI
on local environmental scenarios. One ninth-grade and one tenth-grade comprised this group. Those working with foreign environmental SSI were the treatment group. Therefore, one ninth-grade, one tenth-grade, and the twelfth graders made up this group.

Participants’ Demographics

This sample is representative of the target population as Puerto Rico, and the town of Sabana Grande are mostly made up of medium to low-income citizens. Based on data provided by the federal census of 2010, a socioeconomic study comparing Sabana Grande with Puerto Rico (July 2007) depicted 24.7% of citizens in Sabana Grande were under public assistance compared to 20.08% in Puerto Rico. Unfortunately, more updated information is not available. After Hurricane Maria in 2017, these numbers most likely changed as businesses closed down, leading to a massive exodus and a humanitarian crisis. According to the latest socioeconomic study from the school for the 2018-2019 academic year, 51.8% of its students are under the poverty level or come from families with financial disadvantages.

Also, although Puerto Ricans’ predominant religion is Catholicism, public schools do not include religion in their curriculum to promote free access to all. This small private school follows that norm, as well.

Instrumentation

During the pilot study at the beginning of 2018 (Villarin & Fowler, 2019), participants tested negotiating with a local SSI and completing the QuASSR. The SSI
featured a coastal environmental problem happening in La Parguera, Lajas, which is 15 miles away from the school. SSI are complex, open-ended societal issues with applicable connections to science ideas and principles which are subject to multiple perspectives and solutions (Zeidler, 2014; Sadler & Zeidler, 2005). This brief narrative talked about the dwindling of bioluminescence in this area, along with general background information on this situation. The SSI was appropriately validated and translated into Spanish to accommodate students’ native tongue.

Students completed the QuASSR using the computers available in the school’s library. The survey took each student approximately ten to fifteen minutes to answer. This questionnaire was administered before the intervention and one month later as a post-test. There were no major problems with the use of technology and the completion of the assessment.

**Quantitative assessment of socioscientific reasoning (QuASSR).** Socioscientific reasoning (SSR) refers to how citizens engage through multiple SSI (Sadler & Zeidler, 2009). The goal of SSI is to enable students to consider how science-based issues and the decisions made reflect their virtues and moral principles, as well as, the physical and social world they live in (Driver et al., 1996; Driver, Newton & Osborne, 2000; Kolsto, 2001; Sadler, 2004; Zeidler et al., 2005).

The QuASSR (Romine et al., 2017) is the only reliable quantitative instrument to measure the aspects of SSR. This assessment, comprised of a brief SSI and an ordered multiple-choice (OMC) questionnaire, has a Cronbach’s alpha average reliability of 0.79
across pre- and post-tests. Using two scenarios would increase the reliability of this instrument to a 0.82. The OMC contained ten items. The first-tier in the questionnaire inquired a yes or no question (e.g., Is the issue a straightforward one?). The second-tier question, with three response options, asked the participant to select the reason that best corresponds to the answer provided on the first-tier question. An additional item asked students to take a stance on the issue (Refer to Appendices B – E).

Points were allotted based on the levels of SSR: low (0 points), moderate (1 point), and high (2 points). For example, an item from the “Parguera” QuASSR asked if the problem had an easy solution. Students who chose, “Yes, an admission fee should be implemented to cover the costs of restoration,” received zero points. Those who chose, “No, because it involves balancing the economy with environmental action, legislation, and the possibility of relocating residents,” received two points.

The treatment and the comparison group completed two QuASSR’s each. The treatment group worked with foreign SSI within the QuASSR. The SSI focused on the deterioration of the Indian River Lagoon in Florida (Appendix E) and the health and environmental hazards generated by two thermoelectric coal companies erected along the beaches of two communities in Chile (Appendix C). The comparison group negotiated with two local SSI. Their QuASSR featured a coastal environmental problem in “La Parguera” (Appendix D), and the consequences brought about by ash disposal from a thermoelectric coal company established in Puerto Rico (Appendix B). Since Spanish is the participants’ native tongue, all four QuASSR survey instruments were translated and validated accordingly.
This survey instrument was answered online using Qualtrics software through paid licensing provided by Florida Tech. Therefore, each participant had a numerical code to protect their identity. Data gathered and stored is protected by a password on a personal device to avoid unauthorized access. Only the primary investigator will see the information and maintain the confidentiality of participants.

**Identification with place scale.** Although Puerto Ricans are American citizens, their culture and family-oriented upbringing form their identity. From a young age, parents instill a special appreciation for the island and everything that happens therein. Most Puerto Ricans tend to have a deep emotional connection with the island as they consider it their home. That emotional bond with a place leads to place attachment (Shamai, 1991; Williams, Patterson, Roggenbuck, and Watson, 1992). Since emotions seemed to influence reasoning and decision-making skills (Sadler, 2004), and pro-environmental behavior related to a specific place (Halpenny, 2010), this variable was added to the study.

The participants completed hard copies of the *Identification with Place* scale by Burdge and Luttkke (1972), which measured the extent of attachment towards the place of residence (Appendix A). This instrument consisted of a Likert-type twelve-item summated rating scale with five response categories: strongly agree, agree, neutral, disagree, and strongly disagree. There were eight positive place identification questions and four negative ones. Responses determined the extent of place attachment with Puerto Rico as scores fluctuated between 0 for strongly disagree and 4 for strongly agree. This scale had an excellent reliability coefficient of 0.99 (DeVellis, 2012) and was administered to all participants at the beginning of the study before working with SSI.
Coding evidence-based justifications. A rubric, based on a study by Sadler & Fowler (2006), assessed the number of evidence-based justifications that participants used to support their claims and defend their postures (See Table 1). This rubric tallied justifications as a pre/post measure in the reflective journal entries and the debates after SSI negotiation allocating different scores to each. Scores fluctuated between a 0 and a 4. Those claims that were not justified received a zero. Justifications with no grounds scored a one. Whereas those justifications supported by one, two, or more than two pieces of factual evidence obtained a two, three, and four, respectively. Misconceptions used to justify claims were not accounted in the final tally but classified separately. The primary investigator evaluated the transcriptions and coded the evidence-based justifications with the help of the NVivo qualitative analysis program.

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Translated excerpts in response to whether the “stilt houses” should be removed or not</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No justification</td>
<td>As a resident: “The stilt houses have to stay because they need to.”</td>
</tr>
<tr>
<td>1</td>
<td>Justification with no grounds</td>
<td>As a government agent: “The stilt houses have to be removed because they damage the ecosystem.”</td>
</tr>
</tbody>
</table>
repeating what teacher taught

2 Justification with one formal line of evidence
As an environmentalist: “The houses should not be there in the first place. That is the sea-land zone. The area is considered public domain according to law. No one can restrict my access to the beach.”

3 Justification with two formal lines of evidence
As a resident: “I will fight for my house. Before that memorandum (referring to “La Parguera Recreational Area Memorandum of Understanding” of 1978) was done, my house was already there. I inherited it! You cannot expect to enforce the law since my house was done before it. Also, my house is connected to the sewer system as the government asked me to… and how can you be so sure that my house is polluting? No scientific evidence says it is. I am staying!”

4 Justification with more than two formal lines of evidence
As a government agent: “The stilt houses are part of our culture (probably meant folklore). It helps with tourism and the economy. We need to amend the law and collect “CRIM” (municipal property taxes) from the residents…of the floating houses to help clean the
area. However, the houses cannot be removed because there is (marine) life underneath those structures that have been there for decades. It will be more costly if we do.”

Note: These excerpts come from notes taken by the primary investigator during the debates performed on the pilot study.

Treatment

The SSI activity comprised a period between five to seven days and required students to work in teams of four. During this time, the teacher became a facilitator. On the first day, students watched three 5-10-minute videos on the issue discussed. One video depicted a positive outlook on the situation while the second video focused on a negative one. The third video was neither positive or negative. After each video, the teams answered questions provided by the instructor regarding the credibility or veracity of the video content, and judgments on risks and benefits observed. (Refer to Appendix G)

Roles were assigned to each member as to provoke multiple perspectives on the issue and encourage discourse. These roles included looking at the situations as a citizen, member of an environmental advocacy group, a government official, or keeping a neutral stance as “the leader.” This way, “the leader” gathered the opinions and ideas from each “sector” and helped structure a defending position. This position, against or in favor, was
randomly picked from a box by the teams. Therefore, students had to defend the issue selected even if it was not from their standpoint.

On the second day, students explored three web addresses to specific online information on the assigned scenario. Like the videos, these websites would either favor or condemn the issue or do neither. This time, students summarized the position advocated, evaluated the veracity of the information, and the trustworthiness of the arguments in a reflective journal. Students researched two more websites to confirm further or deny the information read on the assigned websites and defend their positions. (See Appendix G)

On the third day, students compiled formal arguments to defend in a debate. The next two days consisted of group presentations to support or argue their stance on the issue with valid arguments and proper evidence from reliable sources. It was imperative for the teacher to remain neutral during SSI discourse and argumentation, but to encourage active participation through ongoing inquiry. The primary investigator provided proper training and observed the classes daily.

These activities took place in a regular classroom environment, and the allotted time was subject to change as each daily task needed to proceed in order to align with the logistics of the study. Most of the activities were performed in school to avoid stressing out students or getting them overwhelmed by the study. All the materials and resources used were also in Spanish.

The Identification with Place scale and the QuASSR pre-test were answered before the treatment. QuASSR post-tests were administered once the activities culminated. While
some students volunteered for the semi-structured interviews, others were appointed randomly to answer questions and provide feedback on the use of SSI in the classroom. For example, “Did you enjoy working with SSI on local (or foreign) issues? Explain; Did your reasoning ever change after discussing the topic with your peers? Explain.” Interviews were kept short, and inquiries did not include personal information. Reflective journals were collected and evaluated by the primary investigator to ascertain changes in SSR and views or thoughts before and after discussing the issues.

**Validity and Reliability**

**Survey instruments.** Four different professors validated each of the four SSI used in this study. Two professors validated the content, and two others would validate the English to Spanish translation. One limnologist and one environmental science expert, both residents in La Parguera, validated the content of this coastal scenario in Puerto Rico. Two professors from the Ocean Engineering department at Florida Tech validated the SSI content on the Indian River Lagoon. As for the thermoelectric coal company SSI, a doctor in environmental science and a doctor in chemistry validated the local and foreign scenarios. A doctor in Languages and two other professors whose native tongues are Spanish validated the Spanish translation of the SSI and the *Identification with Place* scale. The creator of the QuASSR, Dr. William Romine, granted the final validation of the SSI and the slight adjustments done to this assessment.

**Classes.** One teacher instructed high school science classes to all participants in the study. With over five years of teaching and tutoring experience and a degree in Biochemistry, she
was open to learning about integrating SSI in lectures. The traditional teacher-centered instruction continued before the treatment to provide content knowledge on the topic. During the treatment, the teacher became a facilitator using ongoing inquiry and challenging their evidence as to practice for the debate. The primary investigator, with a strong background in biology and environmental science, provided training before and during the study based on daily observations from class.

Performing the study with intact groups brought students of different intellectual abilities together. Some students remained quiet while others were more motivated to participate. Noticeably, students joined in the discussion when they felt more comfortable or knowledgeable about a topic. To promote participation, the teacher arranged students in heterogeneous groups. She also fostered tolerance and respect towards dissenting views during discourse in class and the debate.

Attrition was not a threat to internal validity. All students completed the semester while some were absent during testing, debate, or reflective journal days. To keep a consistency of data, those who missed one part of the pre or post measure were not in the final tally. For the debates, the leader of the group compiled all of the information from the members of the team. That way, if someone was absent, another member of the team could “play the role” of the student missing.
Data Analyses

**Research question 1.** The first research question, “What is the extent of the participants’ place attachment to the island of Puerto Rico?” addressed how strong the emotional bond of the participants was to their home. The context of SSI can trigger ethical and emotional reasoning in students’, especially when they can relate to a situation (Kinslow et al., 2018). By negotiating with local and foreign environmental scenarios, SSR changes may imply an influence from this variable.

The primary investigator tallied the results of the *Identification to Place* scale. The twelve-item scale (Appendix A) provided a score between zero and four per item. The range of scores fluctuated from 48-36 for high place attachment, 35-24 for moderate place attachment, 23-12 for low place attachment, and 12-0 for no place attachment. Students who did not fully complete the assessment got eliminated from the final tally.

**Research question 2.** The second question, “Is there a significant difference in overall SSR between pre-test and post-test responses after local and foreign SSI negotiations?” explored possible changes in SSR between groups before and after treatment. An initial framework suggested four aspects of SSR related to negotiation and resolution of SSI: recognizing the complexity of SSI, analyzing them through various perspectives, maintaining ongoing inquiry, and employing skepticism when reviewing bias information (Sadler & Zeidler, 2009; Sadler, Klosterman & Topcu, 2011; Romine, Sadler & Kinslow, 2017). Together they amount to an overall SSR score. Answers denoting basic SSR
received a score of zero, moderate SSR was 1 point, and high SSR was 2 points. The highest overall SSR score possible would be a 20.

The Qualtrics program automatically populates the data in an Excel spreadsheet. The program adds the values assigned to the items to find the overall SSR total on the pre-test and post-test. Later, the difference between these scores gets calculated. An independent samples t-test measured SSR changes between the treatment group negotiating with foreign issues and the comparison group dealing with the local issues.

**Research question 3.** The third research question, “Is there a positive correlation between place attachment and SSR changes between local and foreign SSI scenarios?” examined the possibility of a relationship between two ranked variables. In other words, measure the strength and direction of the association between both. The place attachment scale provided an ordinal variable due to the use of the Likert-type answer choice. It is difficult to determine if the same interval level exists between a “strongly agree,” and an “agree” than there is between an SSR interval of 2 or 1. A non-parametric Spearman rank correlation test would analyze the values from research questions 1 and 2 against each other. Place attachment and SSR values were tested between groups and between scenarios. Correlation values close to 1.00 would determine a relationship or possible influence between these variables.

**Research question 4.** The fourth research question, “Are there significant differences in SSR between pre-test and post-test responses after negotiation across local and foreign SSI scenarios?” assessed changes in SSR between negotiation with a thermoelectric coal
company SSI or a coastal environmental SSI. The ANCOVA statistical test examined QuASSR results while using pre-test scores to control for participants’ initial SSR. Therefore, significant differences would translate into SSR changes from foreign and local SSI negotiations.

**Research question 5.** The fifth question, “Do negotiation and discourse improve with SSI implementation of local and foreign scenarios?” evaluated changes in their lines of reasoning and evidence-based decision-making skills after treatment. For this qualitative part of the study, the primary investigator examined audio transcriptions of the debates, the interviews, and the reflective journal entries before and after the intervention. A rubric measured evidence-based justifications (Table 1) during each debate and journal entry on which students defended a position related to the SSI scenario assigned. Journal entries, written before and after the intervention, would assess changes in their informal reasoning after being compared. Finally, transcriptions of the semi-structured interviews provided information on their behavior towards the activity, changes in their lines of reasoning, and place attachment assessment to support quantitative findings.

**Summary**

This chapter described the methods and survey instruments used to explore whether place attachment had any impact on the overall SSR of high school students in Puerto Rico. It explained how participants’ responses toward local and foreign SSI would compare between groups and scenarios from pre and post measures. It described the development and validation process of the SSI, including the translation of resources like
the Identification with Place scale and the QuASSR. Finally, an explanation of the statistical analyses used based on each research question enabled a better understanding of this study’s purpose.
Chapter 4
Results

Introduction

Mixed-methods examined the effect of local and foreign SSI on SSR of high school students and determined place attachment to their home, the island of Puerto Rico. The results of the place attachment scale, the difference in scores between the QuASSR pre-test and post-test, and the use of a rubric during the debates to tally the amount justifications with proper evidence provided by participants comprised the quantitative part of the study. The qualitative part of this study involved the analysis of audio-recorded transcriptions from the debates, reflective journal entries, and semi-structured interviews with a high number of participants. Research questions one through four were analyzed using quantitative analyses, which included independent t-tests, Spearman $\rho$ correlation, and ANCOVA. Research question five provided the means to triangulate results and support quantitative analyses.

Quantitative Results

Research question 1: Place attachment. Research question 1 was, “What is the extent of students’ place attachment to Puerto Rico?” Students in the comparison group were exposed to local environmental SSI while the treatment group negotiated with foreign environmental SSI. According to Halpenny (2010), environmentally responsible behavior was likely among inhabitants of an area who were emotionally-attached to their dwelling and felt the need to take care of it. Thus, place attachment may influence decision-making.
Burdge and Ludtke (1972) created a place attachment scale to measure the extent of participants’ attachment to their place of residence. This instrument experienced changes to align with Puerto Rico’s attributes. There were eight positive place attachment questions and four negative ones to ensure the reliability of responses. Two professors versed in the Spanish language validated the instrument’s translation.

One hundred and six participants completed the Identification with Place scale (Appendix A). Scores fluctuated between a perfect 48 to a low 20. Findings revealed a sense of place attachment to the island of Puerto Rico as their home since no instrument registered a score lower than 20. Most students reflected a moderate (48.1%) or high (42.4%) place attachment. Only 9.4% of the sample revealed a low place attachment. None of the participants revealed not having place attachment to their island (Table 2, Figure 3). Therefore, place attachment to Puerto Rico is a characteristic that this sample shared.

<table>
<thead>
<tr>
<th>Extent of place attachment</th>
<th>Local</th>
<th>Foreign</th>
<th>Participants</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>15</td>
<td>30</td>
<td>45</td>
<td>42.4</td>
</tr>
<tr>
<td>Moderate</td>
<td>20</td>
<td>31</td>
<td>51</td>
<td>48.1</td>
</tr>
<tr>
<td>Low</td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>9.4</td>
</tr>
<tr>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total (N = 106)</td>
<td>39</td>
<td>67</td>
<td>106</td>
<td></td>
</tr>
</tbody>
</table>

Note: Local refers to the comparison group, while foreign represents the treatment group. The place attachment scale ranged from 48 – 0. High place attachment gauged
between 48 and 36, moderate place attachment between 35 – 24, low place attachment between 23 – 12, and no place attachment 11 and under.

Figure 3

*Place Attachment Scale Results by Groups*

Note: The graph illustrates data in Table 2 on the *Identification with Place* scale. With a total of 106 participants, results demonstrate moderate place attachment in 51 participants, high place attachment in 45, and low place attachment in 10. None of the participants showed having no place attachment to the island of Puerto Rico. The comparison group (local) had fewer participants than the treatment group (foreign).
Research question 2: SSR differences between groups after SSI negotiation.

Research question 2 was, “Is there a significant difference in overall SSR between pre-test and post-test responses after local and foreign SSI negotiation?” The QuASSR (Romine et al., 2017) is a valid survey instrument to assess SSR in participants before and after SSI negotiation. The comparison group analyzed the pros and cons of a thermoelectric coal company in Puerto Rico (Appendix B), and the second SSI featured a coastal environmental situation with the dwindling of bioluminescence in a southwestern region in Puerto Rico (Appendix D). The treatment group dealt with similar issues as students researched about coal power plants in Chile (Appendix C) and several environmental threats to the Indian River Lagoon and other aquatic ecosystems in the state of Florida (Appendix E). An independent samples t-test failed to determine changes in SSR between both groups after the intervention.

Total SSR scores from the pre-test and post-test were compared by groups. Therefore, both local and both foreign QuASSR results were compiled, and the differences examined. Eighty-five participants comprised the comparison or local group, while one-hundred twenty-eight made up the treatment or foreign group. QuASSR scores for the comparison group ranged on the pre-test from 2 to 17 and the post-test from 4 to 15. For the treatment group, scores fluctuated from 3 to 15 on the pre-test and from 2 to 16 on the post-test. Descriptive statistics in Table 3 illustrated a mean difference of 0.586 (SD = 3.18) for the treatment group and a mean difference of 0.765 (SD = 3.76) for the comparison groups in overall SSR scores. Normality, linearity, and equality of variance
assumptions were met. However, there was no statistical significance between the groups as \( p = 0.709 \).

| Table 3 |
|---|---|---|---|
| **Independent Samples T-test Values by Groups on Overall SSR** | | | |
| Overall SSR | Foreign | Local | Sig. (2 - tailed) |
| Pretest, Mean (SD) | 8.91 (2.86) | 9.01 (3.20) | 0.816 |
| Posttest, Mean (SD) | 9.50 (3.41) | 9.78 (3.26) | 0.556 |
| Difference, Mean (SD) | 0.586 (3.18) | 0.765 (3.76) | 0.709 |
| **Note:** The last column depicts no statistical significance (\( p < 0.05 \)). |

Post hoc analyses using dependent sample t-tests measured the possibility of SSR changes across pre and post-tests scores for each scenario. Though findings neglected to find significant changes across pre and post measures on the first scenario related to the thermoelectric coal plant, the second scenario on the coastal environmental issue revealed significance with a \( p \)-value lower than 0.05 and 0.01, respectively. The comparison group working with the local situation on La Parguera depicted a \( p = 0.019 \). Whereas, the treatment group dealing with the Indian River Lagoon situation obtained a \( p = 0.004 \). These values reveal changes in SSR that can be explored further in future research.

**Research question 3: Correlation between place attachment and SSR.** Research question 3 was, “Is there a positive correlation between place attachment and SSR changes between local and foreign SSI scenarios?” Changes in SSR relate to several factors, which
include patterns of informal reasoning, epistemological beliefs, moral sensitivity, and emotional attachment (Sadler and Zeidler, 2005; Fowler et al., 2009) to name a few. Further analysis to address the impact of place attachment to SSR led to assessing a possible relationship between these two variables. A nonparametric Spearman ρ correlation data analysis measured this possibility for two reasons. First, it is challenging to assess equivalence between each level on a Likert-type scale, and second, when evaluating assumptions, linearity was violated.

The primary investigator arranged the quantitative data by group and scenario. Participants’ place attachment score and total SSR scores by scenario were considered for this correlation test. The treatment group (N = 45) debated with the foreign scenarios related to the thermoelectric coal power plant AES Gener in Chile and the IRL coastal environmental situation. In contrast, the comparison group (N = 33) dealt with the AES Company in Puerto Rico and the coastal scenario on the threats to bioluminescence in Parguera, Puerto Rico. The Burdge & Ludtke (1972) place attachment scale indicated moderate place attachment scores for most participants, followed by high place attachment and low place attachment, respectively.

Findings revealed a negative correlation between foreign SSI and place attachment not observable in those who worked with local SSI (See Table 4). These values suggested that those with high place attachment reflected low SSR toward foreign issues or vice-versa. From the two foreign SSI, the one related to the thermoelectric coal plants in Chile depicted a significant correlation to the 0.01 level with a p = 0.009, whereas the IRL
situation showed a minimal negative correlation. Place attachment and SSR on local scenarios reflected minimal or no correlation between these variables.

<p>| Table 4 |
|----------------------|-------------------|
| Place Attachment and Correlation Results Between Scenarios |</p>
<table>
<thead>
<tr>
<th>Place attachment and SSR</th>
<th>Foreign SSI</th>
<th>Local SSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Power Plant</td>
<td>-0.386*</td>
<td>0.009</td>
</tr>
<tr>
<td>Coastal Health</td>
<td>-0.242</td>
<td>0.220</td>
</tr>
</tbody>
</table>

Note: *Correlation to the 0.01 level. Significance with p = 0.009

**Triangulation.** The primary investigator examined audio transcriptions from semi-structured interviews given to a random sample of participants from the treatment group and the comparison group. The sample included an equal number of male and female students to maintain the homogeneity of groups. A total of 76 participants comprised the treatment group, whereas the comparison group had 48 participants. Around 44% of the students that participated in the interview process were from the treatment group, and around 49% were from the comparison group. Those interviewed answered six questions after each SSI negotiation (See Appendix F).

One interview addressed the coal thermoelectric power plant scenario and the other the coastal situation issue. The last question on the interview assessed place attachment inquiring participants: “Would you rather have learned about (local or foreign) environmental issues? Why?” The treatment group, who dealt with a foreign SSI, was
asked if they would have instead learned about a local issue, and the comparison group, who negotiated with a local SSI, was asked if they would have instead learned about a foreign issue. These interviews were recorded and transcribed.

The primary investigator evaluated the answers to questions using the following criteria. Those participants who revealed that they would rather know about environmental issues on the island of Puerto Rico were grouped under having place attachment to their home. Participants who would have instead learned about foreign environmental issues were tallied under no place attachment. Finally, those who did not care whether the issue was local or foreign were identified as having a neutral stance. Values reflected a higher sense of place attachment from the comparison group, with 77.3% and 77.1% versus 50% and 41.8% from the treatment group after negotiating with each SSI (Figure 4 and Figure 5). These findings support results from the Identification with Place scale since a high percentage of participants claim to have some attachment to the island of Puerto Rico.
Interview Findings for Place Attachment after Coal Power Plant SSI

Note: Interview findings support the notion of participants’ place attachment to the island of Puerto Rico after SSI negotiation with their first scenario. The comparison group showed a higher percentage of attachment (77.3%), contrasting with the treatment group (50%).
Note: Interview findings after SSI negotiation with the second scenario on a coastal issue illustrate a high percent of place attachment among students in the comparison group (76%) while the participants in the treatment group reflected an equal distribution (33.3%) between having place attachment, no attachment, or being neutral.

**Research question 4: SSR changes across scenarios.** Research question 4 was, “Are there significant differences in SSR between pre-test and post-test responses after negotiation across local SSI and foreign SSI scenarios?” Comparisons of pre and post-test scores suggested possible differences in the data trends for the coal power plant scenario.
and those on the coastal environmental situation. An ANCOVA statistical analysis would examine these trends using the scenarios as the independent variables, pre-test measures as the covariates, and post-test measures as the dependent variables. Results in Table 5 are from students who completed both the pre-test and post-test. Scores for SSR fluctuated between 0 for low SSR, 1 for moderate SSR, and 2 for high SSR. Therefore, students could earn a maximum of 20 points, translating into high SSR.

However, pre-test SSR scores were generally low with group means fluctuating between 8.32 for the coastal scenario and 9.58 for coal power plant SSI. Although both groups showed improvements on the post-test measures with means between 9.59 - 9.64 respectively, the ANCOVA indicated that post-test scores were not significantly different (F = 1.860, p = 0.174) after accounting for pre-test scores as a covariate. This slightly minimal difference between raw mean SSR scores from the pre-test and post-test was consistent with Romine et al. study (2017) as means across SSR dimensions demonstrated this same pattern with the two scenarios used.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Pre and Post-test SSR Descriptive Analyses by Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios</td>
<td>Descriptives</td>
</tr>
<tr>
<td>Coal power plant (AES Gener, Chile, and AES Puerto Rico)</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
</tr>
</tbody>
</table>
Coastal situation (Indian River Lagoon, FL and Parguera, PR)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>106</td>
<td>8.32</td>
<td>2.93</td>
</tr>
<tr>
<td></td>
<td>106</td>
<td>9.59</td>
<td>3.35</td>
</tr>
</tbody>
</table>

Note: Although means in the post-test for both scenarios show a slight improvement from the pre-test mean, it was not enough to detect statistical significance.

