Climate READY: A three-semester youth empowerment program

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Abstract. The Climate Resilience Education and Action for Dedicate Youth (Climate READY) program, developed by the Florida Atlantic University Pine Jog Environmental Education Center (FAU Pine Jog) and funded by the National Oceanic and Atmospheric Administration (NOAA) Environmental Literacy Program, built climate literacy and community resilience through a three-semester dual enrollment program (NOAA-SEC-OED-2020-2006190). Most student participants (~80%) were from Title-

10   1, high schools in low socio-economic communities vulnerable to extreme weather and environmental hazards in Palm Beach County, Florida. The main objectives were to

1. increase knowledge of South Florida's changing climate systems,

2. teach and promote environmentally responsible behavior that results in the stewardship of healthy ecosystems and a reduction in carbon consumption to mitigate future environmental risks, and

15   3. empower students to act as agents of change within the community by teaching community members about local climate impacts and resilience strategies for extreme weather events.

Students in the Climate READY Ambassador Institute (Summer Semester 1) built climate knowledge, explored NOAA Science on a Sphere technology, engaged with scientists and resilience experts, developed communication and advocacy skills, and learned about local resilience solutions. An Afterschool Mentorship (Fall Semester 2) component paired new Climate READY

20   Ambassadors with fourth- and fifth- grade afterschool students to build community resilience awareness through the creation of storybooks. Lastly, Community Outreach (Spring Semester 3) provided ways to share local resilience strategies at public events and promoted civic engagement in climate solutions. Data were collected from students in the form of pre- and post-assessment questionnaires during the 2022-2023 academic year. Summative statistics were analyzed for climate science knowledge, self-identity, self-efficacy, and sense of place. Students felt more prepared, confident, and able to communicate within their

25   communities about climate change and many demonstrated a significantly better understanding of climate science concepts.

1 Introduction

The most recent report from the Intergovernmental Panel on Climate Change (IPCC) provides evidence that climate change is certain to unleash serious impacts globally, including an increase in the exposure of coastal areas to natural disasters (IPCC, 2023). A community's vulnerability to natural disasters is a combination of the exposure to risk that the community faces coupled with

30   the community's available social, economic, political, and institutional resources that allow them to adapt (IPCC, 2023; Southeast Florida Regional Climate 2023 Compact, 2022). To prepare for a future of increasing hazards, communities will need an informed public that is willing to act on decisions at a personal and civic level. How people prepare for, respond to, and cope with natural disasters is linked to community resilience, or how well a community can "bounce back" when a natural disaster occurs (Ronan and Johnson, 2005). This kind of preparedness requires a minimal level of environmental literacy that is, the possession of

35   knowledge and understanding of a wide range of environmental concepts, problems, skills, and abilities. A more environmentally literate public makes more informed decisions and is more involved on a community level, which contributes to community resilience. The complexity of climate change science tends to make it difficult for a less climate-literate general public to gain a

thorough understanding, severely impeding their ability to make informed decisions for themselves, their families, and their communities. A solution to this lack of understanding is education, particularly in schools. A survey in 2012 by Florida Atlantic

40 University (FAU) revealed that over 67% of respondents in South Florida felt that the causes, consequences, and solutions to climate change should be taught in K-12 (youth ages 5 to 18 years old) classrooms (Lambert et al., 2012). However, the educational community has yet to embrace climate change as a subject that is routinely taught. One reason may be that many teachers are not comfortable with the subject and lack the confidence to be able to teach it to their students (Lambert et al., 2012). When compared to other states, the topic of climate change is less prevalent in Florida's classrooms, but the state standards are not devoid of

45 statements about climate education. Oftentimes a standard will cover relevant lessons without specifically mentioning climate change, while other times the issue is combined with other subjects (Sabella, 2019). Without some kind of professional development, teachers are unsure how to approach these topics. As a result, climate change has yet to make it into mainstream education in the Florida classroom.

1.1 Program description

50 This three-year program, entitled Climate Resilience Education and Action for Dedicated Youth Program (Climate READY program) was funded by the National Oceanic and Atmospheric Administration (NOAA) Environmental Literacy Program grant (NOAA-SEC-OED-2020-2006190). It provided the opportunity to use original curriculum developed by FAU Pine Jog Environmental Education Center (FAU Pine Jog) and NOAA assets to strengthen community resilience and adaptive capacity of participants. Specifically, these students were in grades 4-12 (youth ages 9 to 18 years old) with recruitment priority given to

55 underrepresented schools and residents of the larger community in Palm Beach County, Florida. Participants learned the scientific principles behind the global and local changes in climate and studied the relationships and power dynamics of nature, self, and community, which enabled them to become agents in protecting resources and building greater resilience against extreme weather events. Participants also studied the Regional Climate Action Plan (RCAP), which is a guiding tool for coordinated climate action in Southeast Florida to reduce greenhouse gas emissions and build climate resilience (Southeast Florida Regional Climate Change

60 Compact, 2022). The RCAP provided a set of over 100 recommendations and guidelines for implementation and shared best practices for local entities to align with the regional agenda. The Climate READY Program was delivered over three years as described in our methods. The three main components were (1) Climate READY Ambassador Institute, (2) Climate READY Afterschool Program, and (3) Climate READY Community Outreach.

1.2 Geographic location and hazard identification

65 Implementation of all three components of the Climate READY program occurred in six specific regions within Palm Beach County in the Southeastern region of Florida. These included Boca Raton, Boynton Beach/Delray Beach, Lake Worth Beach, Riviera Beach, West Palm Beach, and the Glades areas (Pahokee/ Belle Glade) located near the Everglades Agricultural Area (Fig. 1). For South Florida, the dense population, low-lying coasts, porous geology, and distinctive hydrology characterize it as one of the world's most vulnerable areas from the impacts of climate change. In fact, South Florida could be the next environmental

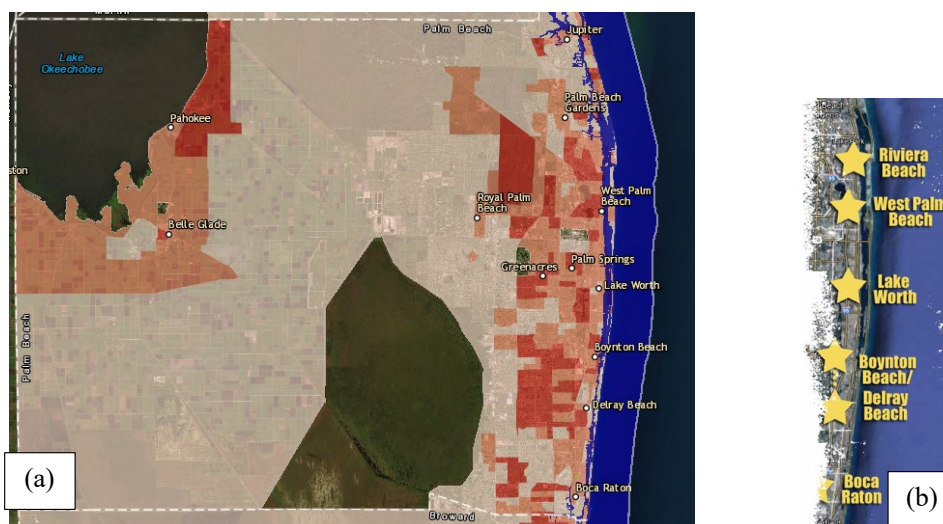
70 "ground zero" (University of Miami Frost Institute for Data Science and Computing, 2015). Sea level rise, threatening water and air quality, saltwater intrusion, and the destruction of the Everglades, are some of Florida's most pressing challenges. South Florida is exposed to nearly all of the nationally identified risks of climate change including urban infrastructure and health risks, increasing flood risks in coastal and low-lying regions, transformation of natural ecosystems, economic and health risks for agricultural communities, increased prevalence of disease-carrying insects, increased frequency of hot weather temperatures, hurricane and

75 storm intensification, risks associated with sea level rise and storm surge, increase in invasive species, and threatened freshwater

quantity and quality (U.S. Global Change Research Program, 2016). The short - term projections for sea level rise in Southeastern Florida are between 6 to 10 inches by 2030 and 14 to 26 inches by 2060. In the longer-term, sea-level rise is projected to be between 31 to 61 inches by 2100. This rise is due to increasing ocean volume due to the thermal expansion of water, groundwater losses, glacier mass loss, and discharge from land-based icesheets (Heimlich, et al., 2009). According to a study by Hauer, Evans, &
80 Mishra (2016), a sea level rise of this level would affect between 24,000 and 57,000 people in Palm Beach County alone. Additionally, according to the NOAA Theory of Change, "societal processes have created unequal exposures to environmental threats and access to solutions within a community" (Bey et al., 2020). This is certainly true in Palm Beach County. The Social Equity Key to Southeast Florida RCAP 2.0 Factsheet highlights the growing concern for low-income areas and communities of color (Center for American Progress et al., 2018):

85   "Communities of color and low-income areas are disproportionately exposed to heat, flooding, and pollution risks—meaning extreme weather events often hit them hardest. In a region where city streets flood even on sunny days, and in the wake of the record-breaking 2017 hurricane season, local leaders recognize that they have little time to waste" (p.1).

        "Climate change threats exacerbate and multiply historic inequities that exist in low-income areas and communities of
90   color……. Many communities of color were purposefully sidelined by 20th-century development decisions resulting in economic and racial segregation, making it particularly difficult for communities without targeted policies and resources to build local economies that are just and resilient to climate change" (p.1).

        "Low-income areas and communities of color are particularly vulnerable to the effects of extreme weather because they
95   are often located in or near flood-prone areas, heat islands—urban neighborhoods where concrete and asphalt surfaces absorb and radiate heat, producing temperatures that are warmer than average—or toxic waste sites. They are also often overburdened by disproportionately high air and water pollution" (p.1).

100 **Figure 1:** Palm Beach County Vulnerability (NOAA's Office for Coastal Management Sea Level Rise Viewer Accessed September 2023). Zones in red represent high vulnerability, personal disruption, and risk, and pink zones demonstrate medium indicators of risk and social vulnerability (a). Map of coastal communities targeted in the Climate READY Program that was used as part of FAU Pine Jog presentation template (b).

In looking at the Glades areas of Pahokee and Belle Glade (Fig. 1), as an example, the demographics reveal some of the most

105   challenging conditions that exist in the state of Florida and most likely the nation, compounding the struggle educators have in

making climate education a priority.

- 72% live in single-parent or non-traditional households

- 74% in households earning less than $29,999 a year

- 93% of students receive free or reduced lunch

110   - 35% live in households earning less than $11,999 a year

- 78% are Black/African American, 5% are Hispanic, 4% are Multiracial, 12% are Undeclared, 1%

are White.