Being that there was only one covariate, there was no need to check for correlation among covariates. The general distribution for each group appeared as a straight-line; thus, meeting the assumption of linearity. Finally, the homogeneity of regression slopes was tested through an interaction between the independent variable and the covariate. There was no significance in any of the sets of data. Assumptions for normality, linearity, and homogeneity of variance were met.

**ANCOVA between AES Puerto Rico and AES Gener in Chile.** The AES company has coal thermoelectric power plants in Puerto Rico and Chile. Similarities between the location of the power plants, environmental policies, and effects on the environment, water quality, and population were the main reasons for choosing this topic for an SSI. The language was also a crucial factor as students needed to scrutinize information, which would be better understood in Spanish being their native tongue.

A sample of 109 participants completed the QuASSR on foreign or local AES SSI, referring to Chile or Puerto Rico, respectively. Descriptive statistics depicted that the
treatment group, which worked with foreign SSI, obtained an $M = 9.50$, $SD = 3.52$, while the comparison group who worked with local SSI had an $M = 9.84$, $SD = 3.04$ reflecting a slightly higher mean.

**ANCOVA between La Parguera, Puerto Rico, and the Indian River Lagoon in Florida.** The coastal environmental situations explored related to a dwindling in bioluminescence intensity in La Parguera, Puerto Rico, and the eutrophication of the Indian River Lagoon (IRL) in Florida. Similarities between both scenarios featured economic and ecological value of these marine ecosystems, the effects of anthropogenic behavior, the government’s involvement in conservation efforts, and the impact due to global warming. These scenarios also provided information and resources in Spanish for students to explore. The primary investigator compared QuASSR overall scores for these coastal situations. An ANCOVA statistical analysis measured changes in SSR across these local and foreign issues. Assumptions were tested for, and none were violated.

A sample of 106 students completed the QuASSR on either the foreign IRL or the local Parguera coastal environmental scenario. Descriptive statistics show a $M = 9.50$, $SD = 3.32$ for the treatment group and a $M = 9.74$, $SD = 3.44$ for the comparison group. The mean is slightly higher for the comparison group who worked with local SSI.

Findings revealed that SSI negotiation fostered participants’ SSR. However, a high SSR level was unattainable by any of the groups. Although a slight increase in the mean of the comparison group was noticeable, it does not imply a difference in SSR across groups dealing with parallel issues.
Qualitative Results

Research question 5: Qualitative data results. Research question 5 was, “Do negotiation and discourse improve with SSI implementation of local and foreign scenarios.” The primary investigator examined transcriptions of students’ reflective journals and audio recordings of the debates and interviews looking to support quantitative data results and maintain reliability. Transcriptions were done in Spanish since it is the students’ native tongue and to avoid altering its “original content” through translation. Transcriptions were exported to NVivo 12 qualitative data analysis computer software and coded with a response rubric inspired by (Sadler & Fowler, 2006) (Table 1, Chapter 3). The rubric addressed the number of justifications with formal evidence provided by students on the reflective journals and debates. A university professor fluent in Spanish reviewed the rubric and examined the coding done by the primary investigator to ascertain accuracy before the final tally.

Reflective journal. A reflective journal completed before and after SSI negotiation was included in the study to complement findings from the debate. Participants adopted a stance, like those on the debate, regarding the topics featured in the SSI. Before learning about each topic, students were inquired about their positions on the use of coal to generate electricity and their points of view on the coastal situations. Their thoughts were displayed in writing as separate journal entries. After the debates concluded, students once again recorded their stance on the issues discussed. For each journal entry, students had around five minutes to write their thoughts.
Transcriptions on the journal entries were reviewed and scrutinized with the help of the rubric. The rubric (Table 1, Chapter 3) enabled the investigator to grant scores to entries that provided justifications with formal factual evidence. Scores fluctuated from zero to four. Answers with no justification would be worth zero points. Those on which justifications had no ground or repeated what the teacher had said in the lecture, were granted one point. These were expected to decrease after SSI negotiation. Justifications with one, two, or more than two formal pieces of evidence received two, three, or four points, respectively, anticipating gains after the intervention.

Findings refer to responses evaluated before and after intervention from the treatment group and the comparison group (Table 6 and Figure 6). Values suggested that the comparison group provided justifications supported by more formal lines of evidence than the treatment group. Although many students in the treatment group could not provide factual evidence-based justifications after intervention [Before + Code, After + Code] (B1 = 41%, A1 = 48.7%), this was not the case for the comparison group (B1 = 58.4%, A1 = 44.2%). The comparison group, dealing with local SSI, revealed improvement in number of justifications with formal evidence from before intervention (B2 = 31.2%, A2 = 36.4%, B3 = 9.1%, A3 = 14.3%, B4 = 0%, A4 = 2.6%). A higher percentage of misconceptions or incorrect facts were also detected in the treatment group, dealing with foreign SSI than the comparison group with 35.6% and 27.6%, respectively.
Table 6

Percent of Justifications in Journal Entries Before and After SSI by Groups

<table>
<thead>
<tr>
<th>Rubric Code</th>
<th>% Before SSI</th>
<th>% After SSI</th>
<th>% Before SSI</th>
<th>% After SSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6</td>
<td>3.4</td>
<td>1.3</td>
<td>2.6</td>
</tr>
<tr>
<td>1</td>
<td>41</td>
<td>48.7</td>
<td>58.4</td>
<td>44.2</td>
</tr>
<tr>
<td>2</td>
<td>35.9</td>
<td>33.3</td>
<td>31.2</td>
<td>36.4</td>
</tr>
<tr>
<td>3</td>
<td>15.4</td>
<td>11.1</td>
<td>9.1</td>
<td>14.3</td>
</tr>
<tr>
<td>4</td>
<td>1.7</td>
<td>3.4</td>
<td>0</td>
<td>2.6</td>
</tr>
<tr>
<td>False evidence</td>
<td>35.6</td>
<td></td>
<td>27.6</td>
<td></td>
</tr>
</tbody>
</table>

Note: Codes 0 and 1 refer to a lack of justification or having no grounds. Percents after intervention were expected to go down. Codes 2, 3, and 4 identify the use of evidence-based justifications. These percents after intervention were expected to go up. The comparison group, working with local scenarios, shows increased gains for the number of evidence-based justifications used after SSI negotiation (Codes 2, 3, and 4) and the absence of proper justifications (Code 1). Whereas, the treatment group, dealing with foreign scenarios, denotes improvement in the absence of proper justifications (Code 1), and the use of more than two evidence-based justifications (Code 4).
Results on Justifications' Use in Journal Entries Before and After SSI

Note: The figure depicts better results from the comparison group. The absence of or use of justifications with no grounds decreased from 58.4% to 44.2%, while the use of evidence-based justifications increased from 31.2% to 36.4%, 9.1% to 14.3%, and from 0% to 2.6% respectively after the intervention. Relying on false evidence to justify a posture was also lower in the comparison group, 27.6% versus 35.6% from the treatment group.

Entries from coal power plant scenario. Fragments from the reflective journal entries found below depict instances on which students’ lines of reasoning improved after negotiation and discourse with SSI. The first scenario evaluated the use of coal thermoelectric power plants to generate electricity. The question for the first journal entry before dealing with this scenario was, “Did you know that power generation through fossil
fuels is the most popular? Why do you think this is so? Do you feel this is the best option?”

After the debate and to close SSI negotiation, students reflected on a similar question, which asked, “After researching about coal thermoelectric companies, are you in favor of or against this kind of power generation? Why?” Please refer to the journal entries by the treatment group (Table 7) and the comparison group (Table 8) below.

<table>
<thead>
<tr>
<th>Student</th>
<th>Rubric code</th>
<th>Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td>208</td>
<td>1</td>
<td>“Yes, people think it is the best way to generate energy. Maybe it is a good way, but it is not because it pollutes. I do not think so (to be the best option) because it pollutes too much.”</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>“I am against because it affects the environment, especially the air. It affects people that have health conditions like asthma, allergies, etc. It also affects the beaches because when they absorb it (pollutants), small marine animals die. Although in Chile there is a lot of poverty and these power companies are cheaper, so they have to use them because people do not have much money to pay for a different one that does not use coal.”</td>
</tr>
<tr>
<td>228</td>
<td>1</td>
<td>“Yes, because fossil fuels are those mostly made up of carbon. I believe the best option is to use solar panels.”</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>“I am against because coal (combustion) releases ash. This fly ash, which is hazardous, causes people to have respiratory problems because you inhale the ash without even knowing it. The use of fossil fuels generates greenhouse gas emissions. Also, coal contains heavy metals, which can be hazardous.”</td>
</tr>
</tbody>
</table>

Note: Italicized font depicts false evidence.
These students are clearly against thermoelectric coal companies for their pollution. Initial comments were lacking substance and only displayed the students’ opinions receiving a one as they were justifications with no grounds. Comments after SSI negotiation depict evidence-based justifications gaining a 3 and 4, respectively. These entries are more detailed in identifying how pollution occurs, the health hazards the population is exposed to, and the production of greenhouse gases by this kind of power generation. Although Chile not only relies on fossil fuels to produce energy, the entry from student 208 reflects an emotional kind of response, assuming that residents do not have a choice, thus resulting in the use of false evidence.

Table 8

Entries from Before and After Intervention with Local SSI on a Coal Power Plant

<table>
<thead>
<tr>
<th>Student</th>
<th>Rubric code</th>
<th>Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td>304</td>
<td>1</td>
<td>“I did not know that power generation by fossil fuels was the most common. I believe it is a good option because it is cheap and good for nature.”</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>I am in favor of coal power generation because there are studies that prove that they (ashes) are not hazardous. <em>It is the easiest and cheapest way when it comes to power generation</em>, and it provides lots of job opportunities.”</td>
</tr>
<tr>
<td>313</td>
<td>3</td>
<td>“Yes, I knew that power generation through fossil fuels was the most common. It is disturbing that this is the oldest way to produce electricity. In my opinion, this form of power generation is inefficient because it creates so much pollution. There are other ways to produce energy that can be more efficient and helpful for the environment like solar and wind power, or even nuclear energy...”</td>
</tr>
</tbody>
</table>
would be better. Power generation through fossil fuels is the old way, and it should be changed with renewable energy methods.”

“I am against coal power generation. In my opinion, coal power generation should be forgotten and replaced. There are so many other ways of producing energy that is more efficient and clean. The ashes are hazardous even though AES and the EPA alleged they are not. The effects of the ashes were observed in the Dominican Republic. AES has committed atrocities everywhere they have disposed of them (coal ash). Residents have been diagnosed with asthma and cancer; children are born with malformations, abortions occur, and sadly others have died because of this. No community deserves this. Here in Puerto Rico, we have protested and made strikes against the ashes, but the government and AES ignore us by continuing to dispose of coal ash.”

Note: Italicized font depicts false evidence.

For years, Puerto Rico’s government has battled against ash disposal by the AES Company. With arguments and protests mostly against the company, this issue is still unresolved. The first student represented a team in favor of continuing to use coal for power generation in the island of Puerto Rico. His entry before the intervention had no grounds as the participant claimed affordability to be the reason for its widespread use. After SSI negotiation, though keeping some of the original flawed claims, the student referred to the Environmental Protection Agency’s regulations that classify coal ash as a non-hazardous waste resulting in one evidence-based justification. Participant 313, on the other hand, was against this kind of power generation in Puerto Rico from the getgo and provided more than one justification. The journal entry after intervention illustrated as
much emotion as the first entry. The student vividly described how the government and the AES Company had jeopardized the health of human beings to continue operating. Though moral sensitivity and empathy were noticeable, evidence-based justifications supported the claim.

**Entries from coastal health scenarios.** For the second scenario, students researched coastal environmental situations in Florida and Puerto Rico. As with the coal power plant SSI, participants completed journal entries before and after the treatment. For the Indian River Lagoon situation, the scenario related to the restoration plan on the reestablishment of the natural water flow, which would, besides other reasons, control the number of freshwater discharges and prevent the formation of toxic algae. Therefore, the discussion comprised other ecosystems like Lake Okeechobee and the Everglades in Central and South Florida, respectively. The question answered before SSI negotiation was, “Do you feel the construction of the levees (around Lake Okeechobee) by the U.S. Corps of Engineers was a good decision? Why?” After the treatment, students were inquired about this topic again. The question was, “After researching about the restoration plan on the water flow in Lake Okeechobee, are you in favor or against it? Why?” Refer to Table 9 for journal entries on this foreign scenario.
### Table 9

**Entries from Before and After Intervention with Foreign SSI on a Coastal Health Issue**

<table>
<thead>
<tr>
<th>Student</th>
<th>Rubric code</th>
<th>Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td>524</td>
<td>2</td>
<td>“I do not think it was a good decision to make the levee in the Everglades. I believe it was done to remedy a situation that was happening at that moment. They did not think about future consequences like the loss of organisms and the excess of pollution in and surrounding the Everglades.”</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>“I am still in favor of restoring the water flow from Lake Okeechobee to the Everglades because this goes beyond a small problem. It involves economic factors that need to be solved, but you also need to consider the organisms that are at risk. You need to keep most of these organisms alive to avoid extinction. Many people depend on the organisms that live here; without them, they have no way of earning a living. Also, altering the original flow of water has altered nature and this whole ecosystem.”</td>
</tr>
<tr>
<td>503</td>
<td>2</td>
<td>“I believe that constructing the levee was not a good decision. This levee has affected the natural flow of this body of water (Lake Okeechobee). Messing with the natural flow of water can cause major problems. For example, after (Hurricane) Maria, the rivers whose flow had been altered overflowed and caused much damage.”</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>In my opinion, they should not restore the flow. I feel that sea level will rise and that in itself will affect many people. Also, the animals that already exist there will get affected once they relocate them elsewhere. This (restoring) will not be cost-effective since sugar cane and citrus are harvested in the area. In conclusion, opening the levee will cause lots of problems that will affect other areas.”</td>
</tr>
</tbody>
</table>

Note: Italicized font depicts false evidence.
The Indian River Lagoon is comprised of three other large bodies of water on the eastern coast of Florida, making this a large and complex marine ecosystem. Students’ responses in their journal entries varied as some focused on the threats to the Indian River Lagoon, while others discussed the negative consequences brought to other ecosystems like the Everglades in southern Florida. Before learning about this topic, the Everglades were familiar to most students. However, no one had heard about the Indian River Lagoon. Therefore, journal entries like that of student 524 were typical as they assumed a connection between the aquatic ecosystems in Florida. Student 503, on the other hand, referred to a similar situation that happened in Puerto Rico after Hurricane Maria a year before, where human-made alterations to riverbeds made them prone to overflowing, leading to flooding and destruction. Meanwhile, journal entries after intervention displayed broader lines of reasoning considering not only environmental but economic factors, and even how global warming may alter the sea level eventually.

The local coastal situation featured possible causes for the dwindling of bioluminescence on the southwest coast of Puerto Rico. Journal entries (Table 10) illustrated their thoughts toward this situation before and after SSI negotiation. The first question was, “Do you believe that the stilt houses in La Parguera have affected the marine ecosystem or the bioluminescence? If so, how? Do you think they should be removed? Explain.” After the debate and the post-test, students answered this question, “After exploring further about bioluminescence and the stilt houses, do you believe they have had any effect on this bioluminescent ecosystem? Why?”
Table 10

Entries from Before and After Intervention with Local SSI on a Coastal Health Issue

<table>
<thead>
<tr>
<th>Student</th>
<th>Rubric code</th>
<th>Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td>118</td>
<td>2</td>
<td>“I believe that stilt houses have affected the environment. These houses can destroy the habitat for organisms. <em>The government wants to remove them.</em> Therefore, I feel that they harm other organisms. However, I feel these houses should stay because they are the home for some people. They can remove those houses that have been abandoned or are not in good shape.”</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>“I believe the houses have harmed bioluminescence and the mangroves. The lights affect the (bioluminescent) organisms, and the houses harm the mangroves just by being there. Also, if no harm were done, there would not be an issue in trying to remove them. These houses could have also altered the environment.”</td>
</tr>
<tr>
<td>116</td>
<td>2</td>
<td>“I understand that they have not affected bioluminescence because the houses have been there for a long time and <em>now is when people claim they affect the environment.</em> I fervently believe that what is causing this is boat traffic, which has increased immensely.”</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>“To my understanding, the stilt houses have NOT affected bioluminescence since there is not enough scientific research or tests to show they have caused harm. I am more inclined to believe that boat traffic has affected bioluminescence over the years. Lately, boat traffic has increased significantly.”</td>
</tr>
</tbody>
</table>

Note: Italicized font depicts false evidence.

The local issue in La Parguera, Puerto Rico, was very close to some of the participants as friends and relatives lived in the area. The stilt houses have existed for over
60 years. Therefore, most of the journal entries featured responses guided more by the ethical and emotional domains rather than scientific reasoning. Nevertheless, though lacking proper structure, both responses after intervention reflected evidence-based justifications when referring to light pollution, boat traffic, and mangrove removal as factors possibly affecting the dwindling in bioluminescence. Journal entries featuring misconceptions were not considered as formal pieces of evidence.

**Debates.** Participants debated in favor of or against each SSI scenario considered in class to conclude the intervention. The treatment group negotiated with the foreign issues on the coal power plants in Chile and the problems in the Indian River Lagoon in Florida. The comparison group dealt with the local issues of the coal power plant in Puerto Rico and the bioluminescence threat in La Parguera, Puerto Rico. Each group was divided into teams of four. Postures were picked randomly from a bag by a member of the team. Although teams would collaboratively research for evidence to defend their postures, each member took on a role. Role-playing allowed participants to distribute the work evenly. The roles consisted of researching as if they were nearby residents, government officials, or environmental advocates. The last member would act as the leader and the neutral member of the group who would compile the information and assure it fulfilled its purpose. Arguments were later scrutinized and scored using the responses’ rubric (Table 1, Chapter 3).

Findings indicated mixed improvement in the number of justifications with formal evidence between the first SSI on the coal power plant and the second SSI on the coastal situation for both groups. The treatment group revealed increases in producing justifications with two and more than two formal lines of evidence between the first and
second SSI negotiations (Table 11, Figure 7). The comparison group showed an increase only for justifications with one and two lines of evidence between the first and second SSI negotiations (Table 11, Figure 7). The use of responses with no justification or justifications with no grounds decreased in both groups from the first SSI debate to the second SSI debate. Misconceptions or false evidence were not accounted for as formal lines of evidence. Nonetheless, they were tallied to contrast any differences between SSI scenarios. For the treatment group, much more false evidence was provided in the first debate on the coal power plants in Chile, 54%, than the second debate on the Indian River Lagoon, 24%. As for the comparison group, they provided more false evidence on the second debate related to bioluminescence threats in La Parguera, 28%, than the power generation with coal issue in Puerto Rico, 21%.

<table>
<thead>
<tr>
<th>Rubric Code</th>
<th>AES Gener, Chile</th>
<th>AES, Puerto, Rico</th>
<th>Indian River, Lagoon, FL</th>
<th>Parguera, Puerto, Rico</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.3</td>
<td>2.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>20.1</td>
<td>8.5</td>
<td>13.3</td>
<td>16.3</td>
</tr>
<tr>
<td>2</td>
<td>22.1</td>
<td>21.3</td>
<td>13.3</td>
<td>32.6</td>
</tr>
<tr>
<td>3</td>
<td>31.2</td>
<td>27.7</td>
<td>30.1</td>
<td>28.6</td>
</tr>
<tr>
<td>4</td>
<td>24.7</td>
<td>40.4</td>
<td>42.6</td>
<td>22.4</td>
</tr>
</tbody>
</table>
Note: The treatment group working with foreign SSI demonstrated higher gains between the first and second SSI by using more than two evidence-based justifications. Their use of false evidence also decreased from the first to the second SSI. The comparison group showed a slight improvement in their use of one or two evidence-based justification by the second SSI.

Figure 7

Percent of Justifications Displayed on the Debates by Scenarios

Note: Each color depicts one rubric code from 0 – 4. During the first SSI negotiation, students worked with AES Gener and AES PR coal power plant scenarios. The other SSI
reflected parallels in the coastal health of ecosystems in Florida and Puerto Rico; the Indian River Lagoon and La Parguera, respectively. Variations in improvements are observable between scenarios and groups.

**Examples of debates on coal power plants’ use.** Audio transcriptions allowed the primary investigator to explore changes in the lines of reasoning and argumentation building through evidence-based justifications between scenarios. Students shared it was their first time experiencing more autonomous forms of learning were the teacher became a facilitator rather than the authority figure. Some expressed frustration creating formal arguments as they claimed to have no previous training or were not sure if their evidence was strong enough. The excerpts below in Table 12 and Table 13 portray examples from those not justified to those that used more than two formal pieces of evidence.

<table>
<thead>
<tr>
<th>Table 12</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Debate’s Introductory Remarks After Foreign SSI Negotiation on Coal Power Plants</em></td>
</tr>
<tr>
<td><strong>Student</strong></td>
</tr>
<tr>
<td>209</td>
</tr>
</tbody>
</table>
companies just warm the water. I have seen videos and people say nothing has happened to them. If the beaches are polluted, why don’t they (government) close them?”

“I am a resident who favors thermoelectric companies. These companies are good for me because my husband works in one, and he brings some of the ash to use it for gardening because it keeps the bugs away while it fertilizes. I live in the city of Coronel in the Biobio region, and the Bocamina coal power plant in Chile is right next to us. During the time we have been here, I have had no complaints. Everyone in my family is doing well, and nothing has happened. Thermoelectric companies do not affect me. I have a friend, my neighbor, who is pregnant. She has seen her gynecologist, and the baby is fine. She is doing well. People and studies say that coal ash can harm pregnant women, but as I mentioned before, my neighbor has not been affected by this. The power bill is still high, but it is because we are paying, not only for thermoelectric (coal) power generation but for other ways of generating power.”

“As a resident, it is tough having to pay a lot for power. Ever since thermoelectric coal companies arrived, it has become easier since it is cheaper, and we do not have to pay that much. Residents, before thermoelectric companies, complained a lot about paying
too much for power and were wondering if there was a cheaper way. When thermoelectric companies were established, well, the coal ash can help with fixing up our roads as they are not toxic. I have been living close to one for a long time and have never gotten intoxicated.”

“As a government official, I have to look after the welfare of my citizens. While being in charge, I cannot risk my residents’ health because of a thermoelectric company. Diseases related to (coal) thermoelectric power plants are many. I found about pulmonary and cephalic diseases, which are related to the pulmonary ones. These are due to arsenic emissions that can measure up to 235 – 225 pounds annually. The use of alternative fuels like “petcoke” produces emissions with large amounts of heavy metals like nickel, vanadium, lead, dioxin, and sulfur dioxide, which are hazardous to our respiratory system. Disease development can be cumulative or immediate. Thermoelectric companies have been in Chile for so long that the beaches have gotten contaminated through time while children are also born with respiratory disease. Other more serious consequences could be lung cancer and that is all I wanted to say.”

“I am an environmental advocate in favor of thermoelectric coal companies. Coal has its benefits as it is a material that forms organically and can decompose itself. Also, more than half of the
energy generation comes from coal. Prevention and decontamination plans have significantly reduced air pollution, improving the quality of the atmosphere. This includes the Clean Air Act, which stipulates that pollutant emissions should be labeled. This helps control pollution because if thermoelectric companies do not follow the rules, they will be fined. The goal is to protect people and prevent hazardous waste from reaching landfills. Coal ash has been classified as non-hazardous waste under the Toxicity Characteristic Leaching Procedure. According to this test, coal and fly ash are non-hazardous. Cleaner procedures in coal combustion for power generation have been developed to drastically reduce particulate matter, sulfur oxides, and nitrogen oxides which may lead to acid rain. These filters made of fabric are good in decreasing particulate matter since it gets trapped. To decrease sulfur oxides, desulfurization transforms these into other elements that are not that harmful. Finally, combustion, through a mix of fuel and air, control the nitrogen oxides.”

Note: The italicized font denotes false evidence.
### Table 13

*Debate's Introductory Remarks After Local SSI Negotiation on a Coal Power Plant*

<table>
<thead>
<tr>
<th>Student</th>
<th>Rubric code</th>
<th>Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td>321</td>
<td>0</td>
<td>“I am a resident, and I live on the beach, and nothing has happened because I am still whole! Coal has done nothing to me. A video of Chile talks about (the effects of) coal, but it has done nothing to me.”</td>
</tr>
<tr>
<td>109</td>
<td>1</td>
<td>“I am in favor of thermoelectric power plants. Practically, all power plants, whether it is coal, nuclear energy, geothermic, solar, biomass, and some natural gas ones, are considered thermoelectric companies. The heat of a gas turbine can be used to generate power, which is known as a combined cycle. This improves efficiency. Non-nuclear thermoelectric companies, particularly those from fossil fuels, are known as provisional thermoelectric companies.”</td>
</tr>
</tbody>
</table>
| 120     | 2           | “Agremax is an aggregate formed after a manufacturing process where water and by-product combine and chemically react to form this material. Coal ash from combustion is classified as non-hazardous waste, *which cannot affect us*. As a resident, I live close to the landfill and the pollutants and have had no problems. However, other people, like those who are against it, have had
issues. Senator Vargas Vidot mentioned that combustion by-products were non-hazardous and had its benefits. The president of AES explained that coal ash had been used in Puerto Rico to make concrete for sidewalks, as cover for landfills, and to make cinder blocks.”

“My group is against coal ash. In a special series about pollution in Puerto Rico and the Dominican Republic by coal ash, the hazards were related to health and the environment. People say AES has polluted underground water. In 2008, the EPA had already accumulated at least 70 cases on which ash, as coal by-product, had killed fish and polluted the soil. Ever since 2002, AES has produced between 400 to 1600 tons of daily waste from coal combustion. Between 2004 and 2011, approximately two million tons of ash of four million pounds of ash have been deposited in Puerto Rico by AES. According to the community, after these disposals, residents have faced health issues like skin disease, baby malformations, and miscarriages. This has been confirmed by the National Federation of Obstetrics and Gynecology, which warns about reproduction risks after being exposed to hazardous chemicals.”

“I am in favor of power generation with coal. Coal is one of the most abundant energy sources. Compared to petroleum and natural
gas, it is inexpensive. It can be transformed into a liquid or gaseous state. Energy production by coal with AES costs around 8 cents per kilowatt, while other energy sources fluctuate between 10 to 15 cents. AES generates 15% of the power on the island. AES provides jobs to around 2,500 Puerto Ricans. Carbon dioxide emissions… Excuse me, sulfur dioxide and nitrogen oxide emissions are six times lower than the federal limit. Two inspectors from the “Junta de Calidad Ambiental” (National environmental agency) visited AES in Guayama and overlooked its operation. They concluded that everything was well-controlled regarding the substances used. The clean coal technology protects the environment while it generates power. *This technology makes AES in Guayama one of the cleanest in the world, which means a better working environment for the employees."

Note: The italicized font denotes false evidence.

The recurring trend for both the local and foreign SSI on coal power plants’ use was the environmental factor. Students used pollution and the health hazards of coal combustion to defend their postures. These claims are not only factual but appealing to the emotional aspect of individuals. Supporting claims with scientific data like how ash is a non-hazardous waste under the Toxicity Characteristic Leaching Procedure, or how heavy metals are found in coal, and its by-products display further research on the topic. On the other hand, those in favor of thermoelectric coal plants for power generation resorted to the
economy’s welfare and how accessible coal is. Between both scenarios, the students
debating on the coal power plants in Chile struggled to defend their stances as many
arguments contained false evidence or misconceptions on the topic. Students possibly had
a hard time understanding the full extent of the issue since they were not familiar with the
country or its socioeconomic status.

**Examples of debates on the coastal health issue.** For this second scenario, students
worked with situations affecting aquatic ecosystems. Though the issues were not the same,
environmental parallels, including their ecological value, were similar. Tables 14 and 15
portray examples from argumentation used by teams to defend their postures. Every
participant provided justifications for their claims, as none received a code of 0. As with
the first SSI, misconceptions or false evidence were not accounted for as evidence-based
justifications.

<table>
<thead>
<tr>
<th>Table 14</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Debate’s Introductory Remarks After Foreign SSI Negotiation on a Coastal Issue</strong></td>
</tr>
<tr>
<td>Student</td>
</tr>
<tr>
<td>N/A</td>
</tr>
<tr>
<td>205</td>
</tr>
</tbody>
</table>
Those in the estuary. This is not good for the residents. This has been happening for a long time now, and some residents should live better.”

“As a resident, I am against the water flow (restoration). First, to complete the project, 23 thousand acres will get destroyed. Ten thousand out of those 23 are residential areas with around six thousand houses. How are you going to move that many people? Why are you going to destroy already built houses? Restoring the water flow will destroy the residential area. That is not a viable option. Actually, besides those 23, 60 thousand would be used in total to restore the water flow. That is a lot of acres! That will affect residents because it is residential, and it will affect farmers that have their farms there, so it will affect all of it. Okay”

“ Toxic algae are affecting four counties in Florida. The water looks dirty and rotten. The governor has declared a state of emergency in those counties. The algae are damaging the health of residents. In 2016, about eight manatees died, and many fish were about to die. I am in favor (of restoring the water flow) because the fish are getting harmed and the humans because it is causing health issues and they have to leave their counties and they will not have a place to live or where to live. I feel they need to restore it because the flow was better before. The water was not polluted, and fish were
well, and the plants grew, and the people did not get sick, so I feel they should restore it.”

“I am against the restoration of the water flow in Lake Okeechobee. Urbanization, agriculture, and economic development have threatened 67 species that lived in this natural, iconic park. Caimans are attractive for tourism. Activists warn that the plan may fail due to economic pressure and the rise of sea level due to climate change. Pathogens are organisms that cause diseases like viruses, bacteria, and parasites, which are in the water and are a hazard for swimmers, scuba divers, surfers, and those who eat seafood.”

Note: The italicized font denotes false evidence.

Table 15

*Debate’s Introductory Remarks After Local SSI Negotiation on a Coastal Issue*

<table>
<thead>
<tr>
<th>Student</th>
<th>Rubric code</th>
<th>Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>114</td>
<td>1</td>
<td>“I am against the relocation of the stilt houses because of one simple reason: I live there! During these ten years of living there, I have never seen pollution. I have a (stilt) house on the water. It is...”</td>
</tr>
</tbody>
</table>
mine, and I do not plan to leave it. As a resident, this is a conscious plea to defend what is better for my island and those who live here. These colorful stilt houses were erected over 60 years ago on the mangroves bordering the Parguera channel. As I mentioned before, I have not seen any pollution throughout the time I have lived here. If the houses are relocated, they will be taking my home away, and I will not have a place to go, and I really doubt the government will help me move.”

“These colorful stilt houses over the water on the mangroves in Parguera have been there for over 60 years, though their coexistence with the environment has always been an issue. Now, a bipartisan Senate initiative has promoted legislation to charge a leasing fee to those using the sea-land area, hoping to produce around three million dollars to help with the conservation of Parguera and the municipality of Lajas.”

“I am against the relocation of the stilt houses in Parguera. These stilt houses have basic services like water, sewage, power, and they even pay CRIM (municipal tax). These houses foster the socioeconomic welfare of Parguera. Some residents work as housekeepers, gardeners, carpenters, plumbers, boat mechanics, or own boat storage facilities. A recent study by Sea Grant at the University of Puerto Rico in Mayaguez and the ECO Company
found no decrease in the number of bioluminescent cells in 
Parguera. They found that during the rainy season, bioluminescent 
levels increase to levels over 10,000 cells per liter. However, 
during the dry season, levels are two times below those from the 
rainy season. Therefore, this means that the area still has favorable 
conditions to host these bioluminescent organisms.”

“La Parguera is a sea-land zone in Lajas, Puerto Rico. The Organic 
Law from the Department of Natural Resources depicts the 
requirements for the enjoyment of the public domain resources, 
including the territorial waters, the submerged waters, and the sea-
land zone. The Bioluminescent Bay in Parguera is one of the most 
important ecosystems in Puerto Rico. An article in “Primera Hora” 
(local newspaper) describes how one of the major threats to the bay 
has been light pollution. Light pollution must be reduced. Stilt 
houses may need to be removed to decrease the amount of light 
that pollutes the Bioluminescent Bay. Nonetheless, many of these 
stilt houses were erected in the mangrove area damaging this 
ecosystem. That is why I think they should be relocated. That is it.”

Note: The italicized font denotes false evidence.

Just like on the first SSI, emotive reasoning influenced their arguments. For the 
foreign issue on the Indian River Lagoon, students' main focus was human and animal 
welfare due to the pollution caused by the toxic algae. The primary investigator noticed
some confusion from students and the teacher as they were not familiar with this ecosystem in the state of Florida. Their lines of reasoning were variable as some felt the situation would put residents and the economy at risk with the restoration of the natural water flow but did not provide viable solutions. Nonetheless, some students showed a slight improvement in the number of evidence-based justifications compared to the first scenario.

On the other hand, the debate on the dwindling of bioluminescence in Parguera did not translate into much improvement from the first SSI for the comparison group. Few students achieved arguments with more than two pieces of formal evidence. Empathy influenced students’ lines of reasoning, as some found unfair having to relocate people from their homes while others felt the houses prevented their free access to the coastline as the sea-land zone is of public domain. A study by Zeidler, Herman, and Sadler (2019) found that decisions were less likely to become positive actions when participants had to sacrifice something personal. Many had relatives living in these stilt houses where they enjoyed summers or weekends. The fact that the stilt houses have been in Parguera for over 60 years makes them a cultural asset that everyone is used to seeing and one of the main attractions to the area. Similar to the treatment group, viable solutions were not fully developed, except for relocating the residents and minimizing boat traffic. False evidence derived from hearsay or blind faith as students found sources of information that would sometimes contradict each other. Though it was an environmental issue close to home, most had a hard time differing between the Parguera waterfront where the houses are located, and the Bioluminescent Bay. A visit to the area or an encounter with residents
could have helped acknowledge spatial issues that may have triggered different decisions and innovative solutions.

Summary

Participants demonstrated a sense of place attachment to the island of Puerto Rico, which was supported by the results of the semi-structured interviews. When analyzing the results for overall SSR between the pre-test and the post-test for both scenarios, the QuASSR depicted higher means in the second scenario. Still, differences were not enough to detect significance at a 95% confidence interval between groups or scenarios.

Nonetheless, a negative correlation between SSR and place attachment was observed from the treatment group in both scenarios. However, a $p = 0.009$ displayed significance at the 0.01 level from the treatment group toward the coal power plants issue in Chile, thus translating in an inverse relationship between place attachment and SSR. The comparison group did not reflect this negative correlation.

Journal entries and audio transcriptions of the debates comprised the qualitative data examined. Reflective journal entries denoted overall gains in the number of evidence-based justifications after SSI negotiation for both scenarios. Audio transcriptions allowed the primary investigator to scrutinize claims used by teams to defend their stances. Though argumentation building was challenging for many students, changes in discourse and debate between scenarios reflected improvement. Thinking skills became more holistic as participants considered the economic, ethical, social, and emotional aspects of the
situations affecting their community and planet. They learned to be more open-minded and respectful toward people with a different point of view. Finally, identifying reliable formal pieces of evidence to support claims indicated growth in students’ research skills.
Chapter 5

Introduction

The purpose of this study was to address whether place attachment influenced overall SSR as groups negotiated with local and foreign environmental SSI. This chapter first discusses the role of place attachment in the participants. Next, a comparison of SSR scores from this study to other science research will put into perspective whether SSI with familiar context impacted their lines of reasoning from groups working on local issues versus those dealing with foreign ones. Then a summary of the qualitative data results will assess changes in the participants’ lines of reasoning based on the number of evidence provided to defend their stances when negotiating with SSI. The chapter closes with a discussion of implications that place attachment has and how it relates to the context in SSI for (1) SSR in science education research and (2) its use by future educators.

Place Attachment and its Influence

Moderate and high place attachment to the island of Puerto Rico was predominant among participants of this study. However, a natural disaster, like Hurricane Maria almost a year before, may have affected students’ emotional attachment to their home and island. A disaster emotionally transforms people (Hobfoll et al., 2008). According to psychologist Prewitt Diaz (2017), Hurricane Maria negatively impacted the place and spirit of the people by fracturing “the social and psychological community networks,” as evidenced in the displacement of Puerto Ricans to the continental United States due to the disruption of
their daily lifestyle and their feelings of personal and financial safety. This forced migration became a crisis to some, causing stress and emotional apprehension (Burdge and Ludtke, 1972) as families divided or left everything behind.

On the other hand, Williams, Patterson, Roggenbuck, and Watson (1992) suggested that place attachment has a lot to do with the informal interactions between friends, neighbors, and co-workers. During the aftermath of Hurricane Maria, people joined efforts to rebuild their communities and slowly resume their lives, unveiling a resiliency that may be rooted in their love for the island and the desire to move forward. These positive actions were exemplary of who Puerto Ricans are. Since place identity defines who we are and how we behave (Proshansky, 1978), this could have rekindled or strengthened the connection to their homeland.

A Spearman ρ correlation reflected a negative correlation between SSR and place attachment for the treatment group who negotiated with foreign SSI. Thus, translating into an inverse relationship between these two variables for this group. However, the comparison group, who dealt with local scenarios for which most participants were familiar with, observed a slight or lack of correlation between place attachment and SSR. This emotional attachment to the island of Puerto Rico did not translate into higher SSR scores.

Dreyfus and Jungwirth (1980), as cited by Zeidler, Lederman, and Taylor (1992), observed variations in the way high school students reacted toward similar scientific situations presented in different contexts. Zeider et al. (2019) add that, in a sense,
variations in geographical area and culture influence how students engage with SSI. Results from this study support this statement. The local and foreign SSI depicted parallel environmental situations in different geographical areas. Responses from participants in the treatment group for both scenarios led to a negative correlation between SSR and place attachment.

Optimal results would feature a positive correlation from the comparison group between SSR and place attachment. However, this is not the case. Zeidler and colleagues (2019) determined that culture acts as a “double-edged sword” (p. 4) as it can strengthen personal identity but limit perspective-taking views that contradict with values and beliefs. The ability to evaluate multiple perspectives on an issue is vital in enabling SSR. A high sense of place may have limited open-mindedness in some participants. Kaltenborn (1998) concluded that sense of place was not a good predictor of environmental sensitivity even in those individuals who seemed more rooted and eager to make decisions on the conservation of an area close to their community. Although the use of local scenarios looked to motivate students and engage them in active citizenry, scores failed to correlate place attachment and SSR in the comparison group.

**Socioscientific Reasoning Assessment**

Socioscientific issues are brief yet complex narratives featuring a real-world problem for which there is no definite answer. Discourse and negotiation of possible solutions to the situation enable SSR (Sadler et al., 2011). Romine and colleagues (2017) agree that “measuring SSR is much more complex than measuring factual knowledge.”
The SSR construct demands the individual to exercise higher-order thinking while understanding the complexities and multiple perspectives behind the issue before making a decision. This combination of factors, also influenced by affect and ethical beliefs, aids an individual in making the best choice based on moral justice and fairness. To stimulate emotive reasoning and bring the relevance of content, the SSI created featured local environmental scenarios that shared similarities with situations in other geographical areas.

Socioscientific reasoning demands cognitive abilities that can reach performance levels representative of informed and sophisticated citizens capable of solving SSI (Romine et al., 2017). Therefore, although individuals reason at higher cognitive levels when they have significant knowledge or interest (Piaget, 1972, as cited by Zeidler et al., 1992), relevant content knowledge and understanding of a situation is not enough if the goal is to enable SSR. Research studies have also suggested minimal or no influence between content knowledge and argumentation quality (Sadler & Donnelly, 2006; Fowler, Zeidler & Sadler, 2008), while others claimed that the familiarity of the content of a problem influences how a student reflects or reasons about it (Zeidler et al., 1992). A pilot study done by the primary investigator (Villarin & Fowler, 2019) illustrated small gains in relevant content knowledge of students after negotiating with SSI for just four weeks. However, these gains did not translate into higher SSR for participants.

Puerto Rican high school students experienced an SSI-infused science class for ten weeks. Even though QuASSR post-test mean scores were higher than those from the pre-test in both groups, there was no statistical significance between the treatment and comparison groups after intervention. Romine et al. (2017) researched SSR changes on
non-science majors who were introduced to SSI on two global issues related to fracking and water quality. Kinslow, Sadler, and Nguyen (2018) incorporated local SSI into a field-based learning course. Although no significant changes in the QuASSR overall SSR scores were observed in either study, researchers acknowledged that dealing with a local situation hands-on increased motivation and developed some SSR competencies, leading to the inclusion of local environmental scenarios in this study.

Local SSI focused on the pros and cons related to the use of a coal power plant to generate electricity and the possible threats to the health of a marine ecosystem on the island. Foreign SSI featured parallels of the local situations in Chile and Florida, US, respectively. However, despite the differences in context, SSR scores in this study did not reflect a significant change across scenarios. Results from Sadler, Barab, and Scott (2007), Sadler, Klosterman, and Topcu (2011), and Romine et al. (2017) observed the same pattern across different SSI contexts.

Recent literature identifies three factors that may impede positive SSR changes after SSI negotiation, (1) limited engagement experiences, (2) lack of proper teaching training, and (3) failure to instruct or practice argumentation-building skills (Herman et al., 2018; Owens, Herman, Oertli, Lannin & Sadler 2019a; Owens, Sadler & Friedrichsen, 2019b; Peel, Sadler, Friedrichsen, Kinslow & Foulk, 2018; Zeidler, 2019). According to Cansiz (2014), as cited by Romine et al. (2017), an intervention length of 10 to 15 weeks is necessary to make advances in SSR competency. However, Zeidler et al. (2019) suggest learning experiences over 18 weeks or the course of a semester to support detectable SSR. Results from Zeidler, Sadler, Applebaum, and Callahan (2009) over a school year were
promising as significant gains in students’ reasoning were noticeable. Nonetheless, incorporating SSI for an extended period may cause discomfort among students who still see the teacher as an authoritarian figure or those who appreciate a variety of learning activities. Attitudes toward SSI negotiation varied between participants and should be considered when implementing this pedagogical strategy. Some felt overwhelmed and frustrated since they were not able to provide a “correct” answer, while others enjoyed debating and adopted a sense of rivalry. Therefore, SSI-infused curricula should be well-structured and include regular teacher-centered activities to keep students interested.

Teacher training in SSI is scarce, primarily when it deals with a population that has a different language and cultural background. To prompt and develop students’ SSR, teachers must engage in and model SSR (Owens et al., 2019a). Having the background knowledge and understanding of the content is not enough to enable SSR. Teachers usually experience hesitation when instructing SSI as they are taken out of their comfort zones while employing information and knowledge outside their scientific domains (Simmoneaux & Simmoneaux, 2009, as cited by Bayram-Jacobs et al., 2019) to encompass the moral, ethical, and financial aspects in these dilemmas. Also, the lack of resources or appropriate teaching material (Sadler, Foulk, and Friedrichsen, 2017) restrains further development of faculty who may be willing to adopt SSI as a means toward achieving scientific literacy.

Finally, some students considered the debate a challenge. Being something new for them, they felt uncertain and were looking to get validation from the teacher to their responses before defending their postures. When students lack the ability to evaluate
evidence, this can impact their quality of argumentation (Acar, Turkmen & Roychoudhury, 2010, as cited by Capkinoglu, Yilmaz & Leblebicioglu, 2019). Even after drawing upon pieces of evidence asjustifications, some participants' flawed reasoning or biased position, mainly toward local scenarios, led to weak arguments or explaining the issue from a single perspective. Socioscientific argumentation demands students to reflect upon social, economic, and moral evidence rather than scientific knowledge-based evidence (Sadler & Fowler, 2006) for which practice is necessary.

**Evidence-based Justifications**

High school Puerto Rican participants in this study assimilate teacher-centered instruction as their standard learning environment. This dependence challenges a student when introducing cross-curricular pedagogy (Zeidler & Nichols, 2009, as cited by Lee, Lee & Zeidler, 2019). Working with SSI demands students to shift roles as preceptors of knowledge while exercising underdeveloped skills, barely prompted in a regular classroom lecture. Although moral issues are involved in SSI negotiation and discourse, teachers do not instruct students what to believe but rather foster flexibility, open-mindedness, and perspective-taking abilities so they can integrate content knowledge with emotive and ethical influences (Kahn & Zeidler, 2019). Researchers often gauge the quality of argumentation by measuring a student’s ability to formulate counterpositions (Sadler & Donelly, 2006). However, during the primary investigator’s pilot study, most students relied on content understanding and dissection of evidence to defend their postures, construct their arguments, and exercise SSR. Any gains or changes in SSR require students
to understand the complexity of the issue, practice ongoing inquiry, evaluate evidence through multiple perspectives, and exercise skepticism. The processes behind this kind of informal reasoning are complex and require practice (Hollbrook & Rannikmae, 2017). Argumentation, through SSI negotiation, forces individuals to provide justifications based on reliable scientific evidence to defend a stance (Capkinoglu et al., 2019). Erduran and Jiménez-Aleixandre (2008) define argumentation as “the connection between claims and data through justifications or the evaluation of knowledge claims in light of evidence, either empirical or theoretical” (p.13). Therefore, to assess increases in the lines of reasoning as a means to develop SSR, a rubric (Table 1, Chapter 3) measured the number of evidence-based justifications provided by participants in the debate.

Since relevance influences intrinsic motivation (Hollbrook & Rannikmae, 2017), the SSI scenarios were picked based on important issues affecting the participants’ home, the island of Puerto Rico. Similar situations in Chile and the state of Florida comprised the foreign SSI. Thus, initially promoting a sense of relevance in students to stimulate self-determination that would aid in the reflection of issues with no particular solution. However, although the comparison group dealing with the local scenarios demonstrated higher motivation than those working with foreign issues, differences in the quality of argumentation between groups or scenarios were minimal. Research by Topcu, Sadler, and Yilmaz-Tuzun (2010, as cited by Capkinoglu et al., 2019), supports this premise as argumentation skills in students did not change within SSI context changes. Sadler and Donelly (2006) also lacked to find improvement in argumentation skills among students with significant gains in content knowledge, whereas those who received explicit
instruction in content knowledge and argumentation-building observed significant gains in both areas.

Although most students reflected increases in their lines of reasoning supported by evidence-based justifications, participants’ reactions toward the debate and the structuring of arguments varied. Being a novel way to learn science, most students showed interest in exploring more about the situations and finding evidence that could support their assigned postures. However, when randomly assigning postures, some seemed frustrated with the one gotten since they felt it was a weak position to win the debate, or it went against their preferences. This sense of rivalry was also present in a study by Lee et al. (2019), where middle school students wanted to appeal to their claims for winning even though each participant had a role and was aware of the multiple perspectives an issue could have. Others, perhaps motivated by obtaining a higher grade, managed to shift their viewpoints but lacking a genuine concern for the consequences of their actions. Kahn and Zeidler (2019) warned about this impacting SSR and suggested promoting moral development to further perspective-taking skills.

Moving from the scenario to trigger motivational scientific thinking that leads to conceptual science learning is heavily dependent on the skill of the teacher (Holbrook & Rannikmae, 2017). Although the teacher received training and guidance from the primary investigator, encouraging students to be precursors of learning, to be open-minded, and to exercise their emotional and moral domains in decision-making became a learning experience for her. She managed to shift from teacher to facilitator when required and kept a positive demeanor to maintain students’ motivation.
Research done by Herman, Owens, Oertli, Zangori, and Newton (2019) observed students employing simplistic linear causal explanations instead of expressing more multi-causal explanations about concepts despite experiencing significant educational interventions on complex biological phenomena. Zeidler et al. (1992) claimed that these errors were evident in students who lacked a conceptual framework about the structure of arguments. Therefore, the coded rubric classified arguments by the use of evidence-based justifications challenging students to scrutinize evidence and avoiding using propositions that seemed intuitively correct.

Participants exhibited gains in performing research and evaluating evidence, which is a fundamental step in the argumentation-building process. Although most students realized that problems are complex as they do not have just one solution, assessing the multiple perspectives and exercising skepticism may take longer to master. Results showed that reflective journal entries barely depicted changes in the number of evidence-based justifications used before and after intervention in both scenarios for the treatment group working on foreign SSI. In contrast, the comparison group illustrated a slight increase in the number of evidence-based justifications presented before than after SSI negotiation. On the debate, the treatment group demonstrated gains in the use of justifications between scenarios (Chapter 4, Table 11). A higher number of justifications were identified on the second SSI about the Indian River Lagoon than the first one on coal thermoelectric plants in Chile. However, the comparison groups presented more justifications on the first scenario about the thermoelectric coal plant in Puerto Rico than the second SSI on the coastal environmental situation in La Parguera. Close proximity and familiarity with this
area most likely enabled the emotional and moral domains in students as most arguments embodied a humanistic point of view and lacked the scientific-based evidence to support them. Misconceptions or false evidence were not accounted for. A longitudinal study may provide the opportunity to perfect the art of argument-building through evidence-based research.

Study Implications

Science education research. “Many environmental issues are considered SSI in that the STEM disciplines alone cannot resolve them” (Owens et al., 2019a, p. 1). The resolutions associated with these issues are burdensome as there are multi-faceted social, political, economic, and moral contentions to consider. SSI negotiation encompasses many skills that require proper instruction and practice. If the goal is achieving scientific literacy, students also need to learn about the underlying scientific and technological principles (Capkinoglu et al., 2019) embedded in real-world social contexts. Such skills are not innate to students (Bady, 1979, as cited by Zeidler et al., 1992). Thus, students and teachers need to be knowledgeable concerning the conventions of argumentation and formal logic. However, challenges like constraints in class time, students’ interests, and pressures to cover a variety of topics (Sadler & Donelly, 2006) impact the efforts of developing a culture of informed citizens.

Promoting SSR, especially among STEM learners, presents a potentially productive approach for environmental education since environmental SSI enhances environmental literacy, encourages civic participation, and advocates for sustainable living
(Owens et al., 2019), resulting in fruitful SSR. A six-week SSI-oriented mixed-methods study by Kinslow and colleagues (2018) on a field-based ecology class determined students’ SSR significantly increased across three of the four SSR dimensions of the QuASSR. Researchers noticed that this SSI approach, capitalizing on a local place-based context, increased environmental literacy as students’ writings evidenced close emotional connections with learning and environmental stewardship. Contextualizing science learning relevant to each student population, allows for opportunities to practice integrating scientific ways of thinking and practice with less formal reasoning (Owens et al., 2019b). The latest research in SSI advocates for place-based and informal science education experiences (Sobel, 2004; Herman, Zeidler & Newton, 2018; Herman et al., 2019; Zeidler et al., 2019) to connect students’ sense of place and attachment to the people and the environment affected by the SSI and its possible resolutions thus fostering ecological and cultural sustainability. Students benefit from immersive environments where they situate in authentic contexts while engaging in numerous direct experiences with those affected by SSI (Kurdyavisev, Stedman & Krasny, 2012 as cited by Herman et al., 2018; Zeidler et al., 2019).

Although place attachment triggered participants’ emotional and moral domain, the lack of direct contact with the area depicted in the local SSI may have narrowed students’ lines of reasoning as reflected by basic SSR scores after intervention. “Science classrooms can distance students from the lived socioscientific challenges their communities face” (Bang and Marin, 2015, p. 531, as cited by Herman et al., 2018). Students may not realize how crucial their contributions to finding desperately needed solutions are for future
generations. Therefore, future science education should focus on student engagement with SSI to develop precursors of change that understand their connection to the world and are willing to restore it by their actions.

**Teaching and learning.** Professional development to support SSI learning experiences is vital in the transformation of teachers into agents of change that can enable SSR and further scientific and environmental literacy. Specific examples of SSI teaching and learning that scaffold the understanding of the complexities behind this approach encourages its adoption in science classrooms (Peel et al., 2018). Lindahl, Folkesson, and Zeidler (2019) claim that teachers have to provide easily understandable prompts to students that will gradually guide them through the complexities of the SSI task without neglecting a student’s production of knowledge. Kahn and Zeidler (2019) explored the fundamental conditions needed in order to exercise perspective-taking and enable SSR. First, (1) students’ engagement through the context of the SSI as it has to be relevant to his or her virtues, (2) empathy or a shift in perspective from being the outsider to being in the “other person’s shoes,” and (3) the use of reflexive and reflective thought to exercise fairness and moral justice. Teachers and students need guidance in order to develop the SSR construct as some may be reluctant to steer away from traditional classroom practices. Others may claim to lack the expertise to either instruct or exercise discourse and debate requiring, at least, satisfactory argumentation skills.

Contextualizing environmental SSI promotes a sense of connectedness and compassion for nature, and the people impacted in the SSI as it triggers students’ affective and experiential ways of knowing (Herman et al., 2018). Research provides disparate
conclusions on the impact of context regarding SSR. Although SSR is transferable across SSI scenarios (Romine et al., 2017), a place-based, hands-on, and “minds-on” approach that demonstrated gains in SSR while using familiar local context to participants (Kinslow et al., 2018) is a promising route to explore.

Some students may feel a detachment between the SSI scenario and their lives (Zeidler et al., 2019) as both teachers and students assume new roles and responsibilities. This is a necessary shift to raise awareness of the problem and promote empathy among students as they place themselves within the scenario. Ideally, this shift encourages a positive transformation from reflection to action. However, to create safe classroom communities of learning around participation and mutual respect, teachers and students need guidance. Even experienced teachers struggle to yield productive learning outcomes since not every course of action is likely to benefit everybody equally (Owens et al., 2019b).

Although the high school science curricula in Puerto Rico has experienced minimal changes since the beginning of the twenty-first century, the focus is mainly on content knowledge and understanding. Factors like time-constraints, lack of professional development, and scarce locally-relevant educational resources impede the enabling of Bloom’s higher-order thinking skills, which are critical competencies of a well-rounded citizen. The science curricula could benefit from instruction that explains proper argument structure, scrutiny of the evidence, avoiding fallacious reasoning, and exercising coherence of claims (Sadler & Donelly, 2006), resulting in more fruitful SSR. Therefore, to raise the next generation of citizens capable of building an island in financial disarray and a world
under environmental stress requires a transformation from the traditional content-based science curricula to one that fosters life skills like decision-making, cultivated during SSI negotiation.