- Crime rates place Belle Glade safer than only 4% of US Cities and Pahokee safer than only 10%

(Belle Glade Crime Rates 2023; Pahokee Crime Rates 2023; Badcock, 2018).

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Other targeted areas in Florida are equally dangerous and are highly affected by poverty. In 2018, two of the target cities, Riviera

Beach and Lake Worth Beach, ranked 30th and 31st as most dangerous cities in the United States (Todaro, 2018). Complicating

Florida's climate and human challenges is Florida's growing population. The US Census data indicates that approximately 960

people relocate to Florida each day. Given Florida's population growth, expected to grow to 33.7 million by 2070, and development

120   trends, new community-based approaches to conservation education and restoration are imperative (Florida Department of

Agriculture and Consumer Services et al., 2017). Florida is now the third most populous state and by 2030, five million more

residents will call Florida home and 1.7 million more jobs will be needed (Florida Chamber Foundation, 2017). In 2018, Florida's

population of people of color under the age of 70 became a majority, at 53.5% of the population (Taylor, 2019).

1.3 Program objectives and hypothesis

125   The main goal of the Climate READY program was to increase the environmental literacy of 4–12 grade students in Palm Beach

County, FL and the general community that they live in so that they can become more resilient to extreme weather and/or other

environmental hazards, thus empowering them to become involved in achieving that resilience. Therefore, our research hypothesis

for the program was that participants in Climate READY will better understand their community strengths and vulnerabilities to a

changing climate and that they will feel empowered to participate on both a personal and civic level to take action, minimize risks,

130   adapt, and weigh the potential impacts of their decisions. This goal and hypothesis are in keeping with the NOAA Resilience

Theory of Change, which theorizes that "environmental literacy, along with community health, civic engagement, social cohesion,

and equity, enhance resilience" (Bey et al., 2020). Objectives for this program are included in Table 1.

Table 1: Climate READY general objectives for all students, for dual enrolled high school/FAU students, and for fourth and fifth

135   grade afterschool students.

General objectives for all students
1. Increase content knowledge of the history and causes of climate change.
2. Identify and evaluate personal and community strengths and vulnerabilities in response to extreme weather events.
3. Acknowledge that disproportionate distribution of vulnerabilities and diverse community values exist.
4. Promote environmentally responsible behavior that results in the stewardship of healthy ecosystems and a reduction in carbon consumption to mitigate future environmental risks.
5. Improve critical thinking skills to assess the sources of different climate change perspectives and attitudes.

Objectives specific to students (grades 9-12)
1. Design and implement community resilience-related service-learning projects based on local environmental challenges.
2. Empower students to act as agents of change within the community by teaching community members about local climate impacts and resilience strategies for extreme weather events.
Objectives specific to students (grades 4-5)
1. Design and complete a storybook on community resilience to build an understanding of climate change and the impacts facing Southeastern Florida.

2 Program Methods

The three-year Climate READY program used original lesson plans developed by FAU Pine Jog staff and NOAA assets to strengthen community resilience and the adaptive capacity of participants in six underserved regions in Palm Beach County, Florida as described in section 1.2. The Sea Level Rise Viewer developed by the NOAA Office for Coastal Management allowed us to

140 add social and economic data overlays (Fig. 1(a)), which identified three of the target regions (Riviera Beach, Lake Worth Beach and the Glades) as red zones of high vulnerability, personal disruption, and risk (2023). The remaining regions, West Palm Beach, Boynton Beach/Delray Beach and Boca Raton were highlighted as pink zones, demonstrating medium indicators of risk and social vulnerability. While these areas have undergone gentrification in sections near the Atlantic Ocean, extreme pockets of poverty and vulnerable populations still exist in these boundaries (Sea Level Rise Viewer 2023). We targeted Title 1 schools in low socio-

145 economic communities as defined by the Bureau of Federal Educational Programs and part of the Every Student Succeeds Act (ESSA), which identifies schools that have at least 60% of their students living in low-income households (Office of Program Policy Analysis and Government Accountability, 2023).

The Climate READY program included the development of three interconnected components that were divided into three-semester

150 courses at FAU listed here and described in the subsections below: Climate READY Ambassador Institute offered as *EDG 4930: Building Community Climate Resilience*, Climate READY Afterschool Program offered as *EDG 4930: Youth Mentorship in Climate Resilience*, and Climate READY Community Outreach offered as *EDG 4930: Community Resilience Outreach*. The new three- semester program was implemented over two full cohorts and a partial third cohort participated in a modified single semester course in summer 2023. An advisory council of local resilience experts was established during the planning phase to provide

155 feedback about the program. Using their advice, FAU Pine Jog staff used the first year of funding from October 2020 to May 2021 to establish an original curriculum for the three-semester dual enrollment components. However, the global pandemic and temporary freeze on in-person classroom interaction required us to create an online learning approach for the first year of implementation, July 2021 to May 2022 (Cohort 1). After restrictions were lifted in 2022, the Climate READY program was implemented with face-to-face interaction as originally designed during the second year of implementation, July 2022 to May 2023

160 (Cohort 2). Using lessons learned from Cohort 1, we revised the curriculum for Cohort 2 and collected data using a pre-questionnaire in the beginning of the Climate READY Institute (July 2022), a post-questionnaire after the Climate READY Institute in July 2022 (Post 1), and we repeated the post-questionnaire at the end of the last semester course that focused on community outreach in May 2023 (Post 2). The three data points were used to assess learning outcomes, retention of content throughout the three-semester program, and to test our hypothesis in this study.

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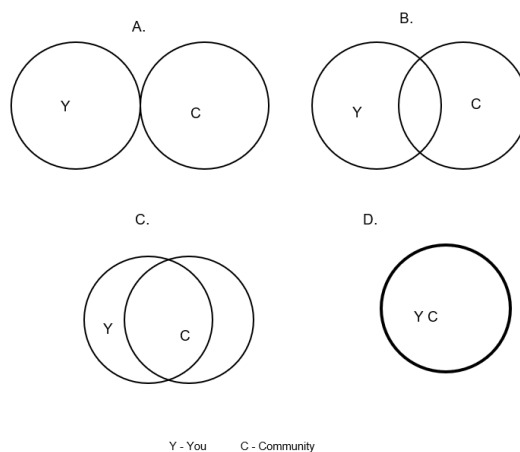
Students were also given pre- and post- questionnaires where they were asked to describe the degree of their connection with their communities using circles to represent sense of place within a community (Fig. 2) and to evaluate self-efficacy. The circle labeled

"Y" represents the student and the circle labeled "C" represents their community. These circles were shown in four different settings representing the degree of closeness between self and community. Students were asked to indicate which setting best represented them followed by space for the student to explain why they chose that setting.

Y - You   C - Community

Look at the circles above. Which set best represents your relationship to your community?
Explain:

Figure 2: Survey question using circles to represent sense of place within a community. The circle labeled "Y" represents the student and the circle labeled "C" represents their community. Adapted from Petersen et al. (2020).

2.1.1 Climate READY Ambassador Institute (9-12 Grade Students, Summer 2021 & 2022; Semester 1):

The Climate READY (CR) Ambassador Institute developed foundational climate literacy knowledge focused on current scientific research, implementation practices, and community resilience measures. Climate science was taught in part by using NOAA's Science on a Sphere (SOS) technology in collaboration with Galaxy E3 Elementary School, a Title-1 public school with Platinum level LEED Certification (Kubba 2008) serving a primarily low socio-economic population in Boynton Beach, Florida vulnerable to climate change (Fig. 1). NOAA's SOS technology uniquely projects seamless imagery on a sphere-shaped projection screen and has shown to effectively enhance student learning of weather and climate concepts using global scale earth system science (Rowley et al. 2013). We created a SOS playlist for the students using data provided by the NOAA SOS datasets (Science On a Sphere Dataset Catalog 2023; See Appendix, Table 25). This playlist was an important part of teaching climate change science as it provided visual representations of global carbon dioxide concentrations, global temperature, global hurricane pathways, and changes in arctic sea ice coverage over time. Video shorts created by NOAA partners and included in their datasets were also shared. In using the SOS, students were able to connect what they learned about the causes and effects of climate change with visual global patterns through time, which reinforced concepts such as the difference between climate and weather, the patterns of greenhouse gas emissions and temperature changes, and how communities can work together towards a common goal. Teen participants in the CR Ambassador Institute would later use the SOS with younger students in the fall semester. Teens also connected with sustainability officers, scientists, researchers, and representatives from local government and the RCAP community. Using place-based active learning strategies, this institute focused on anthropogenic issues impacting South Florida, such as sea-level rise and extreme weather events. Lessons delivered included using a case-study approach, where participants evaluated the risks, assets, and vulnerabilities of their local municipality and explored inequities produced by current systems. Major assignments for students during the summer component included a photovoice project to help students connect with their communities (Photovoice, 2023; Science, Camera, Action! 2023), a "Where I'm From" poem and puzzle piece class project (see

Appendix, Fig. 10), the creation of their own "Climate Story" (Discover Your Climate Story, 2023; example in Fig. 9(b)), and a team assignment to create a storybook using an original template created by FAU Pine Jog (see Appendix, Fig. 11). The storybook lesson was important to help connect with the younger students in the afterschool component during the 2nd semester.

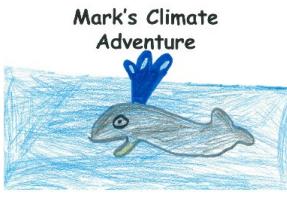
Students from underserved communities were prioritized in the recruitment process and offered the opportunity to register as dual enrolled (high school/university) students under a special topics course in FAU's College of Education. Students that had a strong application for the Climate READY Program but did not qualify for dual enrollment at FAU were able to participate on a non-credit basis and received documented community service hours for completing the program. By design, the institute was created as an intensive five-day residential program at the FAU John D. MacArthur Campus in Jupiter, Florida, which provided the opportunity for a deeper connection and immersion into the climate literacy/resilience content, and a peer experience different from a traditional school-based setting. Field trips to Galaxy E3 Elementary School and MANG, a local mangrove nursery, were organized off campus to expose students to hands on experiences. However, due to the global pandemic and COVID concerns during the Summer 2021 semester, our first cohort of students were not able to participate in the full in-person residential experience. We transitioned from a residential to a hybrid model for the Institute having planned the first and last Saturdays as extended in-person days at Galaxy E3 Elementary School in Boynton Beach and at FAU Pine Jog in West Palm Beach respectively. Classes Monday through Friday during that week were shorter virtual days using WebEx. With restrictions lifted in Summer 2022, student participants in the second cohort were able to attend the originally designed in-person residential model (Fig. 3). In both cohorts, students completed the 80-hour program and were equipped as CR Ambassadors that were responsible for delivering the second component, the Climate READY Afterschool Program.