**Limitations and Suggestions**

The sample population is representative of high school students in Sabana Grande, Puerto Rico, involved in the use of an SSI-infused curriculum and may not be generalized to any other group. Puerto Rico’s detrimental financial situation led to the closing of 283 public, academic institutions for the 2018-2019 academic year (López Alicea, 2018). The Department of Education reported a decrease of 70,000 students between the spring and fall 2018 semesters (Caro González, 2018). The private school where the study took place is the largest affordable academic institution in Sabana Grande, Puerto Rico, which holds around 600 students. Mostly middle to low socioeconomic class students attend. The socioeconomic status report for the 2018-2019 academic year reflected that 51.8% of the student population attending this school came from financially disadvantaged families.

Though culturally homogeneous, performing the study with intact groups allowed for students of different socioeconomic status, and intellectual abilities to be present. Thus, some students remained quiet while others were more motivated to participate. As expected, students felt more eager to join in the discussion in areas where they were more comfortable or knowledgeable. Hence, the teacher displayed a positive demeanor, which created a pleasant learning environment fostering students’ confidence to share their views while using ongoing inquiry. This experienced teacher instructed all five intact classrooms
to help maintain validity. The primary investigator administered training before the semester started and during her office hours going over the progress in SSI negotiation and discourse. Since a teacher’s behavior in a classroom can benefit or hinder the performance of students and the way they learn (Van Tassel-Baska, Quek & Feng, 2007), the primary investigator consistently provided observations and feedback after class.

Science lectures and SSI negotiations were imparted in Spanish, as it is the students’ native tongue. Participants completed translated and validated versions of the survey instruments. Transcriptions from journal entries, interviews, and debates were coded in Spanish using the rubric on the number of evidence-based justifications (Table 1, Chapter 3) to avoid any differences brought about by a translation.

The use of an SSI-infused curriculum was new to students, and SSR results could be associated with the Hawthorne effect. To avoid this, every participant worked with two SSI, whether it was local or foreign. Every intact classroom practiced negotiation and discourse with related scenarios on environmental issues. Therefore, sharing similar experiences. Finally, answering an online survey was not only a novelty but a feat. The school’s library had 30 computers available shared by around 600 students. Therefore, the time it took to complete the QuASSR, around 8 minutes per student may have affected the students’ performance or focus.

A pilot study by the primary investigator did not bring about changes in SSR. However, only one SSI was administered and introduced to students on a local environmental scenario after a four-week exploration. Romine and colleagues (2017) and
Kinslow and colleagues (2018) cite Cansiz, who suggests an intervention length of ten to fifteen weeks to make practical advances in SSR. This 10-week study did not reflect significant changes in SSR between groups or scenarios. Although Zeidler et al. (2019) propose an intervention length of around 18 weeks to support gains in SSR, Kinslow et al. (2018) noticed an improvement in three out of the four SSR competencies in 19 high school participants after incorporating SSI onto a field-based learning environment for two summers. Therefore, those findings indicate that (1) smaller groups may benefit from more personal experience, while (2) immersive, engaging environments in authentic contexts can promote SSR to a higher degree than in formal classrooms.

The population sampled claimed to have difficulty with proper argumentation building. “Debates” for these students test their content knowledge and understanding of a topic without having to take sides. Therefore, this was new to them. Sadler and Donelly (2006) advocate for the inclusion of argument structure as part of the science curricula. Teachers need professional development that can engage them in SSI reasoning and the evaluation of science and non-science considerations (Owens et al., 2019a), which are involved in decision-making and argumentation. As teachers play the students’ role, they can familiarize themselves with the challenges and affordances of SSI use and what the SSR construct entails.

Finally, language and culture may influence an individual’s way of thinking and interacting with others. Bringing SSI to Puerto Rico, involved translating SSI into Spanish and bringing relevance in context through real-world scenarios. Looking to motivate students, local environmental scenarios affecting communities close to their area inspired
the SSI. Foreign SSI, on the other hand, were designed around parallels in their environmental circumstances and the availability of resources in the participants’ native tongue. However, Zeidler et al. (2019) claim that there is a “need for better understanding about how and why science views are contextually operationalized in tandem with social, cultural, and personal factors when people engage SSI” (Zeidler et al., 2019). Therefore, future studies should include creating and testing culturally-relevant SSI that spark awareness of local and global situations fostering transformative action among diverse populations.

**Summary**

One of the goals of contemporary science education is preparing students to become engaged citizens (Sadler, 2011). Providing personal and culturally-relevant context embedded in the scientific realm, through SSI, will not only create future informed citizens, but it will endow individuals with fundamental skills to succeed professionally. Chinn (2012) proposed that “a focus on real places and concerns empowers teachers as local experts and curriculum developers who are able to contextualize learning in students’ communities, practices, and cultural knowledge” (p.331); thus, a great foundation in the development of new socioscientific curricula that will foster SSR.

Though the findings from this study align with previous SSR research, place attachment was an unexplored variable. A place becomes a center of value that determines an individual’s behavior and actions due to its emotional connection (Tuan, 1977). The negative correlation obtained by the treatment group working on foreign SSI between place
attachment and SSR requires further investigation. According to the latest research (Herman et al., 2018; Herman et al., 2019; Zeidler et al., 2019), the new direction for SSI comprises place-based instruction with immersive experiences in local scenarios to foster selfless, sustainable action.

Socioscientific reasoning is a complex construct that needs dedicated teachers who will enable reflection of scientific and nonscientific considerations to make sound judgments. It is a challenging task, but a doable one. Professional development and SSI resources are scarce. However, converging the quantitative and qualitative data from this study revealed stronger emotional connections, awareness of environmental health, and a desire to make decisions for the welfare of their community. These are vital factors in achieving environmental literacy. Therefore, today’s educators are compelled to prepare the future generation not only to face the complexities of the modern, scientific world but to appreciate and value their surroundings, which make up a fraction of the world we all have to share and keep.
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### Appendix A

**Identification with Place Scale**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Completely disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Completely disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Of all the places I have been, I like Puerto Rico best.</td>
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<tr>
<td>People like me just belong in a place like this.</td>
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<tr>
<td>Puerto Rico is in my blood; it is really part of me.</td>
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<tr>
<td>I do not really feel any strong attachment to Puerto Rico.</td>
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<td>Whenever I die, I would like to be buried in Puerto Rico.</td>
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<tr>
<td>I have seen many places that I would really prefer to live rather than Puerto Rico.</td>
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<td>There might be things I would like to have, but Puerto Rico is mine, and I love it.</td>
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<tr>
<td>I think that I could be at home in any number of places away from here.</td>
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<tr>
<td>I have seen other places, but Puerto Rico is the only place I could call home.</td>
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</tbody>
</table>
I think that Puerto Rico is as good as another, so it does not make a difference where I live.

The memories I have of Puerto Rico are the best memories I have.

I really feel that I am a natural part of Puerto Rico.

Based on the *Identification with Place* scale by Burdge & Ludtke in:

<table>
<thead>
<tr>
<th>Preguntas</th>
<th>Completamente en desacuerdo</th>
<th>En desacuerdo</th>
<th>Neutral</th>
<th>De acuerdo</th>
<th>Completamente de acuerdo</th>
</tr>
</thead>
<tbody>
<tr>
<td>De todos los lugares en los que he estado, Puerto Rico es el mejor.</td>
<td></td>
<td></td>
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<tr>
<td>Personas como yo pertenecemos a un lugar como este.</td>
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<tr>
<td>Puerto Rico está en mi sangre, realmente es parte de mí.</td>
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<tr>
<td>Realmente no tengo un enlace fuerte con Puerto Rico.</td>
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<tr>
<td>Cuando muera, me gustaría ser enterrado(a) en Puerto Rico.</td>
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<tr>
<td>He visto varios lugares en los que preferiría vivir en vez de Puerto Rico.</td>
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<tr>
<td>Aunque hay muchas cosas que me gustaría tener, Puerto Rico es mi isla y la adoro.</td>
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<tr>
<td>Pienso que pudiera sentirme como en mi hogar en cualquier otro lugar alejado(a) de aquí.</td>
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<tr>
<td>He visto otros lugares, pero Puerto Rico es el único que puedo llamar hogar.</td>
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</tr>
<tr>
<td>Entiendo que Puerto Rico es tan bueno como cualquier otro lugar, por lo que no hace diferencia escoger donde vivir.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Los recuerdos que tengo de Puerto Rico son los mejores.</td>
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</tbody>
</table>
Siento que soy una parte natural de Puerto Rico.
Appendix B
QuASSR on AES Puerto Rico

ENERGY FROM COAL IN PUERTO RICO

Puerto Rico is an island located in the Western Hemisphere between the Atlantic Ocean and the Caribbean Sea. It is the smallest of the Greater Antilles with 3,515 square miles. Home to around 3.5 million people, the demand for energy is high. As a country that relies on fossil fuels imported from the United States, it ends up being quite costly. People in Puerto Rico already pay more for energy than any other state in the United States except for Hawai’i. To lower cost, the town of Guayama welcomed Applied Energy Systems (AES) and their energy plant powered by coal. Claiming cheaper and cleaner energy, in 2002, a contract with the Puerto Rico Electric Power Authority (PREPA) sealed the deal.

Environmental organizations and inhabitants of nearby communities protested against potential threats to their health and quality of life, AES promised to abide by state and federal regulations as their main goal is the safety and security of everyone. Being so close to the coastline to facilitate the shipment of coal and erected on top of an already impacted groundwater reservoir, environmental damage, including water quality, was again a concern. Back in 1995, the Environmental Protection Agency (EPA) had ordered Chevron Phillips Chemical Company mandatory corrective action after detecting the presence of volatile and semi-volatile organic compounds in groundwater, soil, and sediment within the facility. AES is located feet away from where Chevron Phillips used to be.
AES claimed to be the first company to use water from discharges to assist in the combustion of coal. Therefore, water discharges would not end up in the ocean. As a by-product, bottom ash (heavy) and fly ash (light) with varied chemical compositions were produced. Ash disposal, as agreed in the contract, was done outside of Puerto Rico even though the EPA does not consider ash to be a hazardous waste. No one knew where the ashes ended up until news of a $6 million settlement by this company and the government of the Dominican Republic shed light on the company’s disposal practices.

As no other feasible alternative was found, ash disposal had to be done in Puerto Rico. Even though AES claimed that the EPA and the “Junta de Calidad Ambiental” (JCA) regulations were being followed, protests fired up once again. This time, the residents of the communities close to the landfill did not want to suffer the same fate as their neighboring country. Adding to this, an investigation done in 2016 by the University of Puerto Rico Medical Science Campus revealed a higher incidence of respiratory problems, skin ailments, and cancer in citizens living close to AES as they are exposed daily to fly ash.

Due to these circumstances, Governor Alejandro Garcia Padilla signed a law that prohibits ash disposal on the island. Therefore, AES hired EC Waste to assist and changed their disposal practices coming up with a solidified coal aggregate used in the production of concrete and board walls called Agremax. This way, ash disposal would be eliminated for good. Nonetheless, the fully-lined, EPA-approved Peñuelas Valley Landfill that collects the Agremax is erected on top of groundwater, seven kilometers away from the
coastline, and an hour away from the AES company site. Should citizens be concerned about this whole issue?

**SSR Aspect: Complexity**

1. Is the issue of power generation through coal a complex one? YES/NO

   NO: Select the response below that best explains why the issue of power production through coal is a straightforward one.

   a. Puerto Rico is already paying too much for energy, and coal manages to alleviate this financial burden. Why should consumers pay more? (0)

   b. Coal is the dirtiest and most lethal form of energy production as it pollutes the air and water supplies. Coal should not be an option for generating electricity. (0)

   c. Generating energy through coal combustion has been a controversial issue, but new technologies and green practices can lay concerns to rest. (0)

   YES: Select the response below that best explains why the issue of power production through coal is complex.

   a. Electricity generated by coal is complex because political and economic interests can be complicated to deal against. (2)

   b. Electricity generated by coal is a complex issue because of the multiple tradeoffs related to the supply of energy and environmental impacts. (1)

   c. The issue is complex because there are as many positives as there are negative consequences to this practice. (1)
2. Is the issue of energy generation through coal in Puerto Rico easy to resolve?

YES/NO

NO: Why is the energy production through coal issues in Puerto Rico difficult to resolve?

a. Because it involves balancing the environment, the economy, political issues, and energy demand. (2)

b. Because environmental concerns, financial interests, and energy demand are complicated topics by themselves. (1)

c. The case does not provide enough information on this topic to reach a solution. (1)

YES: Why is the energy production through coal issue in Puerto Rico easy to resolve?

a. Because coal is the only alternative available in Puerto Rico to lower the cost of energy, therefore, it should be allowed. (0)

b. Because coal combustion for generating energy creates by-products that can lead to serious health and environmental problems, therefore, it should stop. (0)

c. Because representatives from every sector can evaluate the situation and establish an agreement with the government that can benefit everyone. (0)

SSR Aspect: Perspective-taking

3. How likely is it that environmental groups and the executives of Applied Energy Systems (AES) endorse the same solution to this problem?

a. It is very likely that environmental groups and AES would endorse the same solution.

b. It is not very likely that environmental groups and AES would endorse the same solution.
Why is it **very likely** that the environmental groups and the executives of AES endorse the same solution?

a. Both groups can work on finding a solution and coming up with a plan. (0)

b. A forum for open discussion between groups will foster reaching a solution. (0)

c. A neutral entity can listen to both parties and come up with a mediation plan. (0)

Why is it **not very likely** that the environmental groups and the executives of AES endorse the same solution?

a. Environmental groups and AES have very different priorities. (2)

b. Environmental groups and AES have not had a chance to meet. (0)

c. AES claims they are following policy while environmentalists do not think so. (1)

4. How likely is it that the community residents and representatives from AES would endorse the same solution to this generating electricity by coal issue?

a. It is **very likely** that the community residents and AES would endorse the same solution.

b. It is **not very likely** that the community residents and AES would endorse the same solution.

Why is it **very likely** that the community residents and the executives of AES endorse the same solution?

a. Both groups can work on finding a solution and coming up with a plan. (0)

b. A forum for open discussion between groups will foster reaching a solution. (0)

c. A neutral entity can listen to both parties and come up with a mediation plan. (0)
Why is it not very likely that the community residents and the executive of AES endorse the same solution?

a. Community residents and AES have very different priorities. (2)

b. Community residents and AES have not had a chance to meet. (0)

c. AES claims they are following policy while residents do not think so. (1)

SSR Aspect: Inquiry

5. If you were asked to make a decision on whether AES should stop or continue operating in Puerto Rico, do you feel as though you have enough information to make a decision?

I feel I have sufficient information to make a decision on whether AES should stop or continue operating.

I do not feel I have sufficient information to make a decision about whether AES should stop or continue operating.

Why is there sufficient information to make a decision about whether AES should stop or continue operating?

a. Both the EPA and JCA certify that AES is following environmental policy; therefore, there is nothing to worry about. (0)

b. Cheaper energy alternatives are needed. If not, Puerto Rican citizens will not be able to afford this basic need. (0)

c. Risks to the health of residents and water pollution are clear and have a negative impact on the human quality of life. (0)
Why is there **not sufficient information** to make a decision about whether AES should stop or continue operating?

a. The Chevron Phillips Chemical Co. polluted the groundwater and not AES. Also, there is no evidence of groundwater contamination from the Peñuelas Valley Landfill, so I need more information on water quality before I can decide. (1)

b. Long-term benefits and risks of power generation by coal are unclear; therefore, more studies need to be done before I can reach a decision. (2)

c. No information on how much more citizens would have to pay for energy without AES is provided, so it is unclear. (0)

6. If you were forced to decide whether AES should stop or continue operating based on the information in this article, what decision would you make?

   a. AES should stop operating (0)

   b. AES should continue operating (0)

7. Do you think AES, community residents, environmental groups, and the government would agree with your decision?

   I feel all parties would agree with my decision.

   I feel one or more parties would not agree with my decision.

   Why would all parties agree with my decision?

   a. If all parties looked at the issue without bias, then it is clear that AES is causing more harm than good. (0)
b. If all parties looked at the issue without bias, then it is clear that the benefits of generating power through coal outweigh the risks. (0)

c. All parties will agree after a thorough explanation of my reasoning. (0)

Why would one or more parties likely not agree with your decision?

a. Certain parties will disagree because they do not have a proper understanding of risks and benefits. (1)

b. It is unlikely that they all agree since the decision will not benefit everyone. (2)

c. It is unlikely since all parties have different priorities, but eventually, they will understand my decision. (0)

8. If the decision you made on whether AES should stop or continue operating were put into action, would you recommend that additional funds and resources be used to continue studying the effects of coal combustion by-products to the water quality and health of nearby residents?

I **would not recommend** continuing to study the effects of coal combustion by-products to the water quality and health of nearby residents.

I **would recommend** continuing to study the effects of coal combustion by-products to the water quality and health of nearby residents.

Why would you **not recommend** continuing to study the effects of coal combustion by-products to the water quality and health of nearby residents?

a. A decision has been reached, so there is no need for these studies. (0)

b. The information was clear and complete to make a decision; therefore, those funds should be used for something more profitable. (0)
c. No studies should be done, especially by foreign investigators. (0)

Why would you recommend continuing to study the effects of coal combustion by-products to the water quality and health of close-by residents?

a. Studies will clarify any confusion allowing people to re-evaluate and understand the validity of my decision. (2)

b. Studies will help foster discussion and address questions or concerns about my decision. (1)

c. Studies should be done only if Puerto Rican students are hired as investigators. (0)

SSR Aspect: Skepticism

9. At a town meeting, a group of scientists hired by AES and another group of scientists hired by the environmental groups and nearby residents provided expert opinions on the coal combustion by-products and their effects. Would you expect their opinions to be similar?

Expert opinions offered by the scientists employed by AES and those employed by the environmental groups and residents will likely be similar.

Expert opinions offered by the scientists employed by AES and those employed by the environmental groups and residents will likely not be similar.

Why would the opinions of both groups of scientists likely be similar?

a. Data is data; and if they are monitoring the same area, they should be getting the same results. (0)

b. Even if their results differ slightly, they can come to an agreement once they are shared. (0)
Scientists base results on objective data and actual findings; therefore, both opinions should be similar. (0)

Why would the opinions of both groups of scientists **not likely** be similar?

a. Even if their results differ slightly, they can come to an agreement once they are shared. (0)

b. Results might bring about positive and negative outcomes that might be difficult to explain, leading to different opinions. (1)

c. Opinions will be based on each of the groups’ interests and goals; therefore, they will not likely be similar. (2)

10. In response to the criticism about the effects of the coal ash on the quality of life of nearby residents, AES should consider using part of its profits to hire a team of epidemiologists to collect data on the illnesses affecting nearby residents and giving regular reports to the local community. The environmental groups and community residents consider hiring a different group of epidemiologists to conduct a similar study. If this were to happen, would you expect the findings of these two groups of epidemiologists to be similar or different?

I **would expect** the findings of the two groups of epidemiologists to be the **same**.

I **would expect** the findings of the two groups of epidemiologists to be **different**.

Why would you expect the findings of both groups of epidemiologists to be the **same**?

a. If the process is done correctly then findings should be the same. (0)

b. Both groups are investigating the same subjects; therefore, findings should be the same. (0)
c. Even though some data might not be the same, after a thorough analysis, findings should match between both studies. (0)

Why would you expect the findings of both groups of epidemiologists to be different?

a. Epidemiologists have been hired by entities with different priorities; therefore, findings will favor each one’s interests. (2)

b. Findings may be different depending on the data collection methods used. (1)

c. AES can pay epidemiologists more money; therefore, their findings may be more reliable than those epidemiologists paid by the environmentalists and residents. (0)

11. An ecologist at a prestigious university publishes an article in a top-ranked journal confirming the toxicity of coal ash and its imminent threat to water and air quality.

Do you think this will change the debate?

I would expect the new findings to change the debate.

I would not expect the new findings to change the debate.

Why would you not expect this to change the debate?

a. A contract cannot be broken, especially when AES has followed environmental policy. (0)

b. This ecologist is an outsider, and the study was not done in Puerto Rico; therefore, it does not apply to this situation. (1)

c. Opposing parties are already convinced that their findings are correct, and they will not consider additional studies. (2)
Why would you **expect** this to change the debate?

a. These findings will become an important piece of evidence that opposing parties will use to strengthen their case. (2)

b. This study will allow all parties to recognize the threat that coal ash represents, and corrective action will be taken. (0)

c. The opposing parties will interpret findings differently and find flaws that will drive them further from a solution. (1)
LA “CARBONERA” EN PUERTO RICO

Puerto Rico es una isla localizada en el hemisferio occidental rodeada por el Océano Atlántico y el Mar Caribe. Es la más pequeña de las Antillas Mayores con 3,515 millas cuadradas. Con una población de 3.5 millones de habitantes, la demanda por electricidad es alta. Debido a la excesiva dependencia de combustible fósil, importado de los Estados Unidos, el costo de energía es elevado. Los habitantes de Puerto Rico pagan actualmente más por la energía que cualquier estado de los Estados Unidos con excepción de Hawaii. Para reducir costos, el gobierno de Puerto Rico y la ciudad de Guayama le dio la bienvenida a la planta de generación de energía por carbón Applied Energy Systems (AES). Con la promesa de energía limpia y accesible, AES firmó un contrato en 2002 con la Autoridad de Energía Eléctrica (AEE).

Mientras grupos ambientales y residentes de comunidades aledañas protestaban en contra de los efectos que esto pudiera traer a su salud y calidad de vida, AES prometía cumplir con todas las leyes y regulaciones ya que la seguridad de todos era primordial para ellos. Debido a su localización cerca de la costa facilitando la importación de carbón y sobre un acuífero ya afectado por otra compañía, el daño ambiental y la calidad de agua fueron nuevamente una preocupación. Para el año 1995, la Agencia para la Protección Ambiental (EPA por siglas en inglés) exigió acción correctiva por parte de la Chevron Phillips Chemical Company luego de detectar la presencia de compuestos orgánicos volátiles y semi-volátiles en las aguas subterráneas, el suelo y el sedimento que
comprendía sus facilidades. AES fue erigida a píes de distancia de donde Chevron Phillips estaba localizada.

AES se distinguía por ser la primera planta de generación de energía que utilizaba aguas usadas durante el proceso de combustión de carbón, por lo que las descargas no terminaban en el mar. Como producto residual, ceniza pesada y liviana con diferentes composiciones químicas se generaban. La disposición de ceniza, como acordado en el contrato, se realizaba fuera de Puerto Rico aunque la EPA no consideraba la ceniza como desperdicio tóxico. Nadie conocía el paradero de la ceniza generada hasta que una noticia reveló que AES había llegado un acuerdo fuera de corte por seis millones de dólares con el gobierno de la República Dominicana por disposiciones de ceniza en el vecino país. Al no encontrar otra alternativa, la disposición de ceniza tenía que hacerse en Puerto Rico. Sin embargo, aunque AES sostenía que las regulaciones ambientales impuestas por la EPA y la Junta de Calidad Ambiental (JCA) se respetaban, las protestas comenzaron nuevamente. En esta ocasión, los residentes de las comunidades aledañas al vertedero temían sufrir la misma suerte de sus hermanos dominicanos. Consecuentemente, un estudio realizado en el 2016 por la Universidad de Puerto Rico Recinto de Ciencias Médicas reveló una alta incidencia de problemas respiratorios, enfermedades de la piel y padecimientos de cáncer entre los habitantes de las comunidades aledañas expuestas a la ceniza liviana de AES.

Debido a estas circunstancias, el gobernador Alejandro García Padilla firma una ley prohibiendo la disposición de ceniza en la isla. AES se ve obligada a cambiar sus prácticas de disposición convirtiendo la ceniza en un agregado de carbón que se solidifica con la ayuda del agua y que se puede utilizar en la producción de concreto y paneles de
interior llamado Agremax. Para esto EC Waste fue contratada y la disposición de ceniza fue eliminada de inmediato. Sin embargo, el vertedero de Peñuelas administrado por esta compañía y aprobado por la EPA por contar con forros de protección contra lixiviados colecta el Agremax. Además se encuentra sobre un importante acuífero en el área sur a siete kilómetros de la costa y a una hora de AES. ¿Debieran los residentes estar preocupados ante esta situación?

Aspecto RSS: Complejidad

1. ¿Consideras el asunto de generación de energía por carbón uno complejo?
   NO: Selecciona la respuesta que mejor explica porque el asunto de la producción de energía por carbón es uno sencillo.
   a. El costo de energía en Puerto Rico es excesivo y la producción de energía por carbón provee un alivio a esta carga financiera. ¿Por qué hacer pagar a los consumidores más? (0)
   b. La producción de energía por carbón es una de las formas más sucias y letales ya que contamina el aire y los suministros de agua. El carbón no debe ser una opción para generar electricidad. (0)
   c. La generación de energía por medio de la combustión de carbón ha sido un asunto muy controversial pero la nueva tecnología y las prácticas más eco-amigables ayudan a disipar las preocupaciones. (0)
SI: Selecciona la respuesta que mejor explica por qué el asunto de la producción de energía por carbón es uno **complejo**.

a. La generación de energía por carbón es un asunto complejo ya que los intereses políticos y económicos dificultan la lucha en contra de esto. (2)

b. La generación de energía por carbón es un asunto complejo por la cantidad de ventajas y desventajas relacionadas a la demanda de energía y su efecto en el ambiente. (1)

c. El asunto es complejo ya que existen consecuencias positivas y negativas al utilizar esta práctica. (1)

2. ¿Consideras el asunto de generación de energía por carbón uno fácil de resolver?

NO: Selecciona la respuesta que mejor explica porque la generación de energía por carbón en Puerto Rico es un **asunto difícil** de resolver.

a. Ya que envuelve saber balancear temas como el ambiente, la economía, la demanda de energía y los intereses políticos. (2)

b. Ya que las preocupaciones ambientales, los intereses financieros y la demanda de energía son temas complicados de por sí. (1)

c. Este caso no provee suficiente información sobre el tema, por lo tanto, no se puede llegar a una solución. (1)

SI: Selecciona la respuesta que mejor explica porque la generación de energía por carbón en Puerto Rico es un **asunto fácil** de resolver.

a. Porque el carbón es la única alternativa viable en Puerto Rico para reducir el costo de la energía, por lo tanto, debe ser permitido. (0)
b. Porque la combustión de carbón para la producción de energía genera productos residuales que pueden causar serios problemas ambientales y de salud, por lo que, no debe continuar. (0)

c. Porque los representantes de cada sector pueden evaluar la situación y llegar a un acuerdo con el gobierno que beneficie a todos. (0)

Aspecto RSS: Perspectiva

3. ¿Cuán probable es que los grupos ambientales y ejecutivos de AES propongan la misma solución a este asunto?

   a. **Es muy probable** que los grupos ambientales y ejecutivos de AES propongan la misma solución.

   b. **No es muy probable** que los grupos ambientales y ejecutivos de AES propongan la misma solución.

¿Por qué es muy probable que los grupos ambientales y ejecutivos de AES propongan la misma solución a este asunto?

   a. Ambos pueden trabajar en conjunto para encontrar una solución y establecer un plan. (0)

   b. Un foro de discusión abierta entre ambos grupos promoverá el alcanzar una solución. (0)

   c. Una entidad neutral puede escuchar a ambos grupos y crear un plan de mediación. (0)
¿Por qué no es muy probable que los grupos ambientales y ejecutivos de AES propongan la misma solución a este asunto?

a. Las prioridades de los grupos ambientales y ejecutivos de AES son completamente diferentes. (2)
b. Los grupos ambientales y ejecutivos de AES no han tenido la oportunidad de reunirse. (0)
c. AES sostiene que siguen las reglamentaciones mientras los grupos ambientales no lo entienden así. (1)

4. ¿Cuán probable es que los residentes de comunidades aledañas y los ejecutivos de AES propongan la misma solución a este asunto de generar energía por carbón?

a. Es muy probable que los residentes y ejecutivos de AES propongan la misma solución a este asunto.
b. No es muy probable que los residentes y ejecutivos de AES propongan la misma solución a este asunto.

¿Por qué es muy probable que los residentes y ejecutivos de AES propongan la misma solución a este asunto?

a. Ambos pueden trabajar en conjunto para encontrar una solución y establecer un plan. (0)
b. Un foro de discusión abierta entre ambos grupos promoverá el alcanzar una solución. (0)
c. Una entidad neutral puede escuchar a ambos grupos y crear un plan de mediación. (0)
¿Por qué no es muy probable que los residentes y ejecutivos de AES propongan la misma solución a este asunto?

a. Las prioridades de los residentes y ejecutivos de AES son completamente diferentes. (2)

b. Los residentes y ejecutivos de AES no han tenido la oportunidad de reunirse. (0)

c. AES sostiene que siguen las reglamentaciones mientras los residentes no lo entienden así. (1)

Aspecto RSS: Cuestionar

5. ¿Si tuvieras que tomar una decisión en cuanto al futuro de las operaciones de AES en Puerto Rico, tendrás suficiente información para hacer la misma?

Siento que tengo suficiente información para tomar una decisión sobre el futuro de las operaciones de AES en Puerto Rico.

Siento que no tengo suficiente información para tomar una decisión sobre el futuro de las operaciones de AES en Puerto Rico.

¿Por qué entiendo que tengo suficiente información para tomar una decisión sobre si AES debe continuar o detener sus operaciones?

a. La EPA y la JCA han certificado que la AES cumple con las leyes ambientales, por lo que, no hay de qué preocuparse. (0)

b. Se necesitan alternativas de energía más económicas. De lo contrario, los habitantes de Puerto Rico no van a poder costear esta necesidad básica. (0)

c. Los factores de riesgo hacia la salud de residentes y la posible contaminación del agua son reales y tienen un impacto negativo a la calidad de vida humana. (0)
¿Por qué entiendo que no tengo suficiente información para tomar una decisión sobre si AES debe continuar o detener sus operaciones?

a. La Chevron Phillips Chemical Co. fue la que contaminó las aguas subterráneas y no AES. Además, no hay evidencia de que el acuífero bajo el vertedero de Peñuelas este contaminado por lo que más información sobre la calidad del agua es necesaria para tomar una decisión. (1)

b. Los beneficios y factores de riesgo a largo plazo por la generación de energía con carbón son inciertos, por lo tanto, más estudios se deben hacer antes de que pueda tomar una decisión. (2)

c. No hay información de cuanto más los ciudadanos pagarían por electricidad si AES cesa operaciones, por lo que no todo está claro. (0)

6. ¿Si te obligaran a tomar una decisión sobre el futuro de AES basado en la información de este artículo, cuál sería tu decisión?

   a. AES debe detener operaciones (0)

   b. AES debe continuar operaciones (0)

7. ¿Crees que AES, los residentes, los ambientalistas y el gobierno de Puerto Rico estén de acuerdo con tu decisión?

Siento que todos van a estar de acuerdo con mi decisión.

Siento que uno o más grupos no va a estar de acuerdo con mi decisión.
¿Por qué todos los grupos van a estar de acuerdo con mi decisión?

a. Si todos los grupos evaluaran el asunto de forma imparcial, se darían cuenta que AES está causando más daño que bien. (0)

b. Si todos los grupos evaluaran el asunto de forma imparcial, se darían cuenta que los beneficios de generar electricidad por carbón son mayores que los riesgos que AES brinda. (0)

c. Todos los grupos estarán de acuerdo con mi decisión luego de una detallada explicación. (0)

¿Por qué uno o más grupos no van a estar de acuerdo con mi decisión?

a. Algunos grupos no estarán de acuerdo con mi decisión porque no tienen un marco claro de los riesgos y beneficios de la generación de energía por carbón. (1)

b. Es probable que no estén de acuerdo ya que la decisión no beneficia a todos. (2)

c. Es probable que no estén de acuerdo ya que sus prioridades son diferentes, pero eventualmente entenderán mi decisión. (0)

8. Si esta decisión sobre las operaciones de AES se pone en marcha, recomendarías que fondos y recursos adicionales se utilicen para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas?

No recomendaría el uso de fondos y recursos adicionales para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas.
Recomendaría el uso de fondos y recursos adicionales para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas.

¿Por qué no recomendaría el uso de fondos y recursos adicionales para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas?

a. Una decisión ya fue tomada por lo que no hay necesidad de más estudios. (0)

b. Se tomó una decisión basada en que la información era clara y concisa, por lo tanto, los fondos deben utilizarse en algo más productivo. (0)

c. No hay necesidad de estudios, especialmente si los mismos son realizados por extranjeros. (0)

¿Por qué recomendaría el uso de fondos y recursos adicionales para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas?

a. Más estudios sirven para aclarar confusiones y permiten que las personas reevalúen y entiendan el porqué de mi decisión. (2)

b. Más estudios promueven la discusión y contestación de preguntas y/o preocupaciones sobre mi decisión. (1)

c. Los estudios se deben fomentar sólo si estudiantes puertorriqueños son contratados como investigadores. (0)
Aspecto RSS: Escepticismo

9. En una reunión de comunidad, un grupo de científicos contratado por AES y otro grupo de científicos contratado por los ambientalistas y residentes de comunidades aledañas expresaron sus opiniones acerca de los productos residuales formados por la combustión de carbón y sus efectos. ¿Esperarías que sus opiniones sean similares?

Las opiniones ofrecidas por los científicos contratados por AES y las opiniones de los científicos contratados por los ambientalistas y residentes serán similares.

Las opiniones ofrecidas por los científicos contratados por AES y las opiniones de los científicos contratados por los ambientalistas y residentes no serán similares.

¿Por qué las opiniones ofrecidas por los científicos contratados por AES y las opiniones de los científicos contratados por los ambientalistas y residentes serán similares?

a. Datos son datos; si el monitoreo se realiza en el mismo lugar, los resultados deben ser los mismos. (0)

b. Aunque los resultados varíen un poco, ambos grupos pueden llegar a un acuerdo al comparar los mismos. (0)

c. Los científicos basan sus conclusiones en datos objetivos y evidencia real, por lo tanto, ambas opiniones deben ser similares. (0)

¿Por qué las opiniones ofrecidas por los científicos contratados por AES y las opiniones de los científicos contratados por los ambientalistas y residentes no serán similares?

a. Aunque los resultados varíen un poco, ambos grupos pueden llegar a un acuerdo al comparar los mismos. (0)
b. Los resultados pueden traer consigo conclusiones positivas y negativas que pueden ser difíciles de explicar dando paso a diferentes opiniones. (1)

c. Las opiniones están basadas en los intereses y metas de cada uno de los grupos, por lo que, probablemente no serán similares. (2)

10. En respuesta a las críticas sobre los efectos de la ceniza de carbón en la calidad de vida de residentes aledaños a AES, la compañía debiera considerar utilizar parte de sus ganancias para contratar un equipo de epidemiólogos que colecten información sobre enfermedades que están afectando a los residentes del área y proveer reportes periódicamente a la comunidad. Los ambientalistas y residentes cercanos considerarían contratar a otro grupo de epidemiólogos para realizar un estudio similar. ¿Si esto sucediera, crees que los resultados de estos dos grupos de epidemiólogos sean similares o diferentes?

Confiaría que los resultados de estos dos grupos de epidemiólogos **serán iguales**.

Confiaría que los resultados de estos dos grupos de epidemiólogos **serán diferentes**.

¿Por qué confiaría que los resultados de estos dos grupos de epidemiólogos **serán iguales**?

a. Si el proceso investigativo se realiza de forma correcta, los resultados serán iguales. (0)

b. Ambos grupos están investigando a las mismas personas, por lo tanto, los resultados serán iguales. (0)

c. Aunque parte de la data no sea la misma, luego de un análisis exhaustivo, los resultados deben ser semejantes en ambos estudios. (0)
¿Por qué confiaría que los resultados de estos dos grupos de epidemiólogos serán diferentes?

a. Los epidemiólogos han sido contratados por entidades que tienen prioridades diferentes, por lo tanto, los resultados favorecerán los intereses de cada cual. (2)

b. Los resultados pueden variar de acuerdo con el método de colección de datos utilizado. (1)

c. AES puede pagar a los epidemiólogos mejor que los ambientalistas y residentes, por lo tanto, sus resultados serán más confiables. (0)

11. Un ecólogo de una prestigiosa universidad publica un artículo en una revista científica de renombre confirmando la toxicidad de la ceniza de carbón y su amenaza inminente al agua y la calidad de aire. ¿Entiendes que esto afectaría el debate?

Entiendo que esto afectaría el debate.

Entiendo que esto no afectaría el debate.

¿Por qué entiendo que no afectaría el debate?

a. Un contrato no se puede romper especialmente cuando AES ha cumplido con la reglamentación ambiental. (0)

b. Este ecólogo es un desconocido y su estudio no fue hecho en Puerto Rico, por lo tanto, no aplica a esta situación. (1)

c. Los grupos de oposición ya están convencidos que sus resultados son los correctos y no van a considerar más estudios. (2)

¿Por qué entiendo que esto afectaría el debate?
a. Los resultados de este estudio serán evidencia clave para que los grupos de oposición fortalezcan sus reclamos. (2)

b. Este estudio permitirá que los grupos reconozcan la amenaza que las cenizas de carbón representan dando paso a una acción correctiva. (0)

c. Los grupos de oposición interpretarán los resultados de forma diferente y encontrarán fallas que los desviarán más lejos de una solución. (1)
Appendix C
QuASSR on AES Gener, Chile

COAL PLANTS IN CHILE

Chile is located in the southwestern part of South America and bordered by the Pacific Ocean on its western side. It extends 748,012.1 square kilometers and 6,435 km along the coastline. With a population of approximately 18.5 million, the demand for energy is quite high. However, since Chilean citizens are primarily vulnerable social classes of medium to low socioeconomic status, thermoelectric companies have managed to keep energy costs down and accessible to everyone. There are different types of thermoelectric companies established in Chile. Although most use fossil fuels, the majority rely on coal, natural gas or petroleum diesel to generate power.

Between 2006 and 2010, a power deficit triggered newly-elected president Veronica Michelle Bachelet to authorize the establishment of 42 new thermoelectric companies. Cuts in gas shipments from Argentina and a massive drought which prevented hydroelectric companies from functioning properly led to this decision. This action was criticized by environmentalists and residents who believed other measures should have been considered before putting citizens and the environment at risk.

As an example, two American coal thermoelectric companies from Applied Energy Systems (AES) were erected on the coastline. These “AES Gener” companies are located in the “Ventanas, Puchuncavi” and the “Angamos Mejillones” sectors. These humble communities’ main sources of income were tourism and fishing due to easy access
to the beach. However, concerns related to the detrimental state of the ocean and the poor health of residents continue. The Superintendency of the Environment (SMA in Spanish), established by the president in 2010, and working under the Ministry of the Environment (MMA in Spanish), monitor the thermoelectric companies’ compliance with the law. These two coal thermoelectric plants have open-through systems in which ocean water is used to cool off condensers before making it back to the ocean. However, during this process small marine animals, plankton, and algae are sucked in and end up dying. Also, residual water is hotter than ocean water, altering the temperature and conditions of this ecosystem on its way back. Additionally, by-products like heavy ash, fly ash, and gas emissions from coal combustion contain particulate material, heavy metals, nitrogen oxides, sulfur dioxide, carbon monoxide and carbon dioxide. Nonetheless, the MMA doesn’t consider ash to be toxic but enforces the use of mesh filters to reduce harmful emissions.

Studies conducted at the University of Chile between 2000 and 2010 show an increase of pulmonary disease, cancer, and premature birth of babies in five regions including “Mejillones” and “Puchuncavi”. Researchers blame it on pollution resulting from the proliferation of coal thermoelectric companies. However, they are still in use and allegedly follow all environmental regulations stipulated. Moreover, “Ventana” residents have witnessed a decrease in fish population, changes in the coloration of the sand along the beach, noise pollution, and the presence of ash or “black dust” within their homes and gardens. Tourism has also noticeably decreased.

Though this has been going on, the MMA and President Bachelet have been awarded for their environmental efforts. The MMA was awarded the “Climate and Clean Air” award because of their plans to decontaminate the atmosphere. Last year, the
president received the prestigious “Champions of the Earth” award granted by the United Nations Organization. Although the award is for Bachelet’s initiatives toward the defense of marine protected areas and her recent plans to establish renewable energy plants, environmental and ecological groups don’t support the award as it sharply contrasts with the situation they are observing. Bachelet plans to shut down all thermoelectric coal companies by 2030. Whether this action is sufficient for the planet or nearby residents continues to be debated. Some parties think this is sufficient. Others want the thermoelectric coal companies to shut down immediately.

**SSR Aspect: Complexity**

1. Is the issue of power generation through coal a complex one? YES/NO

   NO: Select the response below that best explains why the issue of power production through coal is a straightforward one.

   a. Energy costs should remain low and accessible to everyone, and this is done with the establishment of thermoelectric companies. Why should consumers pay more? (0)

   b. Coal is the dirtiest and most lethal form of energy production as it pollutes both air and water supplies. Coal should not be an option for generating electricity. (0)

   c. Generating energy through coal combustion has been a controversial issue, but new technologies and green practices can lay concerns to rest. (0)

   YES: Select the response below that best explains why the issue of power production through coal is complex.
a. Electricity generated by coal is complex because political and economic interests can be difficult to navigate. (2)
b. Electricity generated by coal is a complex issue because of the multiple tradeoffs related to the supply of energy and the environment. (1)
c. The issue is complex because there are as many positive consequences as there are negative consequences to this practice. (1)

2. Is the issue of energy generation through coal in Chile easy to resolve? YES/NO

NO: Why is the energy production through coal issue in Chile difficult to resolve?

a. Because it involves balancing the environment, the economy, political issues, and the energy demand. (2)
b. Because environmental concerns, financial interests, and energy demand are complicated topics by themselves. (1)
c. The case does not provide enough information on this topic to reach a solution. (1)

YES: Why is the energy production through coal issue in Chile easy to resolve?

a. Because coal is the only low-cost energy option available in Chile, therefore, it should be allowed. (0)
b. Because coal combustion for generating energy creates by-products that can lead to serious health and environmental problems, therefore, it should stop. (0)
c. Because representatives from every sector can evaluate the situation and establish an agreement with the government that can benefit everyone. (0)
SSR Aspect: Perspective-taking

3. How likely is it that environmental organizations and government officials endorse the same solution to this proliferation of thermoelectric companies?

   a. It is **very likely** that environmental organizations and government officials would endorse the same solution.
   
   b. It is **not very likely** that environmental organizations and government officials would endorse the same solution.

Why is it **very likely** that the environmental organizations and government officials endorse the same solution to the proliferation of thermoelectric companies?

a. Both groups can work on finding a solution and coming up with a plan. (0)

b. A forum for open discussion between groups will foster reaching a joint solution. (0)

c. A neutral entity can listen to both parties and come up with a mediation plan. (0)

Why is it **not very likely** that the environmental organizations and government officials endorse the same solution to the proliferation of thermoelectric companies?

a. Environmental organizations and government officials have very different priorities. (2)

b. Environmental organizations and government officials have not had a chance to meet. (0)

c. Government officials believe that “AES Gener” is following policy while environmental organizations don’t think so. (1)

4. How likely is it that the community residents and government officials would endorse the same solution to this issue of generating electricity by coal?
a. It is very likely that the community residents and government officials would endorse the same solution.

b. It is not very likely that the community residents and government officials would endorse the same solution.

Why is it very likely that the community residents and government officials endorse the same solution to this issue of generating energy by coal?

a. Both groups can work on finding a solution and coming up with a plan. (0)

b. A forum for open discussion between groups will foster reaching a joint solution. (0)

c. A neutral entity can listen to both parties and come up with a mediation plan. (0)

Why is it not very likely that the community residents and government officials endorse the same solution to this issue of generating energy by coal?

a. Community residents and government officials have very different priorities. (2)

b. Community residents and government officials haven’t had a chance to meet. (0)

C. Government officials believe that “AES Gener” is following policy while residents don’t think so. (1)

SSR Aspect: Inquiry

5. If you were asked to make a decision on whether “AES Gener” should stop or continue operating in Chile, do you feel as though you have enough information to make a decision?
I feel I have **sufficient** information to make a decision on whether “AES Gener” should stop or continue operating.

I do **not** feel I have **sufficient** information to make a decision about whether “AES Gener” should stop or continue operating.

Why is there **sufficient information** to make a decision about whether “AES Gener” should stop or continue operating?

a. Both the SMA and MMA certify that “AES Gener” is following environmental policy; therefore, there’s nothing to worry about. (0)

b. Cheap energy alternatives are needed to keep costs low. If not, Chilean citizens will not be able to afford this basic need. (0)

c. Risks to the health of residents and water pollution are clear and have a negative impact on human quality of life. (0)

Why is there **not sufficient information** to make a decision about whether “AES Gener” should stop or continue operating?

a. “AES Gener” claims that SMA’s environmental regulations are being followed. The companies’ findings fail to find evidence of coastal pollution, which contrasts with what environmental organizations and residents say. I need more information on water quality before I can decide. (1)

b. Long-term benefits and risks of power generation by coal are unclear; therefore, more studies need to be done before I can reach a decision. (2)
c. No information is provided on how much more citizens would have to pay for energy without “AES Gener” and its thermoelectric coal companies, so it is unclear. (0)

6. If you were forced to decide whether “AES Gener” and its thermoelectric coal companies should stop or continue operating based on the information in this article, what decision would you make?
   a. “AES Gener” and its thermoelectric coal companies should stop operating (0)
   b. “AES Gener” and its thermoelectric coal companies should continue operating (0)

7. Do you think “AES Gener,” community residents, environmentalists, and the government would agree with your decision?
   I feel all parties would agree with my decision.
   I feel one or more parties would not agree with my decision.

Why would all parties agree with my decision?
   a. If all parties looked at the issue without bias, then it’s clear that “AES Gener” is causing more harm than good. (0)
   b. If all parties looked at the issue without bias, then it’s clear that the benefits of generating power through coal outweigh the risks. (0)
   c. All parties will agree after a thorough explanation of my reasoning. (0)

Why would one or more parties likely not agree with your decision?
   a. Certain parties will disagree because they don’t have a proper understanding of the risks and benefits. (1)
   b. It’s unlikely that they all agree since the decision will not benefit everyone. (2)
c. It’s unlikely since all parties have different priorities, but eventually they will understand my decision. (0)

8. If the decision you made on whether “AES Gener” and its thermoelectric coal companies should stop or continue operating were put into action, would you recommend that additional funds and resources be used to continue studying the effects of coal combustion by-products to the water quality and health of close-by residents?

   I would **not recommend** continuing to study the effects of coal combustion by-products to the water quality and health of close-by residents.

   I would **recommend** continuing to study the effects of coal combustion by-products to the water quality and health of close-by residents.

Why would you **not recommend** continuing to study the effects of coal combustion by-products to the water quality and health of close-by residents?

   a. A decision has been reached, so there’s no need for these studies. (0)

   b. The information was clear and complete to make a decision; therefore, those funds should be used for something more profitable. (0)

   c. No studies should be done, especially by foreign investigators. (0)

Why would you **recommend** continuing to study the effects of coal combustion by-products to the water quality and health of close-by residents?

   a. Studies will clarify any confusion allowing people to re-evaluate and understand the whereabouts of my decision. (2)
b. Studies will help foster discussion and address questions or concerns about my decision. (1)

c. Studies should be done only if Chilean citizens are hired as investigators. (0)

SSR Aspect: Skepticism

9. At a town meeting, a group of scientists hired by “AES Gener” and another group of scientists hired by the environmental organizations and close-by residents provided expert opinions on the coal combustion by-products and their effects. Would you expect their opinions to be similar?

   Expert opinions offered by the scientists employed by “AES Gener” and those employed by the environmental organizations and residents will likely be similar.

   Expert opinions offered by the scientists employed by “AES Gener” and those employed by the environmental organizations and residents will likely not be similar.

Why would the opinions of both groups of scientists likely be similar?

a. Data is data; and if they’re monitoring the same area, they should be getting the same results. (0)

b. Even if their results differ slightly, they can come to an agreement once the results are shared. (0)

c. Scientists base results on objective data and actual findings; therefore, both opinions should be similar. (0)
Why would opinions of both groups of scientists not likely be similar?

a. Even if their results differ slightly, they can come to an agreement once the results are shared. (0)

b. Results might bring about positive and negative outcomes that might be difficult to explain, leading to different opinions. (1)

c. Opinions will be based on each of the groups’ interests and goals; therefore, they won’t likely be similar. (2)

10. In response to the criticism about the effects of the coal ash on the quality of life of nearby residents, “AES Gener” has suggested using part of its profits to hire a team of epidemiologists to collect data on the illnesses affecting close-by residents and giving regular reports to the local community. The environmental organizations and community residents decide to hire a different group of epidemiologists to conduct a similar study. Would you expect the findings of these two groups of epidemiologists to be similar or different?

   I would expect the findings of the two groups of epidemiologists to be the same.

   I would expect the findings of the two groups of epidemiologists to be different.

Why would you expect the findings of both groups of epidemiologists to be the same?

a. If the process is done correctly then findings should be the same. (0)

b. Both groups are investigating the same subjects; therefore, findings should be the same. (0)

c. Even though some data might not be the same, after thorough analysis, findings should match between both studies. (0)
Why would you expect the findings of both groups of epidemiologists to be different?

a. Epidemiologists have been hired by entities with different priorities; therefore, findings will favor each one’s interests. (2)

b. Findings may be different depending on data collection methods used. (1)

c. “AES Gener” can pay epidemiologists more money; therefore, their findings may be more reliable than those epidemiologists paid by the environmentalists and residents. (0)

11. An ecologist at a prestigious university publishes an article in a top-ranked journal confirming the toxicity of coal ash and its imminent threat to water and air quality. Do you think this will change the debate?

   I would expect the new findings to change the debate.

   I would not expect the new findings to change the debate.

   Why would you not expect this to change the debate?

   a. A contract cannot be broken especially when “AES Gener” has followed environmental policy. (0)

   b. This ecologist is an outsider, and the study wasn’t done in Chile; therefore, it doesn’t apply to this situation. (1)

   c. Opposing parties are already convinced that their findings are correct, and they aren’t likely to consider additional studies with opposing findings. (2)

   Why would you expect this to change the debate?

   a. These findings will become an important piece of evidence that opposing parties will use to strengthen their case. (2)
b. This study will allow all parties to recognize the threat that coal ash represents, and corrective action will be taken. (0)

c. The opposing parties will interpret findings differently and find flaws that will drive them further from a solution. (1)
LAS “CARBONERAS” EN CHILE

Chile es un país costero localizado en el suroeste de América del Sur y bordeado por el Océano Pacífico en la parte occidental. Comprende una extensión territorial de 748,012.1 km² y una costera de 6,435 km. Con una población de 18.5 millones de habitantes, la demanda de electricidad es alta. Debido a la dominancia de las clases media-baja y “vulnerables” reflejadas en estudios socioeconómicos, las termoeléctricas han sido capaces de mantener los bajos costos para proveer la energía más accesible a todos. Hay diferentes tipos de termoeléctricas en Chile. Aunque casi todas funcionan con combustible fósil, la mayoría son generadoras por carbón, gas natural o petróleo “diesel”.

Entre el 2006 y el 2010 debido a una insuficiencia de energía, la recién electa presidenta Verónica Michelle Bachelet autorizó la implantación de sobre 42 termoeléctricas. El recorte de envíos de gas por parte de Argentina y una sequía que no permitía el buen funcionamiento de las centrales hidroeléctricas dio paso a esta decisión por parte de Bachelet. La misma fue criticada por grupos ambientalistas y residentes que opinaban que se debieron evaluar otras alternativas para que ellos ni el medioambiente se vieran afectados.

Como ejemplo tomaremos dos termoeléctricas por carbón pertenecientes a la compañía estadounidense “Applied Energy Systems” (AES) localizadas en la costa chilena. AES Gener cuenta con plantas generadoras en los sectores de Ventanas, Puchuncaví y de Angamos Mejillones. El turismo y la pesca eran una gran fuente de ingreso para estas comunidades por su libre acceso al mar. Sin embargo, las quejas sobre el
daño ambiental costero y la salud de los residentes no han cesado. La Superintendencia del Medio Ambiente (SMA), establecida por Bachelet en 2010, bajo el Ministerio del Medio Ambiente (MMA) monitorean el cumplimiento de ley por parte de las termoeléctricas. Estas compañías son de ciclo abierto por lo que el agua utilizada para enfriar los condensadores proviene del mar y termina en el mar. Durante este proceso, animales marinos pequeños, plancton y algas son succionados y mueren. Del mismo modo, el agua residual que regresa al mar a alta temperatura altera el ecosistema y el pH del océano. Por otro lado, se complica el panorama con las emisiones de material particulado, metales pesados, óxidos de nitrógeno, dióxido de azufre, monóxido y dióxido de carbono a la atmósfera, además de la ceniza pesada y la fugitiva como producto de la combustión. Sin embargo, el MMA no considera la ceniza como producto tóxico y cuenta con legislación a favor del uso de filtros para controlar las emisiones nocivas.

Estudios por la Universidad de Chile entre el año 2000 al 2010 demostraron que en cinco regiones chilenas incluyendo a Mejillones y a Puchuncaví hubo un alza en enfermedades respiratorias, cáncer y nacimientos de bebés prematuros que relacionaron con la proliferación de las termoeléctricas a carbón. Sin embargo, las mismas siguen en funcionamiento y aseguran seguir la reglamentación establecida por el gobierno. Por otro lado, los residentes de Ventanas han evidenciado cambios en su bahía con la disminución en la población de peces, el cambio en la coloración de la arena, el exceso de ruido, y el polvo residual que se deposita en sus casas y jardines. El turismo tampoco se aprecia como antes.

No en pese a esta situación, tanto el MMA y la presidenta Bachelet han sido premiados por sus esfuerzos ambientales. El MMA recibió el premio “Climate and Clean
Air” por sus planes de descontaminación atmosférica. Mientras el año pasado Bachelet recibió el prestigioso galardón de “Campeones de la Tierra” otorgado por la Organización de las Naciones Unidas (ONU). Aunque el premio se debe a las gestiones realizadas por la presidenta en favor de la defensa de áreas marinas protegidas y el reciente impulso de energías renovables, grupos ecológicos y ambientales no ven justo el galardón ya que contrasta con la situación actual del país. Bachelet ha prometido eliminar las termoeléctricas a carbón para el 2030, ¿será justo para el planeta y los residentes o deberán cerrar las termoeléctricas inmediatamente?