Climate READY Teen Institute

	Sun 7/17 Community	Mon 7/18 Climate 101	TUES 7/19 Local Impacts	Wed 7/20 Local Solutions	THURS 7/21 Storytelling	Fri 7/22 Presentations
7:00-8:00 am		Breakfast	Breakfast	Breakfast	Breakfast	Breakfast
8:00-9:00 am		Cranky Uncle/SOS	Discuss Readings (take a stand)	Discuss Readings Travel to Mang	Discuss Readings (take a stand)	Prep to leave
9:00-10:00 am		Travel to Galaxy	Introduce Resilience Toolkit, Risks v. Vulnerabilities, Sea Level Rise Viewer	Visit Mang Mangrove Restoration	Your Climate Story	Group Work
10:00-11:00 am		Climate 101 & Galaxy Scavenger Hunt			Speaker: Delaney Reynolds	Presentations
11:00 am-12pm						
12:00-1:00 pm		Lunch (Media)	Lunch	Lunch (Mang)	Lunch	Lunch
1:00-2:00 pm	Check-in	SOS / Climate Change Mixer	Speakers: Sustain & Resilience Partners	Travel to Jupiter	Team Storybooks	Post Test
2:00-3:00 pm	Welcome & Ice-breaker (Picnic)			Session Demo: Gumdrop Gases		Graduation!
3:00-3:45 pm	Pre-Surveys		Debrief Activity	Game: Resilient Cities		Check-out & Goodbye
3:45-4:30 pm	Intro to Week	Climate Jeopardy	Class activity	BSOB Speaker Confirmed		
4:30-5:00 pm	Community Norms & ID Teams	Back to Jupiter	Session Demo: Climate v. Weather	Speaker Paul Rutter	Session Demo: Emergency Kit	
5:00-6:00 pm	Dinner	Dinner	Dinner	Dinner	Dinner	
6:00-7:00 pm	Take a stand / 6 Americas	Burrow Time	Burrow Time	Burrow Time	Burrow Time	
7:00-8:00 pm	Team work: Share Community Photos	Youth Speaker FXB Confirmed	Journal Reflections	Movie - Population Paradox	Alumni Ambassadors	
8:00-9:00 pm	Movie & Debrief: Life on Our Planet - David Attenborough	Where I'm From Poems	Movie: An Inconvenient Sequel - Truth to Power	Project Drawdown	Journal Reflections	
9:00-10:00 pm		Journal Reflections		Journal Reflections	Group Work	
10:00-11:00 pm	Relax & Lights Out	Relax & Lights Out	Relax & Lights Out	Relax & Lights Out	Relax & Lights Out	

Type of classroom

🟩	Classroom
🟧	Away (Field trip)
🟦	Dorm Rooms
🟨	Auditorium
🟥	Computer Lab
🟪	Outside

Figure 3: Schedule of activities and lessons implemented during Semester 1 of the Climate READY Program (July 2022), a weeklong residential college course designed for dual enrolled high school students, the Climate READY Teen Institute. For the

exception of 2 field trips to Galaxy E3 Elementary School and MANG Nursery (tan), classrooms (green) were within walking distance to dorms (blue) and dining hall (white) where vegan and vegetarian options were given during all meals.

2.1.2 Climate READY Afterschool Program (9-12 Grade Mentorship of 4-5 Grade Students, Fall 2021 & 2022; Semester 2):

Newly certified high school CR Ambassadors from the summer course were enrolled in FAU College of Education's *Youth Mentorship in Climate Resilience* in the Fall semester immediately following the summer semester for each cohort. Students were given the option to take the course as a dual enrolled student or for community service hours as a non-credit course. FAU Pine Jog staff met with the class during five, four-hour online classes using WebEx or Google Meets on Saturday mornings throughout the semester, and a final all-day in-person class to conclude the course and participate in a field experience. CR Ambassadors were also required to meet with their afterschool groups. This course was created as the second part of the three-semester CR Program to connect with local elementary afterschool programs where students delivered grade level appropriate climate resilience activities using four detailed 60-minute sessions aligning with Florida State Standards; *Session 1 - Climate Basics, Session 2 - Local Solutions, Session 3 - Storytime!, and Session 4 – SOS Adventure!* (Table 2).

Table 2: Climate READY Afterschool lessons and activities implemented by the Cohort 2 CR Ambassadors during the fall semester (2022).

Afterschool Session	Lesson	Guiding Questions and Topics Covered	Activities
1	Climate Basics	1. What is the difference between weather and climate? 2. Why is the climate changing? 3. What is the greenhouse effect? 4. What are some greenhouse gases (& where do they come from)?	1. Afterschool Pre-Survey 2. Climate vs. Weather Activity 3. Video Viewing Guide

2	Local Solutions	1. What are some ways climate change could impact us locally?
		  a. Extreme Heat
		  b. Rising Seas
		  c. Stronger Storms
		2. What does community resilience mean?
		3. What are some things we can do to be more resilient/deal with those impacts?
			1. Introduce CR Ambassador Team created Climate Resilience Storybook
			2. Storybook activity using FAU Pine Jog Community Resilience Storybook template. Afterschool students chose:
			  a. Main Character
			  b. Climate Impact
			  c. Action/Solution
			  d. Community Helpers

3	Storytime!	1. Review of story elements chosen by afterschool students:
		  a. Main character
		  b. Impact
		  c. Solution
		  d. Community helpers
		2. CR Ambassadors deliver original story created from the afterschool student choices using the FAU Pine Jog Community Resilience Storybook template.
			1. Afterschool students illustrate the new community climate resilience story using crayons, markers, and their imaginations (See Appendix).
			  a. Example title and cover:
			
			Mark's Climate Adventure

4	SOS Adventure!	1. Field trip from afterschool site to Galaxy E3 Elementary School 2. Introduction to NOAA's Science on a Sphere 3. Sustainable features of a LEED Platinum certified school 4. Extreme weather preparedness	1. Presentation/reading of completed class storybook 2. Introduction to NOAA's Science On a Sphere 3. Tour of Galaxy E3 Elementary Energy-Saving Features 4. "Get Storm Ready" game 5. Program Post-Survey

Guided by educational professionals from FAU Pine Jog, CR Ambassadors worked in teams of four to five, to deliver over four

235   hours of programming to up to six afterschool sites in Palm Beach County during each program cycle. Afterschool programs that targeted underserved communities were given priority in the recruitment process. Activities focused on gaining a conceptual understanding of basic climate processes, potential impacts and local resilience initiatives that are already in place and empowering the students through action by creating a storybook focused on community specific needs (Table 2). The CR Ambassadors used an original template created by FAU Pine Jog to assist the fourth and fifth grade students in developing an illustrated storybook of

240   their own, which highlighted how their community could be resilient to climate change (see Appendix, Fig. 12). The original storybooks were printed and bound through an online company, DiggyPOD (2023; see Appendix Table 26), and distributed to the students that participated in the program to take home and share with their families. Any extra books were given to the participating school to share in their school or classroom libraries. The culminating Lesson 4 provided transportation for all students to visit Galaxy E3 Elementary School in Boynton Beach, Florida to learn about how the school achieved Platinum level LEED certification

245   and for the students to experience standards-based content on NOAA's SOS technology. Lastly, a FAU Pine Jog original game called "Get Storm READY" was used to help teach students the importance of preparing for a hurricane and gave them time to think about what items may be important when creating a hurricane preparedness kit for their families (Fig. 8(c)).

2.1.3 Climate READY Community Outreach (members of the community at large, delivered by CR Ambassadors - Spring 2022 and 2023; Semester 3):

250   The final semester of the CR Program included the FAU College of Education's course *Community Resilience Outreach*. Similar to previous semesters, students were given the choice to take the course for dual enrollment credit or for non-credit and receive community service hours. FAU Pine Jog staff met with the class during five, four-hour online classes using Google Meets on Saturday mornings throughout the semester, and a final all-day in-person class to conclude the CR Program and participate in a field experience. This component of the program emphasized building knowledge and skills to implement climate resilience

255   education curriculum and activities within local communities (Table 1). The design of this course was informed by the NOAA Community Resilience Education Theory of Change, which outlines the goals of community resilience education (Bey et al., 2020):

(1) reason about the ways that human and natural systems interact globally and locally, including the acknowledgement of disproportionately distributed vulnerabilities;

(2) participate in civic processes; and

260   (3) incorporate scientific information, cultural knowledge, and diverse community values when taking action to anticipate, prepare for, respond to, and recover from environmental hazards, including mitigating and adapting to climate change.

Lessons also addressed social emotional learning as well as time management practice to help better prepare our youth for public speaking and to help them with time commitments (see Appendix, Fig. 11). The Climate READY Ambassador teams were required to create a Community Resilience Plan tailored to their assigned communities. Students researched their assigned community's

265   assets, strengths, and vulnerabilities, and then recommended at least three possible solutions to help solve the issues their communities are facing with the threat of climate change. Each team was then required to present their resilience plan by

participating in two presentations to members of their respective communities. One presentation needed to be a formal lecture and discussion style presentation using a PowerPoint or Google Slides format while the second presentation could be a table event at a festival or fair. Each presentation focused on a Community Resilience Plan that included student research on place-based needs

270 to climate resilience throughout the three-semester program. In their presentations, students outlined how their communities could be more resilient to the impacts of climate change, the strengths of their respective communities, and potential solutions to help mitigate and/or adapt to impacts. FAU Pine Jog instructors coordinated the outreach events for Cohort 2 in the spring semester (see Appendix, Fig. 11). Graded "Time Management" lessons were designed and implemented during class time for the dual enrolled students to teach them the importance of scheduling and keeping commitments.

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Four of the 13 graded outreach events during Cohort 2 were not on this student schedule. These events were planned and implemented prior to this Time Management assignment (see Appendix, Fig. 11). Events included 3 Urban Sustainability Directors Network (USDN) grant collaborations with the Palm Beach County Office of Resilience where students interacted with members of the community in Pahokee, Belle Glade, and West Palm Beach (Amplifying Impact Community Partners of South Florida,

280 2023; Fig. 9(a-c). The fourth event, Climate and Art, was coordinated by the Delray Beach Office of Sustainability and Resilience. Students in the Boynton Beach/Delray Beach Team shared the storybook they created during the summer CR Ambassador Institute with the Delray community (Climate and Art Delray Beach 2022, 2023).