**Aspecto RSS: Complejidad**

1. ¿Consideras el asunto de generación de energía mediante la quema de carbón es uno complejo?

NO: Selecciona la respuesta que mejor explica por qué el asunto de la producción de energía mediante la quema de carbón es un tema **sencillo**.

a. El costo de energía debe mantenerse accesible a los habitantes y esto se logra gracias a las termoeléctricas. ¿Por qué hacer pagar a los consumidores más? (0)

b. La producción de electricidad mediante la quema de carbón es una de las formas más sucias y letales ya que contamina el aire y los suministros de agua. El carbón no debe ser una opción para generar electricidad. (0)

c. La generación de electricidad por medio de la combustión de carbón ha sido un asunto muy controversial pero la nueva tecnología y las prácticas más eco-amigables ayudan a disipar las preocupaciones. (0)
SI: Selecciona la respuesta que mejor explica por qué el asunto de la producción de electricidad mediante la quema de carbón es tema complejo.

a. La generación de electricidad mediante la quema de carbón es un asunto complejo ya que es complicado luchar en contra de los intereses políticos y económicos. (2)

b. La generación de electricidad mediante la quema de carbón es un asunto complejo porque hay que cumplir con la demanda de energía y reconocer los efectos en el ambiente. (1)

c. El asunto es complejo ya que existen consecuencias positivas y negativas al utilizar esta práctica. (1)

2. ¿Consideras el asunto de generación de electricidad mediante la quema de carbón uno fácil de resolver?

NO: Selecciona la respuesta que mejor explica por qué la generación de electricidad mediante la quema de carbón en Puerto Rico es un asunto difícil de resolver.

a. Porque requiere saber balancear temas como el ambiente, la economía, la demanda de energía y los intereses políticos. (2)

b. Porque las preocupaciones ambientales, los intereses financieros y la demanda de energía son temas complicados de por sí. (1)

c. Este caso no provee suficiente información sobre el tema, por lo tanto, no se puede llegar a una solución. (1)
SI: Selecciona la respuesta que mejor explica porque la generación de electricidad mediante la quema de carbón en Puerto Rico es un **asunto fácil** de resolver.

a. Porque el carbón es la única alternativa viable en Chile para mantener accesible el costo de la energía, por lo tanto, debe ser permitido. (0)

b. Porque la combustión de carbón para la producción de energía genera productos residuales que pueden causar serios problemas ambientales y de salud, por lo tanto, no debe continuar. (0)

c. Porque los representantes de cada sector pueden evaluar la situación y llegar a un acuerdo con el gobierno que beneficie a todos. (0)

**Aspecto RSS: Perspectiva**

3. ¿Cuán probable es que los ambientalistas y ejecutivos de gobierno apoyen la misma solución al asunto de la proliferación de las termoeléctricas?

a. **Es muy probable** que los ambientalistas y ejecutivos de gobierno apoyen la misma solución.

b. **No es muy probable** que los ambientalistas y ejecutivos de gobierno apoyen la misma solución.

¿Por qué **es muy probable** que los ambientalistas y ejecutivos de gobierno apoyen la misma solución a este asunto?

a. Ambos grupos pueden trabajar en conjunto para encontrar una solución y establecer un plan. (0)
b. Un foro de discusión abierta entre ambos grupos promoverá el alcanzar una solución. (0)

c. Una entidad neutral puede escuchar a ambos grupos y crear un plan de mediación. (0)

¿Por qué no es muy probable que los ambientalistas y ejecutivos de gobierno apoyen la misma solución al asunto de la proliferación de las termoeléctricas?

a. Las prioridades de los ambientalistas y ejecutivos de gobierno son completamente diferentes. (2)

b. Los ambientalistas y ejecutivos de gobierno no han tenido la oportunidad de reunirse. (0)

c. El gobierno sostiene que AES Gener y demás compañías siguen las reglamentaciones mientras los ambientalistas entienden que no las están siguiendo. (1)

4. ¿Cuán probable es que los residentes de comunidades aledañas y los ejecutivos de gobierno apoyen la misma solución a este asunto de generar energía por carbón?

a. Es muy probable que los residentes y ejecutivos de gobierno apoyen la misma solución a este asunto.

b. No es muy probable que los residentes y ejecutivos de gobierno apoyen la misma solución a este asunto.

¿Por qué es muy probable que los residentes y ejecutivos de gobierno apoyen la misma solución al asunto de generar energía por carbón?
a. Ambos grupos pueden trabajar en conjunto para encontrar una solución y establecer un plan. (0)
b. Un foro de discusión abierta entre ambos grupos promoverá el alcanzar una solución. (0)
c. Una entidad neutral puede escuchar a ambos grupos y crear un plan de mediación. (0)

¿Por qué no es muy probable que los residentes y ejecutivos de gobierno apoyen la misma solución al asunto de generar energía por carbón?

a. Las prioridades de los residentes de las comunidades afectadas y la de los ejecutivos de gobierno son completamente diferentes. (2)
b. Los residentes y ejecutivos de gobierno no han tenido la oportunidad de reunirse. (0)
c. El gobierno sostiene que AES Gener y demás compañías siguen las reglamentaciones mientras los residentes entienden que no las están siguiendo. (1)

Aspecto RSS: Cuestionar

5. ¿Si tuvieras que tomar una decisión en cuanto al futuro de las operaciones de AES Gener en Chile, consideras tener suficiente información para hacer la misma?

Siento que tengo suficiente información para tomar una decisión sobre el futuro de las operaciones de AES Gener en Chile.

Siento que no tengo suficiente información para tomar una decisión sobre el futuro de las operaciones de AES Gener en Chile.
¿Por qué entiendo que tengo suficiente información para tomar una decisión sobre si AES Gener debe continuar o detener sus operaciones?

a. La SMA y la MMA han certificado que la AES Gener cumple con las leyes ambientales, por lo tanto, no hay de qué preocuparse. (0)
b. Se necesitan alternativas de energía que mantengan los costos de energía accesibles. De lo contrario, la mayoría de los habitantes de Chile no van a poder costear esta necesidad básica. (0)
c. Los factores de riesgo hacia la salud de residentes y la posible contaminación costera son reales y tienen un impacto negativo a la calidad de vida humana. (0)

¿Por qué entiendo que no tengo suficiente información para tomar una decisión sobre si AES Gener debe continuar o detener sus operaciones?

a. AES Gener alega que sigue los parámetros impuestos por la SMA. Sus estudios no reflejan contaminación costera pero no concuerda con la realidad. Más información sobre el efecto de las aguas residuales en las aguas de las playas aledañas es necesaria para tomar una decisión. (1)
b. Los beneficios y factores de riesgo a largo plazo por la generación de energía con carbón son inciertos, por lo tanto, más estudios se deben hacer antes de que pueda tomar una decisión. (2)
c. No hay información de cuanto más los ciudadanos pagarían por electricidad si AES Gener y sus termoeléctricas a carbón cesan operaciones, por lo que no queda lo suficientemente claro para tomar una decisión. (0)
6. ¿Si te obligaran a tomar una decisión sobre el futuro de AES basado en la información de este artículo, cuál sería tu decisión?
   a. AES Gener y las termoeléctricas a carbón deben **detener** operaciones (0)
   b. AES Gener y las termoeléctricas a carbón debe **continuar** operaciones (0)

7. ¿Crees que AES Gener, los residentes, los ambientalistas y el gobierno de Chile estén de acuerdo con tu decisión?
   Siento que todos los grupos involucrados estarían **de acuerdo** con mi decisión.
   Siento que uno o más grupos **no estarían de acuerdo** con mi decisión.

   ¿Por qué todos los grupos estarían **de acuerdo** con mi decisión?
   a. Si todos los grupos evaluaran el asunto de forma imparcial, se darían cuenta que AES Gener y las termoeléctricas a carbón está causando más daño que bien. (0)
   b. Si todos los grupos evaluaran el asunto de forma imparcial, se darían cuenta que los beneficios de generar electricidad mediante la quema de carbón son mayores que los riesgos que AES Gener brinda. (0)
   c. Todos los grupos estarán de acuerdo con mi decisión luego de una detallada explicación. (0)

   ¿Por qué uno o más grupos **estarían de acuerdo** con mi decisión?
   a. Algunos grupos no estarán de acuerdo con mi decisión porque no tienen un entendimiento claro de los riesgos y beneficios de la generación de energía por carbón. (1)
   b. Es probable que no estén de acuerdo ya que la decisión no beneficia a todos. (2)
c. Es probable que no estén de acuerdo ya que sus prioridades son diferentes, pero eventualmente entenderán mi decisión. (0)

8. ¿Si la decisión que tomas sobre las operaciones de AES Gener y las termoeléctricas de carbón se pone en marcha, recomendarías que fondos y recursos adicionales se utilicen para estudiar los efectos de los productos residuales de la combustión en la calidad del agua y la salud de los residentes de comunidades aledañas?

No recomendaría el uso de fondos y recursos adicionales para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas.

Recomendaría el uso de fondos y recursos adicionales para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas.

¿Por qué no recomendaría el uso de fondos y recursos adicionales para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas?

a. Una decisión ya fue tomada por lo que no hay necesidad de más estudios. (0)

b. Se tomó una decisión basada en que la información era clara y concisa, por lo tanto, los fondos deben utilizarse en algo más productivo. (0)

c. No hay necesidad de estudios, especialmente si los mismos no son realizados por chilenos. (0)
¿Por qué recomendaría el uso de fondos y recursos adicionales para estudiar los efectos de los productos residuales de la combustión de carbón en la calidad del agua y la salud de los residentes de comunidades aledañas?

a. Más estudios servirían para aclarar confusiones y permitirían que las personas reevalúen y entiendan el porqué de mi decisión. (2)

b. Más estudios promoverían la discusión y contestación de preguntas y/o preocupaciones sobre mi decisión. (1)

c. Los estudios se deben fomentar sólo si estudiantes chilenos son contratados como investigadores. (0)

**Aspecto RSS: Escepticismo**

9. En una reunión de comunidad, un grupo de científicos contratado por AES Gener y otro grupo de científicos contratado por los ambientalistas y residentes de comunidades aledañas expresaron sus opiniones acerca de los productos residuales formados por la combustión de carbón y sus efectos. ¿Esperarías que sus opiniones basadas en los resultados sean similares?

Las opiniones ofrecidas por los científicos contratados por AES Gener y las opiniones de los científicos contratados por los ambientalistas y residentes serán **similares**.

Las opiniones ofrecidas por los científicos contratados por AES Gener y las opiniones de los científicos contratados por los ambientalistas y residentes **no serán similares**.
¿Por qué las opiniones basadas en los resultados ofrecidas por los científicos contratados por AES Gener y las opiniones basadas en los resultados de los científicos contratados por los ambientalistas y residentes serán similares?

a. Datos son datos; si el monitoreo se realiza en el mismo lugar, los resultados deben ser los mismos. (0)

b. Aunque los resultados no concuerden, ambos grupos pueden llegar a un acuerdo al comparar los mismos. (0)

c. Los científicos basan sus conclusiones en datos objetivos y evidencia real, por lo tanto, ambas opiniones deben ser similares. (0)

¿Por qué las opiniones basadas en los resultados ofrecidas por los científicos contratados por AES Gener y las opiniones basadas en los resultados de los científicos contratados por los ambientalistas y residentes no serán similares?

a. Aunque los resultados no concuerden, ambos grupos pueden llegar a un acuerdo al comparar los mismos. (0)

b. Los resultados pueden traer consigo conclusiones positivas y negativas que pueden ser difíciles de explicar dando paso a diferentes opiniones. (1)

c. Las opiniones están basadas en los intereses y metas de cada uno de los grupos, por lo que, probablemente no serán similares. (2)

10. En respuesta a las críticas sobre los efectos de la ceniza de carbón y las emisiones nocivas en la calidad de vida de residentes aledaños a AES Gener, la compañía ha sugerido utilizar parte de sus ganancias para contratar un equipo de epidemiólogos que colecten información sobre enfermedades que están afectando a los residentes.
del área y proveer reportes periódicamente a la comunidad. Los ambientalistas y residentes cercanos deciden contratar a otro grupo de epidemiólogos para realizar un estudio similar. ¿Crees que los resultados de estos dos grupos de epidemiólogos sean similares o diferentes?

Confiaría que los resultados de estos dos grupos de epidemiólogos **serán iguales**. Confiaría que los resultados de estos dos grupos de epidemiólogos **serán diferentes**.

¿Por qué confiaría que los resultados de estos dos grupos de epidemiólogos **serán iguales**?

a. Si el proceso investigativo se realiza de forma correcta, los resultados serán iguales. (0)
b. Ambos grupos están investigando a las mismas personas, por lo tanto, los resultados serán iguales. (0)
c. Aunque parte de la data no sea la misma, luego de un análisis exhaustivo, los resultados deben ser semejantes en ambos estudios. (0)

¿Por qué confiaría que los resultados de estos dos grupos de epidemiólogos **serán diferentes**?

a. Los epidemiólogos han sido contratados por entidades que tienen prioridades diferentes, por lo tanto, los resultados favorecerán los intereses de cada cual. (2)
b. Los resultados pueden variar de acuerdo con el método de recolección de datos utilizado. (1)
c. AES Gener puede pagar a los epidemiólogos mejor que los ambientalistas y residentes, por lo tanto, sus resultados serán más confiables. (0)
11. Un ecólogo de una prestigiosa universidad publica un artículo en una revista científica de renombre confirmando la toxicidad de la ceniza de carbón, las emisiones de las termoeléctricas, y su amenaza inminente al agua y la calidad de aire. ¿Entiendes que esto afectaría el debate?

Entiendo que esto affectaría el debate.

Entiendo que esto no afectaría el debate.

¿Por qué entiendo que no afectaría el debate?

a. Un contrato no se puede romper especialmente cuando AES Gener ha cumplido con la reglamentación ambiental. (0)

b. Este ecólogo es un desconocido y su estudio no fue hecho en Chile, por lo tanto, no aplica a esta situación. (1)

c. Los grupos en oposición ya están convencidos que sus resultados son los correctos y no van a considerar más estudios. (2)

¿Por qué entiendo que esto affectaría el debate?

a. Los resultados de este estudio serán evidencia clave para que los grupos de oposición fortalezcan sus reclamos. (2)

b. Este estudio permitirá que los grupos reconozcan la amenaza que las cenizas de carbón y las emisiones de las termoeléctricas representan dando paso a una acción correctiva. (0)

c. Los grupos de oposición interpretarán los resultados de forma diferente y encontrarán fallas que los desviarán más lejos de una solución. (1)
Appendix D
QuAssR on La Parguera, Puerto Rico

COASTAL SITUATION IN PUERTO RICO

La Parguera is a small fishing village in the town of Lajas in the southwest of Puerto Rico. Since the 1940’s, it’s been a critical part of the town’s economy not just for its fishing, but for its coastal and underwater wonders. The opportunity to observe bioluminescent organisms is one of the top reasons tourists visit the area. Very few places in the world have the perfect conditions for dinoflagellates like Pyrodinium bahamense to live. These marine plankton seem emit a blue light when agitated, which can be seen at night. Tour boats offer visitors a chance to get close to these organisms and enjoy their light spectacle.

Not that far away, people have been living in stilt houses along the shore for decades. Other structures called “boathouses” or “floating houses” since they were floating on the water next to the stilt houses were also found. Concerned about the deterioration to the ecosystem and the dinoflagellates, environmental groups forced the government to remove boat houses that were not connected to a sewage treatment facility. Nowadays, only the stilt houses remain.

Pollution left by gas boats, mangrove removal for development, erosion from runoff, and possible improper sewage disposal practices from an inefficient water treatment plant during have brought about organic and nutrient influxes that affect the balance of marine organisms like dinoflagellates. These factors promote a phenomenon called eutrophication or an enrichment of nutrients that may cause “blooms.” Some “blooms” are
due to microscopic algal cells populating the water column to such a degree as to discolor the water, or in extreme circumstances rendering it opaque.

Climate change has also been blamed for the negative state of the ecosystem. Changes in the water column and fluctuations in water temperature and circulation have altered living conditions for marine organisms. Although no recent dinoflagellate population counts have been done, a decrease in the bioluminescence has been observed. Sometimes it worsens, especially when accompanied by the occasional presence of increasing amounts of Sargassum, brought by the currents, which doesn’t allow the light to penetrate the water column, inhibiting photosynthesis and resulting in a lack of oxygen.

Looking to preserve this natural reserve, another controversy has surrounded the possibility of removing the stilt houses. Environmental groups and some government officials, who support this move, claim the houses were illegally erected in the sea-land zone. However, many residents have pleaded with the government to avoid this from happening since some of the houses have been passed down from generation to generation. Discrepancies amongst scientific research findings have led researchers to conclude that the stilt houses are harmless while others conclude that they are unfavorable to this marine ecosystem.

Unfortunately, according to a study done by the University of Puerto Rico Mayaguez Campus published in 2014, no serious environmental or mitigation plan exists to restore “La Parguera” even while the number of visitors and residents has more than doubled since the 1940s. So, who do we blame for this situation: the stilt houses, climate change, the government, or ourselves?
SSR Aspect: Complexity

1) Is the issue of La Parguera a complex issue?

NO: Select the response below that best explains why the Parguera issue is a fairly straightforward issue.

a. It’s clear that the stilt houses are causing damage to the ecosystem, and they need to be removed. (0)

b. The government hasn’t enforced environmental policy. They are the ones at fault. (0)

c. The damage is done, and now it’s time to fix it no matter what. (0)

YES: Select the response below that best explains why the Parguera issue is complex.

a. The Parguera issue is complex because harsh environmental action has to be put into practice without affecting the economy and tourism of the area. (2)

b. The Parguera issue is complex because we don’t know all the consequences (positive and/or negative) this can bring. (1)

c. The Parguera issue is complex because the government must acknowledge the problem and come up with a plan. (0)

2) Are the problems in La Parguera easy to resolve?

NO: Why are the problems in La Parguera difficult to resolve?

a. Because not enough information is provided. If more details were available, it would be easier to resolve. (1)
b. Because it involves balancing the economy with environmental action, legislation, and the possibility of relocating residents. (2)

c. Because it involves the combined effort of the government, the residents, and the environmental groups. (1)

YES: Why are the problems in La Parguera easy to resolve?

a. La Parguera is a tourist attraction and an economic engine for the town of Lajas. Restoration must be a priority. (0)

b. Conservation efforts should include removing the houses and making the residents pay for restoration. They clearly have contributed to the deterioration of the system. (0)

c. An admission fee should be implemented to cover the costs of restoration. (0)

SSR Aspect: Perspective-taking

3. How likely is it that residents of the stilt houses in La Parguera and government officials would endorse the same solution to this problem?

It is **very likely** that the residents of the stilt houses and the government officials would endorse the same solution.

It is **not very likely** that the residents of the stilt houses and the government officials would endorse the same solution.

Why is it **very likely** that the residents of the stilt houses and the government officials would endorse the same solution?

a. Both groups can work on finding a solution and coming up with a plan. (0)

b. A forum for open discussion between groups will foster reaching a solution. (0)
c. A neutral entity can listen to both parties and come up with a mediation plan. (0)

Why is it not very likely that the residents of the stilt houses and the government officials would endorse the same solution?

a. The residents of the stilt houses and the government officials have different concerns and points of view about the situation. (2)

b. The residents of the stilt houses and the government officials may have access to different pieces of information about the environmental situation of the area. (1)

c. The residents of stilt houses and the government officials haven’t had a chance to meet and come up with a plan. (0)

4. How likely is it that an environmental advocacy group and the residents of the stilt houses would endorse the same solution to this situation?

It is very likely that an environmental advocacy group and the residents of the stilt houses would endorse the same solution to this situation.

It is not very likely that an environmental advocacy group and the residents of the stilt houses would endorse the same solution to this situation.

Why is it very likely that an environmental advocacy group and the residents of the stilt houses would endorse the same solution to this situation?

a. Both groups can work on finding a solution and coming up with a plan. (0)

b. A forum for open discussion between groups will foster reaching a solution. (0)

c. A neutral entity can listen to both parties and come up with a mediation plan. (0)
Why is it **not very likely** that an environmental advocacy group and the residents of the stilt houses would endorse the same solution to this situation?

a. The residents of the stilt houses and the environmental advocacy group have different concerns and points of view about the situation. (2)

b. The residents of the stilt houses and the environmental advocacy group may have access to different pieces of information about the environmental situation of the area. (1)

c. The residents of stilt houses and the environmental advocacy group haven’t had a chance to meet and come up with a plan. (0)

**SSR Aspect: Inquiry**

5. If you were asked to decide on whether to leave or relocate stilt houses and their residents in La Parguera, do you feel as though you have enough information to make a decision?

- **I feel I have sufficient information** to make a decision about whether to leave or relocate stilt houses and their residents in La Parguera.

- **I do not feel I have sufficient information** to make a decision about whether to leave or relocate stilt houses and their residents in La Parguera.

Why is there **sufficient information** to make a decision about whether to leave or relocate stilt houses and their residents in La Parguera?
a. The residents of the stilt houses bring money into the local economy and scientific research has endorsed the establishment of these houses as they are harmless to the environment. (0)

b. Scientific research has condemned the establishment of these houses as they have promoted the deterioration of natural resources. (0)

c. The government needs to act upon the removal of the stilt houses so that a decent plan can be implemented. (0)

Why is there **not sufficient information** to make a decision about whether to leave or relocate stilt houses and their residents in La Parguera?

a. The residents of the stilt houses, environmentalists, and government officials need to meet and discuss other options that do not include relocating stilt houses. Where are these people going to go? (0)

b. There is discrepancy between scientific research. Some suggest the stilt houses are not at fault for the deterioration of natural resources while others suggest differently. More research needs to be done before a decision can be made. (2)

c. The number of residents and visitors has more than doubled since the 1940’s. The side effects of urbanization and development may be the ones responsible for the deterioration of the ecosystem. (1)

6. If you were forced to make a decision whether to leave or relocate the stilt houses and their residents based on the information in the article, what decision would you make?

   a. Leave the stilt houses
b. Relocate the stilt houses

7. Do you think the residents of the stilt houses, the environmentalist advocacy group, and the government would agree with your decision?

I feel all parties **would agree** with my decision.

I feel one or more parties **would not agree** with my decision.

Why would all parties **agree** with your decision?

a. If all parties looked at the issue without bias, then it’s clear that the stilt houses are harmless to the ecosystem. (0)

b. If all parties looked at the issue without bias, then it’s clear that the stilt houses need to be removed as they are deteriorating the ecosystem. (0)

c. The long-term benefits of removing the stilt houses will not only be good for the environment, but also for the economy. (0)

Why would one or more parties likely **not agree** with your decision?

a. Certain parties will disagree because they don’t have proper understanding of the risks and benefits of removing the stilt houses. (1)

b. It is unlikely that I could get all parties to agree with my decision because their agreement depends on whether or not they are benefitting from the stilt houses. (2)

c. It is unlikely that all parties would agree at first due to their different perspectives. However, they would eventually come to an agreement about the best course of action to take. (0)
8. If the decision you made on whether to leave or relocate stilt houses were put into action, would you recommend that additional funds and resources be used to continue studying the effect of the stilt houses on La Parguera’s ecosystem?

I **would recommend** continuing to study the effect of the stilt houses on La Parguera’s ecosystem.

I **would not recommend** continuing to study the effect of the stilt houses on La Parguera’s ecosystem.

Why would you **not recommend** continuing to study the effect of the stilt houses on La Parguera’s ecosystem?

a. A decision was reached because there was enough information. There is no need to keep researching about the issue. (1)

b. Any additional funds should be used towards restoring the ecosystem. (0)

c. Residents of the stilt houses can pay researchers to continue studying possible effects on the ecosystem. The government shouldn’t be responsible for this. (2)

Why would you **recommend** continuing to study the effect of the stilt houses to La Parguera’s ecosystem?

a. Collecting additional data would help address and defray criticisms from groups that disagree with my decision. (0)

b. Collecting additional data will likely lead to a common agreement. (0)

c. Collecting additional data will help people continue discussing and re-evaluating my decision. (0)
SSR Aspect: Skepticism

9. At a town meeting, a group of scientists employed by the stilt houses residents and another group of scientists employed by an environmental advocacy group provided expert opinions on the stilt houses issue. Would you expect their opinions to be similar?

Expert opinions offered by scientists employed by the stilt houses residents and the environmental advocacy group will likely be similar.

Expert opinions offered by scientists employed by the stilt houses residents and the environmental advocacy group will likely not be similar.

Why would the opinion of both groups of scientists likely be similar?

a. Data are objective; and if they’re monitoring the same area, they should be getting the same results. (0)

b. Even if their results differ slightly, they can come to an agreement once they’re shared and discussed. (0)

c. Scientists base results on objective data and actual findings, therefore, both opinions should be similar. (0)

Why would the opinion of both groups of scientists likely not be similar?

a. Even if their results differ slightly, they can come to an agreement once they’re shared and discussed. (0)

b. The details behind this issue might be rooted from different sources, so scientists may have different opinions. (1)
c. Opinions will be based on each of the groups’ interests and goals, therefore, these goals will affect how the data is used and interpreted. (2)

10. In response to the criticism about the questionable effects of the stilt houses to Parguera’s ecosystem, the Department of Natural Resources (DRNA) may suggest using part of the tax money to hire a team of scientists dedicated to collecting data on water quality and dinoflagellate population in the area and giving regular reports to the local community. The residents of the stilt houses decide to hire a different group of scientists to also conduct water and dinoflagellate monitoring. Would you expect the findings of these two groups of scientists to be similar or different?

I would expect the findings of the two groups of scientists to be the **same**.

I would expect the findings of the two groups of scientists to be the **different**.

Why would you expect the findings of the two groups of scientists to be the **same**?

a. If the process is done correctly then findings should be the same. (0)

b. Both groups are monitoring the same things; therefore, findings should be the same. (0)

c. Even though some data might not be the same, after thorough analysis, findings should match between both studies. (0)

Why would you expect the findings of the two groups of scientists to be **different**?
a. Scientists have been hired by groups with different priorities; therefore, findings will favor each one’s interests. (2)

b. Findings may be different depending on data collection methods used. (1)

c. The DRNA can pay scientists more money; therefore, their findings may be more reliable than those scientists paid by the residents of the stilt houses. (0)

11. A marine biologist at a prestigious university publishes an article in a top-ranked journal confirming that the nutrient influxes from sewage of structures along the coastline of a major marine ecosystem have been the cause of the deterioration of the ecosystem. Do you think this will change the Parguera stilt houses debate?

I would expect the new findings to change the debate.

I would not expect the new findings to change the debate.