2.2 Curriculum evaluation

285 The evaluation utilized a mixed methods approach focused on measuring changes to participant Behaviors, Attitudes, Skills, Interests, and Knowledge (BASIK) (Creswell, 2006; Davis et al., 2019; Frechtling, 2010). Participants within this study included the second cohort of Climate READY Student Ambassadors that completed the three-semester dual enrollment program with FAU Pine Jog during the July 2022 to May 2023 academic year. Summary reports were filed after each phase of the program as well as an annual report presenting both formative and summative findings and offering recommendations to the NOAA grant co-principle

290 investigators to FAU Pine Jog Program Coordinators and supporting staff.

2.2.1 Pre- and post-assessment questionnaires and surveys

A questionnaire was created by the writers of this paper with thirty-two content knowledge questions to assess CR Ambassador student awareness of climate change science. Many of the questions came from the "Climate Literacy Quiz" published by the

295 Climate Literacy and Energy Awareness Network (Climate Literacy Quiz, 2023). Additional resources for content knowledge questions included texts used in high school and college level environmental science and management courses (Butz, 2008; Myers and Spoolman, 2014; Friedland and Relyea, 2015). Using the "Global Warming Six Americas" as a gauge, students were asked to share their perception of climate change ranging from dismissive to alarmed (Maibach et al., 2011). Pre- and post- surveys were also used to ask students to describe their connection with their communities using circles to represent sense of place within a

300 community (Fig. 2) and to evaluate self-efficacy. We collected information on the demographics of student participants such as age, gender, race, and grade level.

A modified pre- and post- questionnaire was also created for the 4-5 grade student participants; one pre-questionnaire was given before Lesson 1 in the Afterschool Mentorship component and an identical post-questionnaire was given at the end of Lesson 4.

305 This survey contained fewer questions with simpler language to target the 4-5 grade learner. It was given anonymously, so no identifiers of name or location were asked.

2.2.2 Data Analysis

Climate READY Ambassador student responses to pre- and post-assessment questionnaires were categorized into appropriate

310 groups based on the individual response to each question, and then responses summarized. Student numeric responses were summarized and appropriate matched pair statistical analysis (Student's t-test) was applied. Students' scored responses to pre- and post-assessment questions were then analyzed for comparison using a two-sample t-test when data followed the normal probability distribution and the non-parametric Kolmogorov–Smirnov (KS) test when the probability distributions were non-normal. Open response items were analyzed with Kernal Analysis and summarized. The significance level (alpha value) was set to 0.05, and

315 results were considered statistically significant if $p<0.05$.

In a separate analysis, the 4-5 grade responses were anonymous and the mean values for pre- and post- questionnaire followed the normal probability distribution. Mean values for pre (N=60) and post (N=52) questionnaire were analyzed for differences using a Student's t-test ($p<0.05$).

320

3. Results

Data were collected and analyzed using the methods as described in Sect. 2 for Cohort 2 (July 2022 to May 2023). Although FAU Pine Jog staff spent time recruiting students in the Pahokee/Belle Glade area for Cohort 2, no student from that area completed the application process. This contrasted with Cohort 1 where six students from Pahokee/Belle Glade were active CR Ambassadors.

325 Therefore, for Cohort 2 we focused on the five remaining communities of Boca Raton, Boynton Beach/Delray Beach, Lake Worth Beach, West Palm Beach, and Riviera Beach. A total of 22 matched pair responses were summarized for the Pre and Post 1 data. Twenty responses were summarized for the Post 2 data. Most students (96%) were between 15 and 16 years of age and female (72%), 55% of the students described themselves as White, 36% as Hispanic or Latino, and 18% as Black. Students were going to be in 10th (32%), 11th (41%), and 12th grades (27%). Students reported learning about climate change from school (3.0/5), the

330 internet and social media (3.1/5) and television (2.7/5) primarily.

Upon the completion of the three-semester course experience with FAU Pine Jog, students felt significantly more connected with their communities, and more confident in communicating their knowledge to public groups (Table 3). After their experience, they were statistically more likely to feel "Alarmed" about climate change (Table 4) and significantly fewer students reported that they

335 do not question climate change (Table 7). Students showed significant improvements on 23 of 32 content knowledge items from pre to Post 1 with high pre- scores on seven items leaving no room for significant improvement (Tables 8–19). When asked to identify some of the impacts of climate change affecting South Florida, post experience, student responses were more detailed, factual, and considered multiple areas of impact (Table 19).

340 ### 3.1 Community impact and student perception of climate change

Over 700 community members were impacted during Cohort 2 (Fig. 4). Twenty-five high school students were recruited for the dual enrollment summer session Climate READY Teen Institute to become CR Ambassadors. Twenty-four of the students returned for the fall semester afterschool mentorship course where CR Ambassadors led five afterschool programs located in underserved communities and designated as Title 1 (Office of Program Policy Analysis and Government Accountability, 2023). Eighty-one

345 fourth and fifth- grade students participated in the CR Ambassador led climate change resilience lessons and produced five community resilience stories. These stories were made into printed books and given to the student authors and school administrators

for classroom distribution as described in in our methods (see Appendix Table 26). Twenty-three CR Ambassadors returned for the final spring semester course and led a total of 13 community outreach engagement events, impacting over 600 individuals and families within their communities.

350

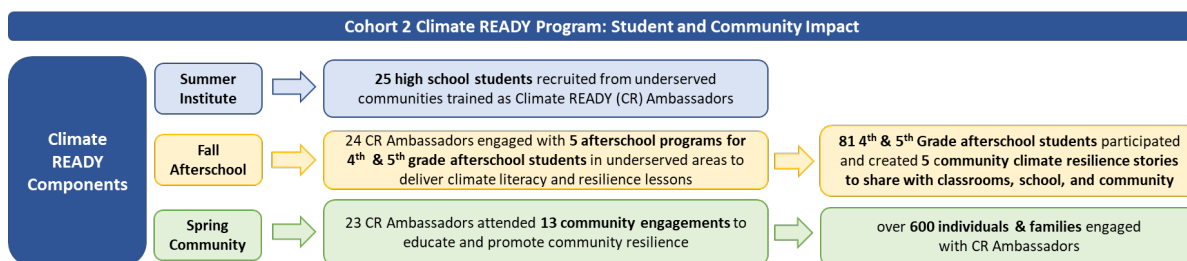



Figure 4: Over 700 community members including high school and elementary school students were impacted during cohort 2 of the Climate READY Program between July 2021 and May 2022.

355 When students were asked to describe their connection with their communities using circles to represent sense of place within a community (Fig. 2) there was a significant ($p<0.05$) increase between pre- and post- survey responses indicating that students felt closer to their communities after the three-semester CR program. Space was given for a written explanation (Fig. 2) and one student stated "I believe C best represents my relationship with my community, which has changed as it was originally B. I feel a lot more involved with my community after all the civic engagement projects I did with Climate READY and at school." Another student
360 reported "I believe that C best represents my relationship to my community since I did many events that built the relationship. For example, the climate presentation I did over at the Lantana Road Library allowed me to connect to the fellow residents of Lake Worth as I got to share them my experience with climate change." Students also reported feeling their community was very special to them, that they like to visit places in their community, and that their community means a lot to them. By the end of the three-semester program more students felt confident in helping their communities be more resilient to climate change (Table 3).

365

Table 3: Climate READY Ambassador students felt more confident in communicating climate change and resilience in front of a public group by the end of the three-semester program.

When you think about helping your community be more resilient to climate change, how well do you think you would be able to do the following? Rank each of the following statements both BEFORE and AFTER your experience using the following scale: 1-
370 Defintely Can't, 2-Probably Can't, 3-Maybe Can, 4-Probably Can, 5- Definitely Can

	Pre	Post 1	Post 2
Create a plan to address the issue of climate change	3.6/5	4.3	4.7*
Get other people to care about this issue	3.9	4.1	4.8*
Organize and run a meeting about this issue	3.7	4.6	4.5
Express your views about climate resilience in front of a group of people	4.4	4.4	4.9*
Identify individuals or groups who could help me with this issue	3.7	4.6	4.6
Write an opinion letter to a local newspaper about this issue	4.0	4.6	4.5
Call someone on the phone that I had never met before to get their help with this issue	3.1	3.7	4.3*
Contact an elected official about this issue	4.0	4.1	4.2
Organize a petition about this issue	3.7	4.4	4.0

*Indicates a significant difference pre to post (p<0.05)

Twenty-two of the 23 CR Ambassadors in Cohort 2 completed all three pre- and post-assessment questionnaires over the course
of the three-semester program. To help gauge student perception of climate change, students were asked "Overall, what are your
375 feelings about climate change?" and the "Global Warming's Six Americas" were given as answer options to choose from (Maibach
et al., 2011). Significantly more students (p<0.05) felt alarmed after the weeklong CR Ambassador Institute in Summer 2023 and
significantly less students (p<0.05) felt alarmed after the completion of the three-semester program (Table 4).

Table 4: Significantly more Climate READY Ambassador students felt alarmed about climate change from pre to post 1
380 assessment, with a 7% decrease in feeling alarmed by the end of the three-semester program.

Data Summary

Overall, what are your feelings about climate change?

	Pre	Post 1	Post 2
Alarmed –convinced it's happening, human-caused, a serious and urgent threat, already taking personal action and support aggressive national action.	59%	82%*	75%*
Concerned – convinced that it is a serious problem and support a national response, not taking very much personal action.	36%	18%	20%
Cautious – believe that it is a problem, but less certain that it is happening, and do not feel a sense of urgency to deal with the issue.	5%	0	5%
Disengaged –have not thought much about the issue at all and do not know much about it.	0	0	0
Doubtful – do not know whether to believe it is happening or not, think it may be caused by natural changes and will not harm humans for decades if at all.	0	0	0
Dismissive – believe that it is not occurring and is not a threat to either humans or nature.	0	0	0

*Indicates a significant difference pre to post (p<0.05)

385 When asked "Do you think your community is already being affected by climate change?" students reported a significantly greater
perception of "A great deal" throughout the course of the program. In addition, they thought that a lack of science knowledge on
the topic was the main reason that people question climate change and that after completing the three-semester program 85% of
the CR Ambassadors said they "do NOT question the science of climate change" (Table 7).

390 **Tables 5–7**: Climate READY Ambassador student perception of community vulnerability, why people question climate change,
and the science of climate change.

Table 5: Do you think your community is already being affected by climate change?

	Pre	Post 1	Post 2
Not at all	0	0	0
Only a little	5%	9%	5%
A moderate amount	41%	64%	30%
A great deal	50%	27%	65%**
Don't know	5%	0	0

**Indicates a significant difference between Post 1 and Post 2 (p<0.05)

395   **Table 6**: What do you think is the main reason that people question the science of climate change?

	Pre	Post 1	Post 2
A lack of science knowledge on the topic	36%	32%	55%**
A lack of trust of scientists	5%	18%	15%
The media presenting "both sides" of the issue	14%	5%	10%
Political or religious background	36%	41%	20%**
Other	9%	5%	0

**Indicates a significant difference between Post 1 and Post 2 ($p<0.05$)

Table 7: What causes YOU to question the science of climate change?

	Pre	Post 1	Post 2
A lack of science knowledge on the topic	23%	9%	10%
A lack of trust of scientists	0	5%	0
The media presenting "both sides" of the issue	9%	0	5%
Political or religious background	5%	5%	0
I do NOT question the science of climate change	64%	82%	85%*

*Indicates a significant difference pre to post ($p<0.05$)

400

3.2 Climate READY Ambassador Student climate change content knowledge Pre, Post 1, and Post 2

Students showed improvement in their understanding of climate change science throughout the three-semester program (Tables 8–19). When asked "if the greenhouse effect is natural, then why is today's climate change a bad thing? (Select all that apply)," significantly more ($p<0.05$) students responded with correct answers during the Post 1 questionnaire (Table 8). Interestingly, 100%

405   of students responded correctly in 4 items of the same question during the Post 2 questionnaire, though it was not a statistically significant difference (Table 8). More students understood that a major concern about climate change is that if CO_2 levels in the atmosphere exceed 450ppm, the effects would be irreversible (Table 9). Students also understood that our best approaches to climate change are adapting and mitigating (Table 10), that restoring natural forests would be the best carbon sequestration strategy with the highest probability of success (Table 11), and that we need to stop burning fossil fuel before 2040 as research indicates

410   (Table 12) (Climate Literacy Quiz, 2023; Maniatis et al., 2021).

Tables 8–19: Climate READY Ambassador student responses to climate change content knowledge questions. Significant differences are identified between pre- and post- questionnaires (*$p<0.05$) and between Post 1 and Post 2 questionnaires (**$p<0.05$). Answers graded as correct have a check mark to the left of the statement.

415   **Table 8**: If the greenhouse effect is natural, then why is today's climate change a bad thing? (Select all that apply)

	% Response		
	Pre	Post 1	Post 2
✓ **A small increase in greenhouse gas concentration can have a large effect of increased warming.**	59%	91%*	100%
✓ **Humans have altered a natural process and exaggerated changes that might normally occur over millions of years.**	68%	86%*	100%

✓ **Once released into the atmosphere, greenhouse gases remain potent for many years, making it difficult to reverse the process.**	50%	91%*	100%
The use of aerosols and other pollutants from human activities has created a hole in the ozone layer, allowing more heat to enter the earth's atmosphere and amplifying the greenhouse effect	95%	73%*	85%
✓ **Abrupt changes to the climate system may have unintended outcomes that may pose challenges for societies, like more extreme weather, spread of diseases, a decline in marine life, or an alteration of ocean circulation patterns.**	68%	86%*	100%

*Indicates a significant difference Pre to Post ($p < 0.05$)

Table 9: Which of the following is the major concern about climate change if CO2 levels in the atmosphere exceed 450 ppm?

	% Response		
	Pre	Post 1	Post 2
The earth would erupt into a huge fireball	5%	0	0
✓ **The effects would be irreversible**	91%	100%	100%
All life on the planet would die	5%	0	0
Some oil companies go out of business	0	0	0

*Indicates a significant difference Pre to Post ($p < 0.05$)

420

Table 10: What are the 2 possible approaches to responding to a changing climate according to NASA and other scientists?

	% Response		
	Pre	Post 1	Post 2
Watching and waiting	0	0	0
Watching and mitigating	9%	0	0
Waiting and adapting	9%	5%	0
✓ **Adapting and mitigating**	82%	95%	100%*

*Indicates a significant difference Pre to Post ($p < 0.05$)

Table 11: Which carbon sequestration strategy has the highest probability of success?

	% Response		
	Pre	Post 1	Post 2
✓ **Restoring natural forests**	73%	100%*	100%
Converting CO_2 to $MgCO_3$	23%	0	0
Injecting CO_2 into beneath the ocean floor	5%	0	0
Mirrors in orbit	0	0	0

425 *Indicates a significant difference Pre to Post ($p < 0.05$)

Table 12: How fast do we need to stop burning fossil fuels to limit global temperature rise to 2 degrees C? (3.6 degrees F)

% Response		
Pre	Post 1	Post 2

We need to stop burning fossil fuels by 2100	23%	5%	0
✓ **We need to stop burning fossil fuels by 2040**	64%	95%*	100%
Fossil fuels don't matter, the Sun will cool and so will the Earth	0	0	0
It's already too late to stay below the 2-degree threshold. We should have stopped burning fossil fuels in the early 2000s	14%	0	0

*Indicates a significant difference Pre to Post (p<0.05)

430   Student responses to six content knowledge items on the Post 2 questionnaire were significantly different from those on Post 1 (p<0.05) (Tables 13–18). These changes in responses suggest that the students continued to develop their climate science knowledge throughout the year and their engagement with the Climate READY program. Student answers were more detailed and factual during Post 1 and more concise in Post 2 with the top three answers being sea levels rising, extreme heat, and stronger storms/hurricanes in both (Table 19; see Appendix Table 27 for ranked tallies of student responses). They also showed a more

435   scientific understanding of climate change in the South Florida area (Table 19).

Table 13: Which two human activities are largely responsible for the observed atmospheric warming?

	% Response		
	Pre	Post 1	Post 2
Burning of fossil fuels and growth of urban areas	22%	9%	50%**
✓ **Burning of fossil fuels and clearing of forest land**	73%	91%*	50%**
Cigarette smoking and the explosion of airline travel	0	0	0
Burning of rainforests and loss of ice in the Arctic	5%	0	0

*Indicates a significant difference Pre to Post (p<0.05)

**Indicates a significant difference between Post 1 and Post 2 (p<0.05)

440

Table 14: How much has CO2 in the atmosphere increased since the Industrial Revolution? In the 10,000 years before the Industrial Revolution in 1751, carbon dioxide levels rose less than 1 percent. Since then, they've risen by:

	% Response		
	Pre	Post 1	Post 2
11%	9%	0	5%
✓ **43%**	50%	95%*	45%**
62%	36%	0	30%**
75%	5%	5%	20%

*Indicates a significant difference Pre to Post (p<0.05)

**Indicates a significant difference between Post 1 and Post 2 (p<0.5)

445

Table 15: When was the last time in Earth's history that CO2 was as high as it is now?

	% Response		
	Pre	Post 1	Post 2
This is the highest it's ever been	45%	0	30%**

CO2 was at least this high during the warm periods between the ice ages	18%	5%	10%
CO2 has not been this high for almost one million years.	14%	5%	0
✓ **The last time CO2 was this high was 3 million years ago.**	23%	91%*	60%**

*Indicates a significant difference Pre to Post (p<0.05)

**Indicates a significant difference between Post 1 and Post 2 (p<0.05)

450 **Table 16**: Modern instruments have only been around for a little over 100 years. So how do we know what greenhouse gas concentrations (and temperature) were in Earth's past? (select all that apply) Answers graded as correct have a check mark to the left of the statement.

	% Response		
	Pre	Post 1	Post 2
✓ **Air bubbles trapped in ice cores provide detailed records of what the atmosphere was like in the past.**	50%	95%*	95%
✓ **Examining organisms in marine sediments can tell us what the temperature was like in the past.**	59%	73%*	90%**
✓ **Pollen in lake beds shows what plant species have lived there during different times. Different plant populations are associated with different types of climates.**	45%	68%*	85%
✓ **Glacial moraines show when and where previous episodes of glaciation occurred.**	86%	86%	90%
✓ **Tree rings show the history of drought, fire, and other environmental variations.**	59%	86%*	95%

*Indicates a significant difference Pre to Post (p<0.05)
**Indicates a significant difference between Post 1 and Post 2 (p<0.05)

455

Table 17: How long does CO2 remain in the atmosphere?

	% Response		
	Pre	Post 1	Post 2
CO2 washes out of the atmosphere seasonally.	0	0	0
CO2 remains in the atmosphere for 5-10 years.	18%	0	20%
✓ **CO2 remains in the atmosphere for up to 200 years, or more.**	41%	100%*	60%**
No single lifetime can be defined for CO2 because of the different rates of uptake by different removal processes.	32%	0	20%

*Indicates a significant difference Pre to Post (p<0.05)
**Indicates a significant difference between Post 1 and Post 2 (p<0.05)

460 **Table 18**: What are the major causes of sea level rise? (There may be more than one correct answer)

	% Response		
	Pre	Post 1	Post 2
Melting sea ice	73%	86%	95%
Melting glaciers and ice sheets	100%	100%	100%
Rivers accelerating	9%	5%	5%
✓ **Seawater expanding as it gets warmer**	18%	59%*	100%**

*Indicates a significant difference Pre to Post (p<0.05)
**Indicates a significant difference between Post 1 and Post 2 (p<0.05)

Table 19: Climate READY Ambassador student free response answers to "Can you identify some of the impacts of climate change
465 that South Florida is likely to experience within the next 30 years? Please list them here." Student responses were more detailed
and factual during Post 1 and more concise in Post 2 (see Appendix Table 9 for ranked tallies of student responses).

Post 1 Student Responses
- Some impacts of climate change that will take place in South Florida include rising sea levels, increasing to extreme temperature, loss of habitats and ecosystems, increased opportunity for flooding, hurricanes and storms with increased strength, more urban heat islands, and decline of native organisms.   - Rising sea level can lead to flooding and damage, the intensifying heat can make living conditions dangerous especially for elderly and low-income communities, the cost of rent can increase as more people move inland, our oceans can face coral bleaching and acidification, our crops and agriculture can also become damaged.   - Rising sea level, coral reef bleaching, more intense hurricanes   - Some impacts of climate change that South Florida is likely to experience is high sea level rise, beach erosion and flooding and also there is a likely chance that South Florida could be going through extreme storms, hurricanes within the next 30 years.   - Sea level rise, extreme heat, more extreme natural disasters, toxic algae blooms, population decrease, increase in prices for resources, loss of coral reefs, coastline erosion.   - Within the next 30 years Florida will see sea levels-rising due to climate change and the melting glaciers and we will see temperate rising, and more heat waves; which can cause more horrific hurricanes and other natural disasters.   -rising sea levels -increasing temperatures -salt-water intrusion -more impactful natural disasters   - idk   - Concerning Florida, within the next 30 years sea level rise will raise a multitude of impacts on South Florida. The rising of our oceans due to global warming can cause shoreline erosion, habitat destruction of animals and humans, as well as plant life across Florida's shores.   - flooding due to rising sea levels, extreme heat, and extreme hurricanes   - Florida is likely to experience extreme heat, sea-level rise, land going underwater, and more.   - Sea level rise, worsening hurricanes, ocean acidification, flooding, mangroves dying, etc.   - South Florida will experience sea level rising, slat water intrusion, more severe storms, and heat index rising. All of these issues will harm the thousands of people who live on the coast as well as the agriculture industry here. Honestly, they will affect everyone (not equally) in some shape of form. Our coastlines and natural habitats are already being eroded as floods increase.   - Sea levels rising into our neighborhoods, loss of wildlife including mangroves, human migration   - South Florida is likely to experience flooding, rising sea levels, and more severe storms (hurricanes).   - Rising sea levels, Higher coast erosion, Stronger and more common hurricanes, Urban Heat Islands, Increasing overall temp   - Increased temperatures - Rising sea levels - Overpopulation -Extinction of certain species   - Some of the major impacts that South Florida is likely to experience within the next 30 years due to Climate Change include increases in overall temperature and heat, more intense weather and storms, and rising sea levels. An increase in temperature can result in hospitalities due to heat-related illnesses, while more intense weather and storms can lead to home destruction and the harming of local ecosystems. Finally, rising sea levels can cause the submersion of residences near the coast of Florida and can result in increasing soil erosion.