Why would you expect the new findings to change the stilt houses’ debate?

a. These findings will become an important piece of evidence that opposing parties will use to strengthen their case. (2)

b. This study will allow all parties to recognize the threat that the stilt houses represent, and corrective action will be taken. (0)

c. The opposing parties will interpret findings differently and find flaws that may drive them further from a solution. (1)

Why would you not expect the new findings to change the stilt houses’ debate?

a. The water conditions of that major marine ecosystem may not be the same. (0)

b. This marine biologist is an outsider, and the study wasn’t done in Puerto Rico; therefore, it doesn’t apply to this situation. (1)
c. Opposing parties are already convinced that their findings are correct, and they aren’t likely to consider additional studies. (2)
SITUACIÓN COSTERA EN PUERTO RICO

La Parguera es una villa pesquera, localizada en el pueblo de Lajas, en la región Suroeste de Puerto Rico. Desde el 1940 ha sido parte esencial de la economía del área, por la pesca y por sus maravillas costeras y submarinas. La Bahía Bioluminiscente, una de las pocas en el mundo, es una de las razones primordiales por la que los turistas visitan el área. Pocos lugares en el mundo exhiben condiciones perfectas para que vivan los dinoflagelados como el *Pyrodinium bahamense*, los cuales producen la bioluminiscencia. Estos brillan y emiten una luz azul al ser agitados. Botes de excursión ofrecen a visitantes la oportunidad de visitar la bahía y acercarse a estos organismos para disfrutar de su espectáculo lumínico.

A poca distancia de la bahía, por décadas, personas han estado habitando unas estructuras montadas en pilotes, mejor conocidas como “casetas”. Otras estructuras flotaban sobre la superficie del mar y se les llamaba “casas bote”. Preocupados por el deterioro del ecosistema y el crecimiento y reproducción de los dinoflagelados, movimientos ambientales exigieron que el gobierno obligara a los residentes de las “casas bote” a conectarse al servicio de alcantarillado y de negarse, serían removidos. En la actualidad, solo las casetas permanecen en el área.

La contaminación por parte del combustible de los botes, la remoción de mangles para el desarrollo urbano, la erosión por las escorrentías y posible mala disposición de las aguas usadas de la planta de tratamiento, han resultado en la afluencia de nutrientes y
material orgánico que ha afectado el balance de organismos marinos como los
dinoflagelados. Estos factores promueven un fenómeno conocido como eutrofización o
enriquecimiento de nutrientes que puede llevar a “florecimientos”. Algunos florecimientos
surgen por algas microscópicas que se proliferan en la columna de agua alterando el color
y la turbulencia.

El cambio climático ha sido otra de las causas responsables del daño a este y otros
ecosistemas. Los cambios en la columna de agua, y las fluctuaciones en temperatura y
circulación de las corrientes han alterado el hábitat de estos organismos marinos. Por
ejemplo, aunque no se han realizado conteos últimamente, se ha detectado una disminución
en la bioluminiscencia que se puede agravar, en ocasiones, por una alta presencia de
sargazo arrastrado por las corrientes evitando el paso de la luz solar, impidiendo la
fotosíntesis y a su vez se afectando los niveles de oxígeno.

Buscando preservar esta reserva natural, una nueva controversia ha rodeado la
posibilidad de remover las casetas. Grupos ambientales y algunos oficiales de gobierno,
que están de acuerdo con esta movida, indican que las casas fueron ilegalmente construidas
en la zona marítimo-terrestre. Muchos residentes, han solicitado al gobierno que las casetas
no sean removidas, ya que sus casas han pasado de generación en generación. Sin
embargo, ciertas discrepancias en los resultados de investigaciones científicas han llevado
a algunos científicos a concluir que las casas flotantes no causan daño al ambiente,
mientras otros piensan que sí.
Desafortunadamente, de acuerdo con un estudio realizado por la Universidad de Puerto Rico, Recinto de Mayagüez, publicado en el 2014, no existe plan de mitigación ambiental formal para restaurar La Parguera aunque el número de visitantes y residentes ha aumentado considerablemente desde el 1940. Por lo que, ¿quién tiene la culpa: las casetas, el cambio climático, el gobierno o nosotros?

Aspecto RSS: Complejidad

1. ¿Será el problema de La Parguera uno complejo?

**NO**: Selecciona la respuesta que mejor explica porque el problema de La Parguera **no es complejo**.

a. Está claro que las casetas están causando daño al ecosistema por lo que deben ser removidas. (0)

b. El gobierno no ha puesto en práctica la legislación ambiental. Ellos tienen la culpa. (0)

c. El daño ya está hecho y ahora hay que arreglarlo a como de lugar. (0)

**SI**: Selecciona la respuesta que mejor explica porque el problema de La Parguera es uno **complejo**.

a. El problema de La Parguera es complejo porque una fuerte acción ambiental debe ser implementada sin afectar la economía y el turismo del área. (2)
b. El problema de La Parguera es complejo porque no conocemos todas las consecuencias (positivas y/o negativas) que esto pueda traer. (1)

c. El problema de La Parguera es complejo porque el gobierno debe reconocer el problema primero para luego crear un plan. (0)

2. ¿Serán fáciles de resolver los problemas de La Parguera?

**NO:** ¿Por qué los problemas de La Parguera **son difíciles** de resolver?

a. No hay suficiente información. Si hubiese más detalles disponibles, sería más fácil de resolver. (1)

b. Porque envuelve balancear la economía con la acción ambiental, la legislación, y la posibilidad de relocalizar residentes. (2)

c. Porque envuelve el esfuerzo combinado del gobierno, los residentes y los ambientalistas. (1)

**SI:** ¿Por qué los problemas de La Parguera **son fáciles** de resolver?

a. La Parguera es una atracción turística y el motor económico del municipio de Lajas. La restauración debe ser una prioridad. (0)
b. Los esfuerzos de conservación deben incluir la remoción de las casetas y hacer pagar a los residentes por la restauración del ecosistema. Claramente han contribuido al deterioro del mismo. (0)

c. Se debe implementar un costo de entrada que ayude a cubrir los gastos de restauración. (0)

Aspecto RSS: Perspectiva

3. ¿Cuán probable es que los residentes de las casetas de La Parguera y oficiales de gobierno propongan la misma solución a este problema?

Si crees que es muy probable, contesta aquí: ¿Por qué es muy probable que los residentes de las casetas de La Parguera y oficiales de gobierno propongan la misma solución a este problema?

a. Ambos pueden trabajar en conjunto para encontrar una solución y establecer un plan. (0)

b. Un foro de discusión abierta entre ambos grupos promoverá el alcanzar una solución. (0)

c. Una entidad neutral puede escuchar a ambos grupos y crear un plan de mediación. (0)
Si crees que no es muy probable, contesta aquí: ¿Por qué no es muy probable que los residentes de las casetas de La Parguera y oficiales de gobierno propongan la misma solución a este problema?

a. Los residentes de las casetas y los oficiales de gobierno tienen diferentes preocupaciones y puntos de vista sobre este asunto. (2)

b. Los residentes de las casetas y los oficiales de gobierno pueden tener acceso a diferentes recursos de información ambiental sobre este asunto. (1)

c. Los residentes de las casetas y los oficiales de gobierno no han tenido la oportunidad de reunirse y redactar un plan. (0)

4. ¿Cuán probable es que el grupo de ambientalistas y los residentes de las casetas propongan la misma solución a este asunto?

Si crees que es muy probable, contesta aquí: ¿Por qué es muy probable que el grupo de ambientalistas y los residentes de las casetas propongan la misma solución a este asunto?

a. Ambos pueden trabajar en conjunto para encontrar una solución y establecer un plan. (0)

b. Un foro de discusión abierta entre ambos grupos promoverá el alcanzar una solución. (0)
c. Una entidad neutral puede escuchar a ambos grupos y crear un plan de mediación. (0)

**Si crees que no es muy probable, contesta aquí:** ¿Por qué no es muy probable que el grupo ambientalista y los residentes de las casetas propongan la misma solución a este asunto?

a. Los residentes de las casetas y el grupo ambientalista tienen diferentes preocupaciones y puntos de vista sobre este asunto. (2)

b. Los residentes de las casetas y el grupo ambientalista pueden tener acceso a diferentes recursos de información ambiental sobre este asunto. (1)

c. Los residentes de las casetas y el grupo ambientalista no han tenido la oportunidad de reunirse y redactar un plan. (0)

**Aspecto RSS: Cuestionar**

5. ¿Si tuvieras que tomar una decisión en cuanto a mantener o relocalizar las casetas de La Parguera y sus residentes, sientes que tienes suficiente información para hacer la misma?

**Si crees que tienes suficiente información, contesta aquí:** ¿Por qué entiendo que tengo suficiente información para tomar una decisión en cuanto a mantener o relocalizar las casetas de La Parguera y sus residentes?
a. Los residentes de las casetas aportan dinero a la economía local y las investigaciones científicas llevadas a cabo indican que las mismas son inofensivas hacia el ambiente. (0)

b. Las investigaciones científicas llevadas a cabo indican que las mismas han promovido al deterioro de los recursos naturales. (0)

c. El gobierno debe tomar acción a favor de la remoción de las casetas para que un plan apropiado pueda ser implementado. (0)

**Si crees que no tienes suficiente información, contesta aquí:** ¿Por qué no tengo suficiente información para tomar una decisión en cuanto a mantener o relocalizar las casetas de La Parguera y sus residentes?

a. Los residentes de las casetas, los ambientalistas y los oficiales de gobierno necesitan reunirse y discutir otras opciones que no incluyan relocalizar las casetas. ¿A dónde irá esa gente? (0)

b. Existe una discrepancia entre las investigaciones científicas realizadas. Algunas sugieren que las casetas no son culpables del deterioro de los recursos naturales mientras que otras sugieren lo contrario. Más investigación es necesaria antes de tomar una decisión. (2)

c. El número de residentes y visitantes se ha duplicado desde el 1940. Los efectos secundarios del desarrollo urbano han sido los responsables del deterioro del ecosistema. (1)
6. ¿Si te obligaran a tomar una decisión en cuanto a mantener o relocalizar las casetas de La Parguera basado en la información provista en este artículo, cuál sería tu decisión?

a. Mantener las casetas (0)

b. Relocalizar las casetas (0)

7. ¿Piensas que los residentes de las casetas, el grupo de ambientalistas y el gobierno estarán de acuerdo con tu decisión?

**Si estarán todos de acuerdo, contesta aquí:** ¿Por qué todos los grupos estarán de acuerdo con mi decisión?

a. Si todos los grupos evaluaran el asunto de forma imparcial, se darían cuenta que las casetas son inofensivas al ecosistema. (0)

b. Si todos los grupos evaluaran el asunto de forma imparcial, se darían cuenta que las casetas deben ser removidas ya que han colaborado con el deterioro del ecosistema. (0)

c. A largo plazo, la remoción de las casetas no sólo beneficiará el ambiente, sino la economía. (0)
Si uno o más no están de acuerdo, contesta aquí: ¿Por qué uno o más grupos no estarán de acuerdo con mi decisión?

a. Algunos grupos no estarán de acuerdo porque no tienen un marco claro de los riesgos y beneficios que conlleva la remoción de las casetas. (1)

b. Es poco probable que consiga que todos los grupos estén de acuerdo con mi decisión ya que la misma dependerá en si estos salen beneficiados o no. (2)

c. Es poco probable que todos los grupos estén de acuerdo con mi decisión al principio por tener diferentes perspectivas sobre el asunto. Sin embargo, eventualmente llegarán a un acuerdo sobre el mejor curso de acción a tomar. (0)

8. ¿Si la decisión de mantener o relocalizar las casetas se pone en marcha, recomendarías que fondos y recursos adicionales se utilicen para continuar el estudio sobre el efecto de las casas flotantes al ecosistema de La Parguera?

Si lo recomiendas, contesta aquí: ¿Por qué recomendaría continuar el estudio del efecto de las casetas al ecosistema de La Parguera?

a. Recolectar datos adicionales ayudaría a contestar y rechazar la crítica de los grupos que no están de acuerdo con mi decisión. (1)

b. Recolectar datos adicionales probablemente llevará a alcanzar un mutuo acuerdo. (0)
c. Recolectar datos adicionales ayudará a que la gente siga discutiendo y reevaluando mi decisión. (2)

Si no lo recomiendas, contesta aquí: ¿Por qué no recomendaría continuar el estudio del efecto de las casetas al ecosistema de La Parguera?

a. La decisión fue tomada porque había suficiente información. No se debe investigar más sobre este asunto. (0)

b. De tener fondos adicionales, estos deben ir hacia la restauración del ecosistema. (0)

c. Los residentes de las casetas pueden pagarle a investigadores para que continúe el estudio de los posibles efectos al ecosistema. El gobierno no debe ser responsable por esto. (0)

Aspecto RSS: Escepticismo

9. En una reunión de la comunidad, un grupo de científicos contratados por los residentes de las casetas y otro grupo de científicos contratado por un grupo ambientalista proveen sus opiniones sobre el asunto de las casetas. ¿Esperarías que sus opiniones sean similares?

Si crees que serán similares, contesta aquí: ¿Por qué las opiniones ofrecidas por los científicos contratados por los residentes de las casetas y las opiniones de los científicos contratados por el grupo ambientalista serán similares?
a. Los datos son objetivos; si el monitoreo se realiza en el mismo lugar, los resultados deben ser los mismos. (0)

b. Aunque los resultados varíen un poco, ambos grupos pueden llegar a un acuerdo al comparar y discutir los mismos. (0)

c. Los científicos basan sus conclusiones en datos objetivos y evidencia real, por lo tanto, ambas opiniones deben ser similares. (0)

**Si crees que no serán similares, contesta aquí:** ¿Por qué las opiniones ofrecidas por los científicos contratados por los residentes de las casetas y las opiniones de los científicos contratados por el grupo ambientalista **no serán similares**?

a. Aunque los resultados varíen un poco, ambos grupos pueden llegar a un acuerdo al comparar y discutir los mismos. (0)

b. Los detalles detrás de este asunto pueden provenir de diferentes fuentes, por lo que los científicos puedan tener opiniones diferentes. (1)

c. Las opiniones están basadas en los intereses y metas de cada uno de los grupos, por lo que, estas metas pueden afectar la manera en que se usan e interpretan los datos. (2)
10. En respuesta a la crítica sobre los efectos cuestionables de las casas flotantes al ecosistema de La Parguera, el Departamento de Recursos Naturales y Ambientales (DRNA) pudiera sugerir utilizar parte del dinero recaudado del impuesto municipal para contratar un equipo de científicos que se dedique a recopilar datos sobre la calidad de agua y la población de dinoflagelados en el área para proveer reportes regularmente a la comunidad. Los residentes de las casetas deciden contratar otro grupo de científicos para llevar a cabo el mismo monitoreo de calidad de agua y población de dinoflagelados. ¿Esperarías que los resultados de ambos grupos sean iguales o diferentes?

**Si crees que son iguales, contesta aquí:** ¿Por qué esperaría que los resultados de ambos grupos de científicos sean iguales?

a. Si el proceso investigativo se realiza de forma correcta, los resultados serán iguales. (0)

b. Ambos grupos están investigando las mismas cosas, por lo tanto, los resultados serán iguales. (0)

c. Aunque parte de la data no sea la misma, luego de un análisis exhaustivo, los resultados deben ser semejantes en ambos estudios. (0)

**Si crees que son diferentes, contesta aquí:** ¿Por qué esperaría que los resultados de ambos grupos de científicos sean diferentes?

a. Los científicos han sido contratados por entidades que tienen prioridades diferentes, por lo tanto, los resultados favorecerán los intereses de cada cual. (2)
b. Los resultados pueden variar de acuerdo con el método de recolección de datos utilizado. (1)

c. El DRNA puede pagar a los científicos mejor que los residentes de las casetas, por lo tanto, sus resultados serán más confiables. (0)

11. Un biólogo marino de una universidad prestigiosa publica un artículo en una revista científica de renombre confirmando que las afluencias de nutrientes provenientes de las aguas usadas de las estructuras encontradas a lo largo de la costa de un importante ecosistema marino son la causa del deterioro del mismo. ¿Crees que esto cambie la opinión del debate de las casetas de La Parguera?

**Si crees que afectaría, contesta aquí:** ¿Por qué entiendo que estos resultados **afectarían** el debate de las casetas?

a. Estos resultados serán evidencia clave que los grupos opositores usen para fortalecer su caso. (2)

b. El estudio permitirá que todos los grupos reconozcan la amenaza que las casetas representan y que acción correctiva se lleve a cabo. (0)

c. Los grupos opositores interpretarán los resultados de forma diferente y encontrarán faltas que pueden desviarlos más lejos de una solución. (1)
Si crees que no afectaría, contesta aquí: ¿Por qué entiendo que estos resultados no afectarían el debate de las casetas?

a. El ecosistema marino al cual se hace referencia puede tener condiciones del agua diferentes. (0)

b. Este biólogo marino es un extranjero y el estudio no se hizo en Puerto Rico, por lo tanto, no aplicaría a esta situación. (1)

c. Los grupos opositores ya están convencidos de que sus resultados son correctos y probablemente no considerarían estudios adicionales. (2)
Appendix E
QuASSR on the Indian River Lagoon, Florida

COASTAL SITUATION IN FLORIDA

The Indian River Lagoon (IRL) is one of the most biologically diverse estuaries in North America as it contains over four thousand species of plants and animals (https://www.fws.gov/refuge/pelican_island/wildlife_and_habitat/indian_river_lagoon.html).

It covers around 30% of the eastern coast of Florida and stretches approximately 156 miles. The northern section of the IRL is comprised of three bodies of water: the Mosquito Lagoon, Banana River, and Indian River. The central and southern sections of this system are fed by freshwater sources such as the San Sebastian River, and the St. Lucie Canal which is connected to the largest freshwater lake in Florida, Lake Okeechobee. As Florida’s population has exponentially increased in the past decades, concern around the health of one of the most important natural resources has been on the rise as well. Being an essential part of Florida’s economic engine, this estuary, separated from the ocean by barrier islands, has always been an attractive area for recreating and living due to its wealth of resources and mild climate.

Besides hosting thirty-five threatened or endangered species, it also hosts *Pyrodinium bahamense* during the summer and early fall. However, nutrient pollution has affected the health of the IRL and its inhabitants, including these dinoflagellates. Climate change and anthropogenic activities are to blame for the declining state of the IRL. Excessive rainfall causes periodic freshwater releases from Lake Okeechobee through the St. Lucie Canal into the IRL; this happens because the historic flow of surface waters in the
Greater Everglades Watershed was changed to address flood control, water supply, and agricultural needs. Droughts, on the other hand, set a limit on freshwater releases. Both cause an imbalance in the salinity and nutrients in IRL waters, which can have other negative consequences for aquatic life in the IRL.

Development, alteration of surface water drainage, alteration of shoreline vegetation, fertilizer use, and septic tank discharges are factors that have led to the accumulation of muck at the bottom of the IRL and/or the influx of high levels of phosphorus and nitrogen that trigger toxic algae blooms. These factors can induce a phenomenon known as eutrophication or excessive richness of nutrients which may trigger “blooms”. Most blooms in the IRL are due to microscopic algal cells populating the water column to such a degree as to discolor the water, in extreme circumstances rendering it opaque. Some blooms, such as those associated with Okeechobee waterway releases, can form a tangible sludge or skin on the surface of the water. Some of its negative consequences include death of marine plants due to the lack of light for photosynthesis and anoxic conditions which lead to fish kills. Some blooms also emit toxins which are a health threat.

Scientists and environmental groups have been monitoring conditions in different sections of the lagoon for years and many conservation efforts are starting to be put into practice. For example, with the help of universities and grants from federal authorities, programs to restore the shoreline through the renewal of the mangrove population and to introduce oysters to filter the water and reduce the erosion hope to spark awareness and motivate others to learn about the importance of this natural resource. Much more needs to be done to educate and involve the public in restoration efforts such as these. Authorities
have recognized this need when, in March 2016, Brevard County voters approved a sales tax to raise money for cleanup efforts, which include upgrading wastewater treatment plants, removing old septic tanks from old infrastructures along the shoreline, and restoring the natural flow of freshwater from Lake Okeechobee. Should agriculture and water supply be risked in restoring the natural flow of freshwater? Will the Indian River Lagoon ever be saved, or is it too late?

SSR Aspect: Complexity

1. Is the issue of the Indian River Lagoon a complex issue?

NO: Select the response below that best explains why the IRL issue is a fairly straightforward issue.

a. It’s clear that agriculture is causing damage to the ecosystem, and it needs to stop. (0)
b. The government hasn’t enforced environmental policy properly. They are the ones at fault. (0)
c. The damage is done, and now it’s time to fix it no matter what. (0)

YES: Select the response below that best explains why the IRL issue is complex.

a. The IRL issue is complex because harsh environmental action has to be put into practice while avoiding affecting the economy and tourism of the area. (2)
b. The IRL issue is complex because negative consequences have outweighed positive ones, and we don’t know what this can bring. (1)
c. The IRL issue is complex because the government must acknowledge the problem and come up with a plan. (0)

2. Are the problems in the Indian River Lagoon easy to resolve?

NO: Why are the problems in the IRL difficult to resolve?

a. Because not enough information is provided. If more details were available, it would be easier to resolve. (1)

b. Because it involves balancing the economy with environmental action, legislation, and the possibility of switching agricultural practices and residents’ lifestyles. (2)

c. Because it involves the combined effort of the government, the residents, and the environmental groups. (1)

YES: Why are the problems in the IRL easy to resolve?

a. The IRL is a tourist attraction and an economic engine for Florida. Restoration must be a priority. (0)

b. Conservation efforts should include making the residents pay for the restoration. They clearly have contributed to the deterioration of the system. (0)

c. An admission fee should be implemented anywhere there’s access to the IRL to cover the costs of restoration. (0)

**SSR Aspect: Perspective-taking**

3. How likely is it that farmers and government officials would endorse the same solution to this problem?
It is **very likely** that farmers and government officials would endorse the same solution.

It is **not very likely** that the farmers and government officials would endorse the same solution.

Why is it **very likely** that the farmers and government officials would endorse the same solution?

a. Both groups can work on finding a solution and coming up with a plan. (0)

b. A forum for open discussion between groups will foster reaching a solution. (0)

c. A neutral entity can listen to both parties and come up with a mediation plan. (0)

Why is it **not very likely** that the farmers and the government officials would endorse the same solution?

a. The farmers and government officials have different concerns and points of view about the situation. (2)

b. The farmers and government officials may have access to different pieces of information about the environmental situation of the area. (1)

c. The farmers and the government officials haven’t had a chance to meet and come up with a plan. (0)

4. How likely is it that an environmental advocacy group and the government would endorse the same solution to this situation?

It is **very likely** that an environmental advocacy group and the government would endorse the same solution to this situation.
It is not very likely that an environmental advocacy group and the government would endorse the same solution to this situation.

Why is it very likely that an environmental advocacy group and the government would endorse the same solution to this situation?

a. Both groups can work on finding a solution and coming up with a plan. (0)
b. A forum for open discussion between groups will foster reaching a solution. (0)
c. A neutral entity can listen to both parties and come up with a mediation plan. (0)

Why is it not very likely that an environmental advocacy group and the government would endorse the same solution to this situation?

a. Although aware of the situation, the government and the environmental advocacy group have different concerns and points of view about the situation. (2)
b. Although aware of the situation, the government and the environmental advocacy group may have access to different pieces of information about the environmental situation of the area. (1)
c. Although aware of the situation, the government and the environmental advocacy group haven’t had a chance to meet and come up with a plan. (0)

SSR Aspect: Inquiry

5. If you were asked to decide on whether to leave or restore the natural water flow of Lake Okeechobee, do you feel as though you have enough information to make a decision?
I feel I have sufficient information to make a decision about whether to leave or restore the natural flow of Lake Okeechobee.

I do not feel I have sufficient information to make a decision about whether to leave or restore the natural flow of Lake Okeechobee.

Why is there sufficient information to make a decision about whether to leave or restore the natural flow of Lake Okeechobee?

a. The farmers bring money into the local economy, and the change in flow addressed other problems like flood control and water supply. (0)

b. Scientific research has condemned the change of the freshwater flow as it has promoted the deterioration of this natural resource. (0)

c. The government needs to act upon the removal of the septic tanks, which is the real problem. (0)

Why is there not sufficient information to make a decision about whether to leave or restore the natural flow of Lake Okeechobee?

a. The farmers, environmental groups, and government officials need to meet and discuss other options that do not include relocating farmlands. (0)

b. The deterioration of the IRL is a multifactorial problem from climate change to anthropogenic activities. More research needs to be done to decide where is the best place to start. (2)
c. The number of residents and visitors has exponentially increased in the last decades. The side effects of urbanization and development may be the ones responsible for the deterioration of the ecosystem. (1)

6. If you were forced to make a decision whether to leave or restore the natural flow of Lake Okeechobee based on the information in the article, what decision would you make?
   a. Keep the flow (to the east and west)
   b. Restore the natural flow (south towards the Everglades)

7. Do you think the farmers, the environmental advocacy group, and the government would agree with your decision?
   I feel all parties would agree with my decision.
   I feel one or more parties would not agree with my decision.

Why would all parties agree with your decision?
   a. If all parties looked at the issue without bias, then it’s clear that the flow of water is not the cause of the IRL deterioration. (0)
   b. If all parties looked at the issue without bias, then it’s clear that the natural flow of water needs to be restored to foster the restoration of the ecosystem. (0)
   c. The long-term benefits of restoring the natural flow of Lake Okeechobee will not only be good for the IRL, but also for the economy. (0)
Why would one or more parties likely **not agree** with your decision?

a. Certain parties will disagree because they don’t have a proper understanding of the risks and benefits of restoring the natural flow of Lake Okeechobee. (1)

b. It is unlikely that I could get all parties to agree with my decision because their agreement depends on whether or not they are benefitting from the restoration of the natural freshwater flow. (2)

c. It is unlikely that all parties would agree at first due to their different perspectives. However, they would eventually come to an agreement about the best course of action to take. (0)

8. If the decision you made on whether to leave or restore the natural flow of Lake Okeechobee were put into action, would you recommend that additional funds and resources be used to continue studying the effect of the freshwater releases into the Indian River Lagoon’s ecosystem?

I **would recommend** continuing to study the effect of freshwater releases into the IRL’s ecosystem.

I **would not recommend** continuing to study the effect of freshwater releases into the IRL’s ecosystem.

Why would you **recommend** continuing to study the effect of the freshwater releases into the IRL’s ecosystem?

a. Collecting additional data would help address and defray criticisms from groups that disagree with my decision. (1)
b. Collecting additional data will likely lead to a common agreement. (0)
c. Collecting additional data will help people continue discussing and re-evaluating my decision. (2)

Why would you not recommend continuing to study the effect of the freshwater releases into the IRL’s ecosystem?

a. A decision was reached because there was enough information. There is no need to keep researching about the issue. (0)
b. Any additional funds should be used towards restoring the ecosystem. (0)
c. The government can pay researchers to continue studying possible effects on the ecosystem. The citizens shouldn’t be responsible for this. (0)

SSR Aspect: Skepticism

9. At a town meeting, a group of scientists employed by the farmers and another group of scientists employed by an environmental advocacy group provided expert opinions on the freshwater flow restoration plan. Would you expect their opinions to be similar?

Expert opinions offered by scientists employed by the farmers and the environmental advocacy group will likely be similar.