- Some of the impacts that South Florida is likely to experience in the next 30 years is extreme heat, rising sea-levels, and the exponential growth in world population. Sea levels may rise to about 3 feet, the average temperature will rise up about 1 degree Celsius, and the global population would be too overwhelmed from an incoming carrying capacity.
- Rising sea levels,
  Temperature increase,
  eroding beaches,
  increased intensity in storms
- sea level will rise harming the community and wildlife.
- Seal Level Rise, Flooding, Severe Hurricanes

Post 2 Student Responses

- Sea level rising, increased insurance prices, stronger storms, hotter summers and cooler winters, and increased precipitation.
- Sea level rise, worsening storms, ocean acidification, coastal erosion, extreme heat, etc
- rising sea levels increasing temperatures flooding strengthened natural disaster (hurricanes)
- Rising seas level, increased urban island effects, extinction of native species, sealine corrosion, stronger storms
- Rising sea levels, stronger storms/ hurricanes.
- Sea level rise, stronger hurricanes from extreme heat and the greenhouse effect(greenhouse gases and more evaporation leading to stronger storms), permafrost melting and causing pathogenic diseases to come out from years ago, biodiversity decreasing including us
- Sea level rise, extreme heat, loss of habitat, stronger storms
- Stronger Storms, warmer temperatures, sea level rise, and the urban heat island effect
- Sea level rise Stronger storms Increasing temperatures Shoreline erosion Urban island heat Loss of habitat
- Sea level rise Urban heat islands Global warming
- Increase temperature Sea Level Rise Amplified storms
- Increased temperatures -Sea level rise -Increased heat waves -Increased storm strength, frequency, and duration
- extreme heat - rising sea levels - strengthening storms and hurricanes - loss of ecosystems - coastal erosion
- Rising sea levels, urban heat islands, general higher heats, habitat loss
- Sea level rise and high temperatures.
- Rising sea levels, increasing temps, loss of habitat
- Rising sea levels and increasing heat.
- Extreme heat, salt water intrusion, hurricane, floods, etc
- Rising sea levels, worsening storms, increasing temperature, harming of both terrestrial and marine ecosystems, etc.
- sea level rise urban heat island effect loss of habitat flooding

3.3 Fourth and fifth grade pre- and post- questionnaire results.

A total of 60 fourth and fifth grade learners completed the pre- questionnaire before the Climate READY Ambassador led

470   Lesson 1 and 53 completed the post- questionnaire after Lesson 4 (see methods). Significantly fewer learners reported being "not at all" worried about climate change after their experience. Significantly more students felt that people were causing climate change after their experience with fewer feeling it was part of a "natural cycle" (Table 20). Significantly more students correctly identified the greenhouse effect as being "gasses in the atmosphere that trap heat" after their experience (Table 22). Significantly more learners understood that extreme heat and rising seas are ways that climate change could affect South Florida after their

475   experience (Table 23). Learners were significantly more able to identify ways of to help reduce climate change including walking or riding a bike in place of driving, unplugging TVs and computer when not in use, turning off lights when leaving a room, and restoring coastal habitats (Table 24). There were no significant changes in how the learners felt about being able to

solve problems in their community, knowing how to make their community a better place, feeling like they can make a difference in their community, and feeling like they can make a difference in protecting the environment.

480

Tables 20–24: Pre- (N=60) and post- (N=53) questionnaire results from fourth and fifth grade afterschool students. Significant differences were found (*$p<0.05$) using a Student's T-test with normal distribution. Answers graded as correct are highlighted in yellow.

Table 20: What do you think is causing our current climate change?

	% Chosen	
	Pre	Post
I think it is part of a natural cycle	45%	28%*
I think people are causing it	37%	58%*
I do not think the climate is changing	8%	2%
Don't know	10%	11%

*Indicates a significant difference pre to post ($p<0.05$)

485

Table 21: True or False

	% Correct	
	Pre	Post
✓ **Climate means average weather conditions in a region over time.**	77%	79%
Climate and weather are pretty much the same thing.	75%	81%
Weather is usually expressed in terms of temperature, precipitation, and wind.	91%	83%

Table 22: The greenhouse effect refers to:

	% Chosen	
	Pre	Post
The Earth's protective ozone layer	22%	19%
Pollution that causes acid rain	17%	8%
✓ **Gasses in the atmosphere that trap heat**	24%	60%*
How plants grow	17%	10%
Don't know	20%	4%*

*Indicates a significant difference pre to post ($p<0.05$)

490

Table 23: What ways could climate change affect south Florida?

	% Chosen	
	Pre	Post
✓ **Extreme heat**	55%	74%*
✓ **Rising seas**	57%	72%*
✓ **Shorter days**	13%	8%
✓ **Stronger storms**	55%	66%
✓ **Fewer hurricanes**	25%	23%

*Indicates a significant difference pre to post ($p<0.05$)

Table 24: Which of the following actions can people take to help reduce the impacts of climate change?

		% Chosen	
		Pre	Post
✓	**Walk or bicycle instead of drive**	65%	91%*
✓	**Unplug TVs and computers when not in use**	60%	77%*
✓	**Turn off the lights when leaving the room**	65%	87%*
✓	**Don't waste food**	47%	43%
✓	**Put houses on stilts**	10%	23%
✓	**Restore coastal habitats**	38%	55%*
✓	**Make a family emergency plan**	25%	28%
✓	**Eat less meat**	13%	9%

495   *Indicates a significant difference pre to post (p<0.05)

4. Discussion

The three-semester model for teaching and training high school dual enrolled students at FAU Pine Jog to be Climate READY Ambassadors has proven to be an effective way to empower our youth and to engage the community in climate resilience education

500   and action. In its second year of implementation, the Climate READY program was able to provide a pathway for 23 teen students to participate in the global youth climate movement (Cloughton 2021) and reach as many as 700 local South Florida community members of all ages.

4.1.1 Objectives for all students

505   The program focus was to build environmental literacy of 4-12 grade students, teachers and the public so they are knowledgeable of South Florida's changing climate systems, the ways in which their community can become more resilient to extreme weather and/or other environmental hazards, and how they can become involved in achieving that resilience (Table 1). The Climate READY Program accomplished this by creating and implementing a comprehensive three-semester dual enrollment opportunity for high school students as described in our methods. Student coursework and feedback through pre- and post- survey questionnaires

510   demonstrated an increase in student understanding of climate change (Tables 8–18; p<0.05) and student responses to identifying impacts on Florida were more detailed, factual, and considered multiple areas of impact (Table 19). The most significant changes came as students gained more experience as Climate READY Ambassadors. From the summer to the spring, they became more aware of the effects of climate change on their communities, shifted their thinking about the reasons people question climate change to be more focused on the science and less on politics or religion, and increased their knowledge about key concepts associated

515   with climate change and climate resilience.

4.1.2 Objectives - Summer 2022 Climate READY Ambassador Institute (9-12 Grade Students, Semester 1)

The first semester (Summer 2022) worked through objectives (Table 1) that increased student content knowledge of the science of climate change (Fig. 3), improved critical thinking skills to assess the sources of different climate change perspectives and attitudes,

520   highlighted local impacts within South Florida (Table 19), explored possible local solutions (i.e. mangrove restoration with MANG, Fig. 3, Fig. 5), met professionals that work towards equitable solutions such as those within the Southeast Florida Climate Change Compact (2023, Fig. 3), and provided a starting point for students to communicate this knowledge through creating storybooks (See Appendix, Table 26).

525

Figure 5: Climate READY Ambassador students participating in a service-learning field activity with MANG nursery in West Palm Beach, FL in the Summer 2022. Co-founder Keith Rossin taught students how mangroves are used in coastal restoration and guided them through methods to grow and plant them.

530 In addition, the Climate READY Program successfully established relationships between students across Palm Beach County through the in-person residential summer semester course. On the last day of the class students were asked in an informal setting, "Think about all the things we have done this week…the speakers, assignments, etc. What word or short phrase comes to mind?" using a word cloud generator (Mentimeter, 2023) where words become larger when used multiple times. The final image indicated that the largest and most used words were "fun, resilience, climate change, and science on a sphere" followed by "community,

535 adaptation, and mitigation" (Fig. 6). Many other words were added to create a large word cloud that represented the wealth of information they received from the course and most importantly, reinforcing the evidence in the survey results that the information was retained. This was all while students reported to have "fun," indicating that they not only learned through the experience, but that it was also enjoyable. The use of fun activities in the learning environment is often used with younger students, though previous research indicates that it can be used with all age groups and that experiencing fun and enjoyment can be "identified as a proven

540 way to build a socially connected learning environment," (Lucardie, 2014), which can make a lasting impression on a learner and help them retain information. This is also seen in storytelling lessons (Miley, 2009).

Figure 6: Word cloud (Mentimeter, 2023) used to generate a visual representation of student perception of the summer semester 2022, the first of the 3 semesters in the FAU Climate READY Program.

545

Storytelling has been used in communicating scientific concepts including climate change (Coren 2022; Moezzi et al. 2017) and research has shown that storybooks can be used to bring communities together (Peters, 2023). For example, one way to teach students how to communicate complex concepts such as climate change is by creating and sharing storybooks with elementary school students. This idea came from a four-year collaboration with students from Boca Raton Community High School in Boca

550 Raton, FL and Galaxy E3 Elementary School in Boynton Beach, FL within the Palm Beach County School District, a public school system (Fig. 7). In 2018 high school students were given an assignment to create a storybook of an ecological issue as part of an Advanced International Certificate of Education (AICE) Environmental Management course (Cambridge International AS Level Environmental Management – (8291), 2023). The purpose of the lesson was for high school students to research an ecological issue of choice and to identify the main causes, effects, and possible solutions. The exercise required students to breakdown

555 complex issues into smaller digestible units that could be easily described to an elementary school student (ages 5 to 10). At the same time, creative freedom was given, which gave students an opportunity to gain confidence in communicating the subject. As part of the course, these high school students took a field trip to share their stories with kindergarten through second grade students at Galaxy E3 Elementary School where the teens became the teachers. While at Galaxy, students were also exposed to another form of storytelling through NOAA's SOS technology to reinforce earth system science concepts they were teaching earlier that

560 day. Due to a successful first year of implementation, the collaboration continued for an additional three years, until Spring 2022, with a virtual year in 2020 during the global pandemic (Fig. 7; NOAA Grant Helps Teach Students About the Environment, 2023).

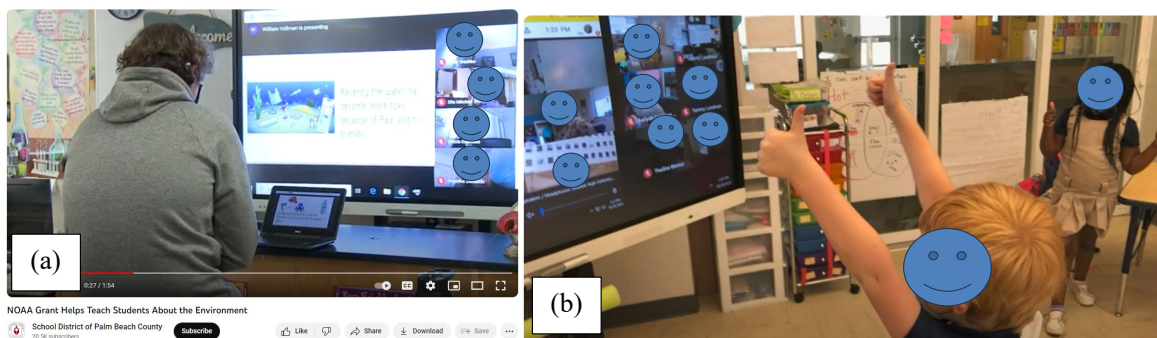



Figure 7: AICE Environmental Management student from Boca Raton Community High School (a) sharing his ecological
565 storybook project with kindergartners at Galaxy E3 Elementary School (b) (NOAA Grant Helps Teach Students About the Environment, 2023).

Classroom surveys were conducted to analyze student feedback and although the results of the four-year program are not currently published, the testimonials of both elementary and high school students were noted and used to improve the lesson for the AICE

570 course. One student reported "Whatever you do, keep the storybook activity and field trip to Galaxy. I will never forget my experience with the little kids" after being asked for feedback about the overall course. The storybook lesson impacted everyone involved including the students, teachers, volunteers, and administrators. One teacher reported "This experience gave me goosebumps!" and "I even learned something new today." The storybook lesson brought the community together and it gave them a safe space to talk to each other about environmental issues and solutions. The Climate READY Program took this idea a step

575 further by creating a unique storybook template that highlights climate change in the local community (see Appendix Table 26; Fig. 12). The CR Ambassador created team stories during the first semester to help them understand the meaning of climate change resilience and to help them connect with the issues their communities are facing. It was used as a final project grade. These stories

were then shared in the second semester afterschool program as part of the lessons given to fourth and fifth grade students in the same community as described in our methods section.

580

4.1.3 Objectives – Fall 2022 Climate READY Afterschool Program (9-12 Grade Mentorship of 4-5 Grade Students; Semester 2)

During the fall semester (2022), CR Ambassadors learned to teach a four-lesson afterschool program that brought students together to investigate the complex issue of climate resilience as a team (Table 2; Fig. 8(a-c). This provided a safe space for students to talk

585 about the challenges they face in their own community. For example, the Lake Worth Beach team learned that one of their fourth and fifth grade students at Barton Elementary School experienced a heat stroke during school hours, earlier that school year. Although the student was given immediate medical attention and he was ok and able to share his story, this was a traumatic event that affected the entire school population. Our CR Ambassadors used this personal story to discuss how climate change effects such as extreme heat can cause health problems like heat exhaustion or heat stroke and that the dangers are real for their community

590 (The Fifth National Climate Assessment, 2023; Southeast Florida Regional Climate 2023 Compact, 2022; U.S. Global Change Research Program, 2016). When it was time to create a new climate resilient storybook, the Barton Elementary afterschool students decided to write about extreme heat, *Pablo Protects the Community from Extreme Heat* (see Appendix Table 26), which addressed the program objective for fourth and fifth grade students to "design and complete a storybook on community resilience to build an understanding of climate change and the impacts facing Southeastern Florida (Table 1). The personal experiences from the students

595 helped them consider solutions and with the help of the CR Ambassadors and the training they received through the Climate READY Program, students chose to plant trees to create more shade, decreasing the heat island effect, and reducing risk of heat related illnesses. In their storyline, a gardener, a tree caretaker, and everyone from their community worked together to plant trees throughout the community. In the end, they celebrated with an ice cream party, and everyone was protected from the dangers of heat exhaustion and heat stroke. Even though the CR Ambassadors were the teachers in this setting, they were also learning from

600 the elementary school students through this student community engagement activity, an important tool in training future leaders (Millican and Bourner, 2011).

Figure 8: Afterschool students participating in the Climate READY Program. NOAA's Science on a Sphere and mobile application
605 was used to help students understand climate change and how it relates to the effects seen in Florida (a). Climate READY Ambassadors were the teachers of 4 lessons including the creation of a storybook (b), and students were given a hurricane resilience game called "Get Storm Ready" to help them decide what might be the best items to pack in preparing for stronger storms (c).

Pre- and post- surveys were given to the afterschool participants before and after the four-lesson program (Table 20–24). Sixty
610 learners (N=60) completed the pre survey and 53 completed the post. The results indicate that significantly (p<0.05) more learners understood the science of the greenhouse effect, that humans are causing the current climate change we're witnessing, that extreme heat and rising seas are ways that climate change could affect South Florida, and they were able to identify ways to help reduce

climate change (p<0.05) including walking or riding a bike in place of driving, unplugging TVs and computers when not in use, turning off lights when leaving a room, and restoring coastal habitats, the last being somewhat unexpected (Table 24). From classroom experience, many of our underserved youth in Palm Beach County have claimed to have never been to the ocean, let alone fully understand the dynamics of a coastline. It seems that their interactions with the CR Ambassadors helped them explore this ecosystem and they recognized that ecological restoration projects like planting native mangroves along our coastline would improve community resilience to sea level rise and other effects of climate change (Su et al. 2021). Our CR Ambassadors experienced this with the in-service project at the MANG nursery in the summer (Fig. 5) and they communicated their experience with the younger students. These outcomes from both groups of students are seemingly very successful, where students demonstrated learning by doing and/or learning by storytelling (Maccanti et al., 2023; Lawrence and Paige, 2016).

4.1.4 Objectives – Spring 2023 Climate READY Community Outreach (members of the community at large, delivered by CR Ambassadors; Semester 3)

Similar to other community-based approaches to address climate change (Clark et al., 2023; Semmens et al, 2023; McNamara and Buggy, 2017; Uitto and Shaw, 2006), the Climate READY Program reached out to the greater community during the spring semester. In the course *Community Resilience Outreach*, students were given the task to generate a community resilience plan based on what they learned throughout the program and to present their plan during a community event. While targeting the objectives to "identify and evaluate personal and community strengths and vulnerabilities in response to extreme weather events," "acknowledge that disproportionate distribution of vulnerabilities and diverse community values exist," and "design and implement community resilience-related service-learning projects based on local environmental challenges (Tabel 1), students learned from local professionals throughout the program and developed community-specific resilience plans for each target community (Fig. 1). These plans were then shared with each community in at least two settings, one being a public presentation, and another could be a table event (see Appendix Fig. 11). Once again, the CR Ambassadors were the teachers for community members, adults and families, addressing the objective "empower students to act as agents of change within the community by teaching community members about local climate impacts and resilience strategies for extreme weather events" (Table 1). An optional survey was conducted for those that attended a presentation session with our CR Ambassadors and we received 24 responses ranging from ages 10-15 to 51-60 (see Appendix, Table 31). Most were male (96%) and with varying levels of education (middle school to doctorate) (see Appendix 33–34). Community members (N=24) rated the organization, quality, relevance, and usefulness of the presentation with high averages of 9/10 or above (see Appendix Table 28). When asked "Did the interaction with the students change your thinking about community actions to address climate change? If so, how?" 23/24 of the responses were yes (see Appendix Table 29). Several of the responses included "usually I don't think about things unless they affect me directly, so having people talk about it to us really opened my perspective," "I learned about legislation and landscaping," and "I think that having a younger person presenting gave us a better perspective."

Students who participated in the table events were also well received, though a survey was not given. For example, our Lake Worth Beach team caught the attention of the current vice mayor, Christopher W. McVoy, a soil scientist and wetland expert, at an Earth Day Taco Fiesta event. Lake Worth Beach has not created an Office of Sustainability and/or Resiliency like the surrounding cities of Boca Raton, Boynton Beach, Delray Beach, and West Palm Beach, so the students were captivated by his attention to climate change education, resilience, and their youth involvement in the community. Much of their discussion focused on the need for their community to have a sustainability office in Lake Worth Beach local government and what steps the youth could take to encourage Lake Worth Beach to work towards a more informed community. Dr. McVoy shared his contact information, and the students

were excited to continue the conversation. Part of the hope for this program was that local governments would give these students a platform to share their perspectives and research on environmental issues much like Boca Raton has done with a Youth

655   Subcommittee (Youth subcommittee puts words into action in Boca Raton, 2023). The interaction with Dr. McVoy was an excellent first step towards involving youth in local government for Lake Worth Beach; therefore, meeting active local government officials proved to be an important aspect of the Climate READY Program. Another example where government officials interacted with our CR Ambassadors (outside of the course guest speaker encounters during class time) was through the Palm Beach County Office of Resilience (PBCOOR) and the urban sustainability directors network (USDN). The Director of PBCOOR, Megan Houston, and

660   a Resilience and Sustainability Analyst, Natalie Frendberg, contacted our CR Ambassadors to participate in an USDN funded project, Strengthening Frontline Capacity for Climate Resilience Planning in Palm Beach County, FL (Final Report 2023). Ten of our CR Ambassadors from our Boca Raton, Lake Worth Beach, and Riviera Beach teams represented Palm Beach County Youth in presentations involving community members in Belle Glade, Pahokee, and West Palm Beach (Fig. 9A-C). These students were able to play active roles in climate resilience planning for these communities, further addressing the program objective to "empower

665   students to act as agents of change within the community by teaching community members about local climate impacts and resilience strategies for extreme weather events," and influencing their sense of community (Table 1; Fig. 9A-C).