Expert opinions offered by scientists employed by the farmers and the environmental advocacy group will likely not be similar.
Why would the opinion of both groups of scientists likely be similar?

a. Data are objective, and if they’re monitoring the same area, they should be getting the same results. (0)

b. Even if their results differ slightly, they can come to an agreement once they’re shared and discussed. (0)

c. Scientists base results on objective data and actual findings; therefore, both opinions should be similar. (0)

Why would the opinion of both groups of scientists will not likely be similar?

a. Even if their results differ slightly, they can come to an agreement once they’re shared and discussed. (0)

b. The details behind this issue might be rooted from different sources, so scientists may have different opinions. (1)

c. Opinions will be based on each of the groups’ interests and goals; therefore, these goals will affect how the data is used and interpreted. (2)

10. In response to the criticism about the costs and consequences of the restoration of the freshwater flow of Lake Okeechobee, the government could allocate funds to hire a team of scientists dedicated to collecting data on water quality in the area and giving regular reports to the local community. The farmers are considering hiring a different group of scientists to also conduct water monitoring. If this were to happen, would you expect the findings of these two groups of scientists to be similar or different?
I would expect the findings of the two groups of scientists to be the same.

I would expect the findings of the two groups of scientists to be different.

Why would you expect the findings of the two groups of scientists to be the same?

a. If the process is done correctly then findings should be the same. (0)

b. Both groups are monitoring the same things; therefore, findings should be the same. (0)

c. Even though some data might not be the same, after a thorough analysis, findings should match between both studies. (0)

Why would you expect the findings of the two groups of scientists to be different?

a. Scientists have been hired by groups with different priorities; therefore, findings will favor each one’s interests. (2)

b. Findings may be different depending on the data collection methods used. (1)

c. The government can pay scientists more money; therefore, their findings may be more reliable than those scientists paid by the farmers. (0)

11. A marine biologist at a prestigious university publishes an article in a top-ranked journal confirming that the excessive freshwater discharges to a marine ecosystem have been the cause of the deterioration of the ecosystem. Do you think this will change the IRL debate on the restoration of the freshwater flow?

I would expect the new findings to change the debate.

I would not expect the new findings to change the debate.
Why would you expect the new findings to change the IRL debate?

a. These findings will become an important piece of evidence that opposing parties will use to strengthen their case. (2)

b. This study will allow all parties to recognize the threat that the freshwater discharges have represented, and corrective action will be taken. (0)

c. The opposing parties will interpret findings differently and find flaws that may drive them further from a solution. (1)

Why would you not expect the new findings to change the IRL debate?

a. The water conditions of that major marine ecosystem may not be the same. (0)

b. This marine biologist is an outsider, and the study wasn’t done in Florida; therefore, it doesn’t apply to this situation. (1)

c. Opposing parties are already convinced that their findings are correct, and they aren’t likely to consider additional studies. (2)
SITUACIÓN COSTERA EN FLORIDA

La Laguna del rio Indian (IRL por sus siglas en inglés) es uno de los estuarios más biológicamente diversos en América del Norte ya que contiene más de cuatro mil especies de plantas y animales (https://translate.google.com/translate?hl=es-419&sl=en&u=https://www.fws.gov/refuge/pelican_island/wildlife_and_habitat/indian_river_lagoon.html&prev=search). La misma cubre alrededor del 30% de la costa este de la Florida y se extiende aproximadamente 156 millas. La porción norte de la IRL se compone de tres cuerpos de agua: la Laguna Mosquito, el río Banana, y el río Indian. La parte central y sur de este sistema se alimenta de cuerpos de agua dulce como lo son el río San Sebastián y el canal St. Lucie el cual conecta al lago de agua dulce más grande de la Florida, el lago Okeechobee. Debido al incremento desmesurado de la población de Florida en las últimas décadas, preocupación sobre la salud de uno de los recursos más importantes volvió relucir. Siendo la mayor fuente económica, este estuario separado del océano por grandes islotes, siempre ha sido un atractivo para la recreación y la vivienda debido a su riqueza de recursos y un clima fresco.

Además de servir de hogar a 35 especies amenazadas o en peligro de extinción, alberga al microorganismo Pyrodinium bahamense durante el verano y comienzo del otoño. Sin embargo, la contaminación por nutrientes ha afectado la salud de este ecosistema y todos los que allí viven incluyendo estos dinoflagelados. El cambio climático y las actividades antropogénicas son responsables del estado crítico del IRL. La precipitación excesiva contribuye a las recurrentes descargas de agua dulce del lago Okeechobee por el canal St. Lucie. Esto sucede ya que el flujo regular de las aguas
superficiales hacia la cuenca mayor de los Everglades fue desviado para controlar el riesgo de inundaciones, asegurar abastecimientos de agua, y asignar terrenos para la agricultura. Por el contrario, durante los periodos de sequía los afluentes de agua dulce se limitan. Ambos causan un desbalance en la salinidad y los nutrientes del IRL lo que puede traer otras consecuencias negativas a la vida acuática del mismo.

El desarrollo urbano, la alteración al drenaje de agua, la alteración de la vegetación costera, el uso de fertilizantes, y las descargas de los pozos sépticos son factores que han promulgado la acumulación de fango en el fondo del IRL y el flujo de altos niveles de fósforo y nitrógeno promoviendo el crecimiento o “florecimiento” de algas nocivas. Estos factores inducen un fenómeno conocido como eutroficación o enriquecimiento excesivo de nutrientes. La mayoría de los florecimientos en la IRL ocurren por la proliferación de algas microscópicas en la columna de agua al punto de alterar el color de la misma y bajo circunstancias extremas opacarla. Algunos florecimientos, especialmente los asociados a las descargas de agua dulce del Lago Okeechobee, pueden formar una capa de material espeso de color verdoso sobre la superficie del agua. Varias de las consecuencias negativas de estos “florecimientos” incluyen mortandad de plantas marinas por falta de luz para la fotosíntesis y condiciones anóxicas que producen la muerte de peces. Algunos “florecimientos” emiten toxinas que presentan ser una amenaza para la salud.

Científicos y grupos ambientales han monitoreado diferentes secciones de la laguna por años lo que ha llevado a la implantación de iniciativas de conservación. Por ejemplo, con la ayuda de universidades y fondos federales, programas para la restauración de la costa mediante la siembra de manglares y la introducción de ostras para promover la filtración y reducir la erosión esperan despertar consciencia y motivar a otros sobre la
importancia de este recurso natural. Sin embargo, falta mucho por hacer para educar y
envolver a la población en los esfuerzos de restauración. Las autoridades han reconocido
esta necesidad ya que, en marzo de 2016, los votantes del condado de Brevard aprobaron
un impuesto de venta para recaudar fondos para los esfuerzos de limpieza que incluían:
mejoras en las plantas de tratamiento de aguas, la remoción de pozos sépticos de viejas
infraestructuras a lo largo de la costa, y la restauración de flujo original de las aguas dulces
superficiales del lago Okeechobee. ¿Se debe sacrificar la agricultura y los abastecimientos
de agua para restaurar el flujo original de agua dulce? ¿Se podrá salvar la IRL o será
demasiado tarde?

Aspecto RSS: Complejidad

1. ¿Será el problema de la Laguna del rio Indian uno complejo?

**NO**: Selecciona la respuesta que mejor explica porque el problema de la IRL **no es**
Complejo.

a. Es claro que la agricultura está causando daño al ecosistema por lo que se debe
detener. (0)

b. El gobierno no ha puesto en práctica la legislación ambiental. Ellos tienen la culpa.
(0)

c. El daño ya está hecho y ahora hay que arreglarlo a como de lugar. (0)

**SI**: Selecciona la respuesta que mejor explica porque el problema de la IRL es uno
Complejo.

a. El problema de la IRL es complejo porque una fuerte acción ambiental debe ser
implementada sin afectar la economía y el turismo del área. (2)
b. El problema de la IRL es complejo porque las consecuencias negativas han sobrepasado las positivas y no sabemos lo que esto pueda traer. (1)

c. El problema de la IRL es complejo porque el gobierno debe reconocer el problema primero para luego crear un plan. (0)

2. ¿Serán fáciles de resolver los problemas de la Laguna del rio Indian?

NO: ¿Por qué los problemas de la IRL son difíciles de resolver?

a. No hay suficiente información. Si hubiese más detalles disponibles, sería más fácil de resolver. (1)

b. Porque envuelve balancear la economía con la acción ambiental, la legislación, y la posibilidad de transformar las prácticas de agricultura y el estilo de vida de los residentes. (2)

c. Porque envuelve el esfuerzo combinado del gobierno, los residentes y los ambientalistas. (1)

SI: ¿Por qué los problemas de la IRL son fáciles de resolver?

a. La IRL es una atracción turística y el motor económico de la Florida. La restauración debe ser una prioridad. (0)

b. Los esfuerzos de conservación deben incluir hacer pagar a los residentes por la restauración del ecosistema. Claramente han contribuido al deterioro del mismo. (0)

c. Se debe implementar un costo de entrada que ayude a cubrir los gastos de restauración. (0)
Aspecto RSS: Perspectiva

3. ¿Cuán probable es que los agricultores y oficiales de gobierno propongan la misma solución a este problema?

Si crees que es muy probable, contesta aquí: ¿Por qué es muy probable que los agricultores y oficiales de gobierno propongan la misma solución a este problema?

a. Ambos pueden trabajar en conjunto para encontrar una solución y establecer un plan. (0)

b. Un foro de discusión abierta entre ambos grupos promoverá el alcanzar una solución. (0)

c. Una entidad neutral puede escuchar a ambos grupos y crear un plan de mediación. (0)

Si crees que no es muy probable, contesta aquí: ¿Por qué no es muy probable que los agricultores y oficiales de gobierno propongan la misma solución a este problema?

a. Los agricultores y los oficiales de gobierno tienen diferentes preocupaciones y puntos de vista sobre este asunto. (2)

b. Los agricultores y los oficiales de gobierno pueden tener acceso a diferentes recursos de información ambiental sobre este asunto. (1)

c. Los agricultores y los oficiales de gobierno no han tenido la oportunidad de reunirse y redactar un plan. (0)
4. ¿Cuán probable es que el grupo de ambientalistas y el gobierno propongan la misma solución a este asunto?

Si crees que es muy probable, contesta aquí: ¿Por qué es muy probable que el grupo de ambientalistas y el gobierno propongan la misma solución a este asunto?

a. Ambos pueden trabajar en conjunto para encontrar una solución y establecer un plan. (0)

b. Un foro de discusión abierta entre ambos grupos promoverá el alcanzar una solución. (0)

c. Una entidad neutral puede escuchar a ambos grupos y crear un plan de mediación. (0)

Si crees que no es muy probable, contesta aquí: ¿Por qué no es muy probable que el grupo ambientalista y el gobierno propongan la misma solución a este asunto?

a. Aunque están conscientes de la situación, el gobierno y el grupo ambientalista tienen diferentes preocupaciones y puntos de vista sobre este asunto. (2)

b. Aunque están conscientes de la situación, el gobierno y el grupo ambientalista pueden tener acceso a diferentes recursos de información ambiental sobre este asunto. (1)

c. Aunque están conscientes de la situación, el gobierno y el grupo ambientalista no han tenido la oportunidad de reunirse y redactar un plan. (0)
Aspecto RSS: Cuestionar

5. ¿Si tuvieras que tomar una decisión en cuanto a mantener o restaurar el flujo original del lago Okeechobee, sientes que tienes suficiente información para hacer la misma?

Si crees que tienes suficiente información, contesta aquí: ¿Por qué entiendo que tengo suficiente información para tomar una decisión en cuanto a mantener o restaurar el flujo original del lago Okeechobee?

a. Los agricultores aportan dinero a la economía local y el cambio en el flujo atiende otros problemas como la susceptibilidad a inundaciones y el abastecimiento del agua. (0)

b. Las investigaciones científicas denuncian que el cambio en el flujo de agua dulce ha promovido el deterioro de este recurso natural. (0)

c. El gobierno debe tomar acción a favor de la remoción de los pozos sépticos ya que son los verdaderos responsables. (0)

Si crees que no tienes suficiente información, contesta aquí: ¿Por qué no tengo suficiente información para tomar una decisión en cuanto a mantener o restaurar el flujo original del lago Okeechobee?

a. Los agricultores, los ambientalistas y los oficiales de gobierno necesitan reunirse y discutir otras opciones que no incluyan relocalizar los terrenos agrícolas. (0)

b. El deterioro de la IRL es un problema que envuelve muchos factores desde el cambio climático a las actividades antropogénicas. Más estudios son necesarios antes de tomar una decisión. (2)
c. El número de residentes y visitantes se ha incrementado exponencialmente en las últimas décadas. Los efectos secundarios del desarrollo urbano han sido los responsables del deterioro del ecosistema. (1)

6. ¿Si te obligaran a tomar una decisión en cuanto a mantener o restaurar el flujo original del lago Okeechobee basado en la información provista en este artículo, cuál sería tu decisión?
   a. Mantener el desvío del flujo (hacia el este y el oeste) (0)
   b. Restaurar el flujo original (hacia el sur) (0)

7. ¿Piensas que los agricultores, el grupo de ambientalistas y el gobierno estarán de acuerdo con tu decisión?
   Si estarán todos de acuerdo, contesta aquí: ¿Por qué todos los grupos estarán de acuerdo con mi decisión?
   a. Si todos los grupos evaluaran el asunto de forma imparcial, se darían cuenta que el flujo de agua no es la causa del deterioro de la IRL. (0)
   b. Si todos los grupos evaluaran el asunto de forma imparcial, se darían cuenta que el flujo de agua debe ser restaurado ya que ha colaborado con el deterioro del ecosistema. (0)
   c. Los beneficios a largo plazo de la restauración del flujo de agua dulce del lago Okeechobee no sólo beneficiará la IRL, sino la economía. (0)
Si uno o más no están de acuerdo, contesta aquí: ¿Por qué uno o más grupos no estarán de acuerdo con mi decisión?

a. Algunos grupos no estarán de acuerdo porque no tienen un marco claro de los riesgos y beneficios que conlleva la restauración del flujo original del Lago Okeechobee. (1)

b. Es poco probable que consiga que todos los grupos estén de acuerdo con mi decisión ya que la misma dependerá en si estos salen beneficiados o no luego de la restauración del flujo de agua dulce. (2)

c. Es poco probable que todos los grupos estén de acuerdo con mi decisión al principio por tener diferentes perspectivas sobre el asunto. Sin embargo, eventualmente llegarán a un acuerdo sobre el mejor curso de acción a tomar. (0)

8. ¿Si la decisión de mantener o restaurar el flujo del lago Okeechobee se pone en marcha, recomendarías que fondos y recursos adicionales se utilicen para continuar el estudio sobre el efecto de las descargas de agua dulce al ecosistema de la laguna del rio Indian?

Si lo recomiendas, contesta aquí: ¿Por qué recomendaría continuar el estudio del efecto de las descargas de agua dulce al ecosistema de la IRL?

a. Recolectar datos adicionales ayudaría a contestar y rechazar la crítica de los grupos que no están de acuerdo con mi decisión. (1)

b. Recolectar datos adicionales probablemente llevará a alcanzar un mutuo acuerdo. (0)
c. Recolectar datos adicionales ayudará a que la gente siga discutiendo y reevaluando mi decisión. (2)

Si no lo recomiendas, contesta aquí: ¿Por qué no recomendaría continuar el estudio del efecto de las descargas de agua dulce al ecosistema de la IRL?

a. La decisión fue tomada porque había suficiente información. No se debe investigar más sobre este asunto. (0)

b. De tener fondos adicionales, estos deben ir hacia la restauración del ecosistema. (0)

c. El gobierno puede pagarle a investigadores para que continúe el estudio de los posibles efectos al ecosistema. Los ciudadanos no deben ser responsable por esto. (0)

Aspecto RSS: Escepticismo

9. En una reunión de la comunidad, un grupo de científicos contratados por los agricultores y otro grupo de científicos contratado por un grupo ambientalista proveen sus opiniones sobre el plan para restaurar el flujo de agua dulce.

¿Esperarías que sus opiniones sean similares?

Si crees que serán similares, contesta aquí: ¿Por qué las opiniones ofrecidas por los científicos contratados por agricultores y las opiniones de los científicos contratados por el grupo ambientalista serán similares?

a. Los datos son objetivos; si el monitoreo se realiza en el mismo lugar, los resultados deben ser los mismos. (0)

b. Aunque los resultados varíen un poco, ambos grupos pueden llegar a un acuerdo al comparar y discutir los mismos. (0)
c. Los científicos basan sus conclusiones en datos objetivos y evidencia real, por lo tanto, ambas opiniones deben ser similares. (0)

Si crees que no serán similares, contesta aquí: ¿Por qué las opiniones ofrecidas por los científicos contratados por los agricultores y las opiniones de los científicos contratados por el grupo ambientalista no serán similares?

a. Aunque los resultados varíen un poco, ambos grupos pueden llegar a un acuerdo al comparar y discutir los mismos. (0)

b. Los detalles detrás de este asunto pueden provenir de diferentes fuentes, por lo que los científicos puedan tener opiniones diferentes. (1)

c. Las opiniones están basadas en los intereses y metas de cada uno de los grupos, por lo que, estas metas pueden afectar la manera en que se usan e interpretan los datos. (2)

10. En respuesta a la crítica sobre los costos y las consecuencias de la restauración del flujo de agua dulce del Lago Okeechobee, el gobierno pudiera asignar fondos para contratar un equipo de científicos que se dedique a recopilar datos sobre la calidad de agua en el área para proveer reportes regularmente a la comunidad. Los agricultores considerarían contratar otro grupo de científicos para llevar a cabo el mismo monitoreo de calidad de agua. ¿Si esto sucediera, esperarías que los resultados de ambos grupos sean iguales o diferentes?

Si crees que son iguales, contesta aquí: ¿Por qué esperarías que los resultados de ambos grupos de científicos sean iguales?
a. Si el proceso investigativo se realiza de forma correcta, los resultados serán iguales. (0)

b. Ambos grupos están investigando las mismas cosas, por lo tanto, los resultados serán iguales. (0)

c. Aunque parte de la data no sea la misma, luego de un análisis exhaustivo, los resultados deben ser semejantes en ambos estudios. (0)

Si crees que son diferentes, contesta aquí: ¿Por qué esperaría que los resultados de ambos grupos de científicos sean diferentes?

a. Los científicos han sido contratados por entidades que tienen prioridades diferentes, por lo tanto, los resultados favorecerán los intereses de cada cual. (2)

b. Los resultados pueden variar de acuerdo con el método de colección de datos utilizado. (1)

c. El gobierno puede pagar a los científicos mejor que los agricultores, por lo tanto, sus resultados serán más confiables. (0)

11. Un biólogo marino de una universidad prestigiosa publica un artículo en una revista científica de renombre confirmando que el exceso de afluencias de agua dulce a un importante ecosistema marino son la causa del deterioro del mismo. ¿Crees que esto cambie la opinión del debate de la restauración del flujo de agua dulce hacia la laguna del río Indian?

Si crees que afectaría, contesta aquí: ¿Por qué entiendo que estos resultados afectarían el debate de la restauración del flujo de agua dulce?
a. Estos resultados serán evidencia clave que los grupos opositores usen para fortalecer su caso. (2)

b. El estudio permitirá que todos los grupos reconozcan la amenaza que representan las descargas de agua dulce y que acción correctiva se debe llevar a cabo. (0)

c. Los grupos opositores interpretarán los resultados de forma diferente y encontrarán faltas que pueden desviarlos más lejos de una solución. (1)

**Si crees que no afectaría, contesta aquí:** ¿Por qué entiendo que estos resultados no afectarían el debate de la restauración del flujo de agua dulce?

a. El ecosistema marino al cual se hace referencia puede tener condiciones del agua diferentes. (0)

b. Este biólogo marino es un extranjero y el estudio no se hizo en Florida, por lo tanto, no aplicaría a esta situación. (1)

c. Los grupos opositores ya están convencidos de que sus resultados son correctos y probablemente no considerarían estudios adicionales. (2)
Appendix F
Semi-structured Interview Questions

Interview Questions Format (English version)

The interview will be performed in Spanish. It should last between five to ten minutes, and students will be interviewed individually. Recordings will later be transcribed and translated.

1. Did you enjoy discussing about environmental issues? Explain
   a. (YES) Which one did you like the best? Why?
   b. (NO) What didn’t you like about it? Explain

2. What was your position on the issue? Did it match your stance?

3. What were your initial thoughts on the issue?

4. Did they ever change throughout the discussion or exploration of the issue?
   a. (YES) When did this happen? How did they change?
   b. (NO) Did someone ever try to influence your beliefs on the issue?

5. Did you know anything about the issues discussed in class prior to discussion?
   a. (YES) Could you explain?
   b. (NO) Next question

6. Would you rather have learned about (local or foreign) environmental issues?*
   Why?

*Students in the “treatment group” will be asked about local issues. Students in the “comparison group will be asked about foreign issues.
Interview Questions Format (Spanish version)

La entrevista será en español. La misma durará entre cinco a diez minutos y se realizará individualmente. La grabación será transcrita y traducida al inglés.

1. ¿Te gustó discutir acerca de temas ambientales como parte de la clase?
   a. (SI) ¿Cuál fue tu favorito? ¿Por qué?
   b. (NO) Explica que no te gustó.

2. ¿Qué posición te tocó defender? ¿Coincidía con tu posición?

3. ¿Cuál era tu pensar al inicio del tema?

4. ¿Hubo cambios en tu forma de pensar durante la exploración o discusión del tema?
   a. (SI) ¿Cuándo ocurrió? ¿Cómo cambió?
   b. (NO) ¿En algún momento, alguien trató de influenciarte?

5. ¿Tenías algún conocimiento de los temas antes de ser discutidos en clase?
   a. (SI) Puedes abundar sobre eso.
   b. (NO) Pasar a próxima pregunta

6. ¿Hubieras preferido haber aprendido sobre problemas ambientales (locales o extranjeros)?* ¿Por qué?

*La pregunta a los estudiantes bajo el “tratamiento” será sobre los problemas ambientales locales. La pregunta a los estudiantes bajo el grupo de “comparación” será sobre los problemas ambientales extranjeros.
Appendix G
Educational Resources

AES Puerto Rico

Videos:

1) La EPA insiste en que cenizas no son peligrosas (El Nuevo Día)
https://www.elnuevodia.com/noticias/locales/nota/laepainsisteenquecenizasnosonpeligrosa-s-2343926/

2) Cenizas de carbón causa deformaciones
https://www.youtube.com/watch?v=VCAN9foYYdc

3) Usos beneficiosos de las cenizas de AES Puerto Rico
https://www.youtube.com/watch?v=JuJQvc2EEUM

Websites or online sources:

1) JCA reitera que cenizas de carbón no son tóxicas (Metro.pr)

2) CPI: Cenizas de AES contaminan aguas subterráneas (Telemundo 60)
https://www.telemundosanantonio.com/historias-destacadas/cpi-cenizas-de-aes-estan-contaminando-ahuas-subterranneas/1947294/
3) 10 cosas que debes saber sobre el Agremax y su uso en Puerto Rico (CB.pr)

https://cb.pr/10-cosas-que-debes-saber-sobre-el-agremax-y-su-uso-en-puerto-rico/?en-reloaded=1

**AES Gener, Chile**

Videos:

1) Generación eléctrica central termoelectrica VOXEL

https://www.youtube.com/watch?v=0-XQWdoFp_1

2) Termoeléctrica Angamos AES Gener (Mejillones)

https://www.youtube.com/watch?v=d3MurKahmsA

3) El riesgo que corren veraneantes en Ventanas por altos índices de contaminación

https://www.youtube.com/watch?v=mPJ4IoY_2eM

Websites or online sources:

1) Sobran centrales termoeléctricas: es hora de cerrar las 10 más contaminantes

(chilesustentable.net)

http://www.chilesustentable.net/sobran-centrales-termoelectricas-es-hora-de-cerrar-las-10-mas-contaminantes/

2) Energía eléctrica en Chile: quienes y donde la generan (Sectorelectricidad.com)

3) AES tendría que pagar millonaria multa por contaminación en playa Puchuncaví

(nuevamineria.com)

http://www.nuevamineria.com/revista/aes-gener-tendria-que-pagar-millonaria-multa-por-contaminacion-en-playa-de-puchuncavi/

**La Parguera, Puerto Rico**

Videos:

1) Contaminación: Cuerpos de agua bioluminiscentes de Puerto Rico

https://www.youtube.com/watch?v=CCyDJEDOxve

2) Zona Marítimo-Terrestre Departamento de Recursos Naturales y Ambientales

(drna.gov.pr)


3) N24/7 Informa: Alcalde Lajas apoya proyecto sobre casas costeras en La Parguera

https://www.youtube.com/watch?v=pRXFRITf940

Websites or online sources:

1) Sistema de Referencia Oficial para el Deslinde de la Zona Marítimo-Terrestre

(drna.pr.gov)

http://drna.pr.gov/historico/zmt

2) Estudio sobre los niveles de bioluminiscencia (pressreader.com, El Nuevo Día)

https://www.pressreader.com/puerto-rico/el-nuevo-d%C3%ADa/20160731/282213715194198
3) Bahías bioluminiscentes y contaminación lumínica (corrienteverde.com)

http://www.corrienteverde.com/articulos/bahias%20bioluminiscentes%20y%20contaminacion%20luminica.html

4) Mentiras sobre La Parguera (endi.com)

https://www.elnuevodia.com/opinion/columnas/mentirasobrelaparguera-columna-2219893/

Indian River Lagoon, Florida

Videos:

1) Biología: La Eutrofización

https://www.youtube.com/watch?v=5X84yi0g__k

2) Catástrofe por alga toxica (Al Rojo Vivo, Telemundo)

https://www.youtube.com/watch?v=xaR8YVYxlW0

3) Reabren las compuertas del Lago Okeechobee pese al riesgo de alga toxica (El Sol de la Florida)

https://www.youtube.com/watch?v=mCark6hp3xY

4) We Care about our Local Waterways (US Sugar) (A Spanish transcription of the audio was provided to students.)

https://youtu.be/j8R_o5qoYCQ
Websites or online sources:

1) El problema de restaurar los Everglades, el mayor proyecto ambiental

   (animalpolitico.com)

   https://www.animalpolitico.com/2015/04/el-problema-de-restaurar-los-everglades-el-mayor-proyecto-ambiental-del-mundo/

2) EPA en español: Los retos de los estuarios (espanol.epa.gov)

   https://espanol.epa.gov/espanol/los-retos-de-los-estuarios

3) Tanques sépticos vinculados a la floración de algas en Florida (fluencecorp.com)

   https://www.fluencecorp.com/es/estudio-vincula-tanques-septicos-a-floracion-de-algas/

4) El problema de las algas proviene de décadas de contaminación del Lago (Sun-Sentinel.com) (Students had to translate the page to view the article in Spanish.)

Appendix H
Acronym List

List of acronyms with defined terms in alphabetical order:

AES – Applied Energy Systems
ANCOVA – analysis of covariance
EPA – Environmental Protection Agency
IRL – Indian River Lagoon
NOS – Nature of science
OMC – Ordered multiple choice
PBE – Place-based education
QuASSR – Quantitative Assessment of Socioscientific Reasoning
SD – Standard deviation
SSI – Socioscientific issues
SSR – Socioscientific reasoning
STS – Science-technology-society
STSE – Science-technology-society-environment