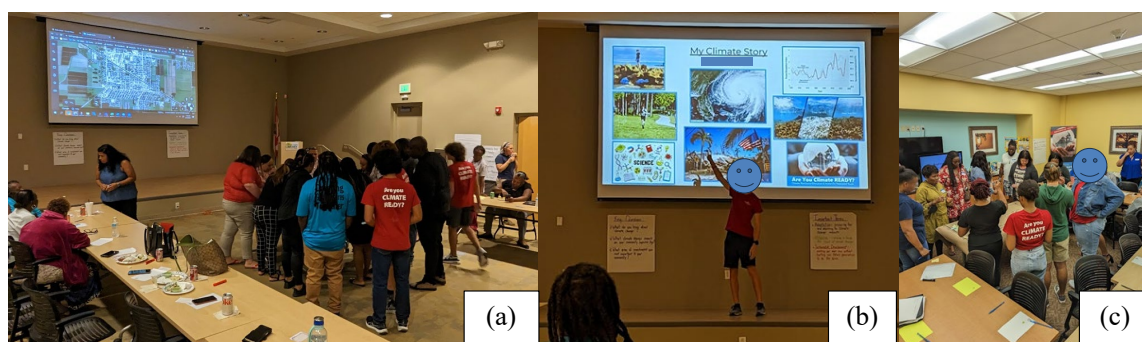



Figure 9: CR Ambassadors with the Palm Beach County Office of Sustainability participating in the USDN funded project,
670   Strengthening Frontline Capacity for Climate Resilience Planning in Palm Beach County, FL (Final Report 2023). Students travelled to Belle Glade and assisted in determining community assets (a) and shared their climate stories with community members (b). Students also interacted with community members in West Palm Beach (c).

4.2 Hypothesis Analysis

675   Our hypothesis for the program was that participants in the Climate READY program will better understand their community strengths and vulnerabilities to a changing climate and that they will feel empowered to participate on both a personal and civic level to take action, minimize risks, adapt, and weigh the potential impacts of their decisions. We tested this hypothesis by designing and implementing a three-semester dual enrollment program and using pre- and post- questionnaires to compare means and identify significant differences (p<0.05). The mixed methods approach allowed us to focus on measuring changes to participant

680   Behaviors, Attitudes, Skills, Interests, and Knowledge (BASIK), and proved to be an effective tool in telling our Climate READY story. Through evidence as discussed in this paper, students that completed all 3 semesters and all pre- and post- questionnaires (N=23) were effectively taught climate change science and resilience (Tables 8–19), engaged in community settings to understand strengths and vulnerabilities (Tables 5–7; Fig. 6, 8-9), and felt empowered to take action and be more involved in community decision making (Table 3; Fig. 9). In addition, the younger participants that took part in the four-lesson afterschool part of the

685   program and answered pre- (N=60) and post- (N=53) questionnaires demonstrated an increased understanding of climate change,

community resilience, and how they could contribute to being an active community member in combatting the effects of climate change (Table 20–4). Therefore, the results of this study support our hypothesis.

4.3 Program Challenges and Recommendations

690 The Climate READY program described in this paper encountered several challenges throughout the course of the grant funded period (October 2020 to September 2023). The largest challenge was to adapt our in-person model to a hybrid virtual one through the unexpected global pandemic (COVID-19) in 2020. The School District of Palm Beach County opened their schools for hybrid in-person and online learning throughout the 2020-2021 academic year where students and parents were given a choice (School District of Palm Beach County COVID-19 Guiding Document 2020 – 2021 School Year, 2023). All teachers and school staff were

695 required to be onsite. Therefore, our Climate READY three-semester model also needed modifications as described in this paper to accommodate all eligible students, teachers, and afterschool staff involved. Restrictions were lifted for the 2021 – 2022 academic year and all students were required to return to in-person schools, which proved to be another challenge for our community as everyone needed to learn new routines for a second time. We faced other challenges such as our struggle to recruit students in the more rural target communities of Pahokee and Belle Glade, and we underestimated the amount of staff time needed to perform all

700 our planned tasks successfully. In the end, the support of our community from all levels (10–12-year-old afterschool students to adult community members) gave us the strength and drive to complete our work.

Using our lessons learned from the Climate READY program, we recommend that future projects:

1. invest in quality staff and program coordination time, allowing for unexpected events such as global pandemics and

705   natural hazards like hurricanes, earthquakes, flooding, etc.
2. plan for multiple in-person recruitment meetings at several target schools, especially those in the most underrepresented and underserved areas.
3. create and use an advisory council wisely to understand the real needs of the targeted community and stay in touch with them throughout the entire process with regular meetings. Our advisory council played a major role in our success.

710

5. Conclusions

The student Climate READY Ambassadors (N=23) in our three-semester long study have shown improvements in multiple areas including content knowledge of the causes, effects, and solutions of climate change, sense of place, and self-efficacy. They also built relationships with their communities. This program gave them a sense of empowerment to be agents of change to build

715 community resilience to the effects of climate change. Our methods provided a safe space for members of the community to discuss important complex environmental issues. It also built skills for our youth to communicate to multiple stake holders such as government officials, resilience professionals, and the community at large. Students were inspired, motivated, and more likely to retain information while participating in this place-based climate resilience program. The three-semester experience at FAU Pine Jog gave students confidence to act and empowered them to be a part of their community decision making processes.

720

The fourth and fifth grade students (Pre N=60, Post N=53) in our study also showed significant improvements in their understanding of climate change and were able to identify ways to help reduce climate change. Several community members (N=24) took the time to answer questionnaires that indicated that the CR Ambassadors were effective in communicating community resilience to climate change. In addition, we estimate that over 700 community members were impacted during the

725 three-semester study (Cohort 2), making a lasting impression among underserved regions of Palm Beach Couty, Florida (Fig. 2).

The Climate READY Program was a success and laid out a foundation for future climate resilience programming at FAU Pine Jog. It also provides an example of a youth empowerment program that could be shared and implemented within other colleges and universities. The data collected, experiences, and lessons learned from this study have given us the tools we need to move
730 forward in our South Florida community to be more resilient to the challenges ahead and to be ready for the impacts of climate change.

Appendix

FAU Pine Jog selected a sequence of 10 NOAA SOS datasets to create a playlist for the students. This playlist was an important
735 part of teaching climate change science as it provided visual representations of global carbon dioxide concentrations, global temperature, global hurricane pathways, and changes in arctic sea ice coverage over time. Video shorts created by NOAA partners were also used.

Table 25: Playlist of NOAA SOS datasets used in order of presentation. Source Data: https://sos.noaa.gov/Datasets/

	Name	Data Type	Duration	Notable Features
1.	Blue Marble	Satellite Earth	NA	- Vastness of the Sahara Desert - Shading done in true color: gives Earth's appearance from space
2.	Changing Climate, Changing Ocean	Movie	6:30	Focuses on impacts of CO2 on climate and ocean health and need for action.
3.	Carbon Dioxide Concentration: GEOS-5 Model	CO2 Model	NA	- In North America, notice how weather patterns affect carbon dioxide distribution in the atmosphere. Emissions in the U.S. Midwest and East Coast are carried east by the westerly winds to the Atlantic Ocean. - In Asia, major emissions in industrialized Asian countries are apparent and move eastward. - In Africa, plumes of white, carbon monoxide emissions, are seen from fires.
4.	Climate Model: Temperature Change CCSM b1 1870-2100	Temp Model	NA	The temperatures displayed in the datasets are all a comparison to temperatures in 2000. Blue tones on the visualization represent temperatures cooler than those in 2000, while red tones represent temperatures warmer than those in 2000.

5.	Sea Ice Extent- 1978 - Present	Satellite Sea Ice Data	NA	• Seasonal change of sea ice • Shrinking of Arctic sea ice concentration, especially in summers • The disappearance of the Odden, a thumb-shaped sea ice feature east of Greenland, which often is visible prior to the late 1990's • The minimum sea ice concentration in 2007 shattered the previous minimum sea ice record set in 2005 by 23% and contained 39% less ice than the 1979 to 2000 average. • The minimum sea ice extent record was broken again in September 2012
6.	Rising Sea	Movie	6:23	Scientists estimate sea levels could rise more than three feet by the end of this century. That would mean the flooding of commercial and residential property along the coast.
7.	Hurricane Tracks: Cumulative 1950-2020	Satellite Hurricane Data	NA	• All recorded hurricanes worldwide from 1950 - 2020 are included • No hurricanes cross the equator • Very few hurricanes make it to South America because of wind shear patterns.
8.	Hurricane Season 2020	Satellite Hurricane Data		• 30 named storms, of which 13 became hurricanes and 6 of those became major hurricanes • Fifth consecutive above-normal year for hurricane activity • 10 storms formed in September alone • 12 storms hit the US coastline
9.	Resilient Cities: Key to Thriving on a Changing Planet	Movie	4:17	• Cities have long been crucibles of creativity, innovation and wealth generating engines. Ex. Athens, Rome, Delhi and Peking • More than 50% of the global population live in cities, will reach 70% by 2050 marking the largest migration of humans in history. • Cities provide rich and unusual opportunities to reduce the human ecological footprint on Earth and to leave more open space for nature… but seizing these opportunities requires that our cities become denser, greener, and smarter.

10.	Holocene/Little Boxes	Movie	5:48	• A scientifically responsible, arts-expressed film with visceral imagery, a succinct narrative, and global data that invites us to reflect on our relationship to our changing climate and rising levels of CO2. • Everyday behaviors are translated into a visual metaphor about the complex and connected relationship between our actions and ways of being in the Anthropocene and our ever-changing climate.

740

Students were asked to write a "Where I'm From" poem to evaluate self-awareness and sense of place early in the summer 2022 CR Ambassador Institute (Semester 1). They were then asked to illustrate their poems on a paper puzzle piece that was later placed together in a community puzzle with their fellow CR Ambassadors at the end of the course (Fig. 10).

745 **Figure 10:** Community puzzle created by Climate READY Ambassadors during the summer 2022 CR Ambassador Institute (Semester 1).

Scheduling and time management assignments were very important to the success of the Climate READY program. Shared calendars were used in the fall and spring semesters to help students and instructors manage their time efficiently (Fig.11). Students

750 were given the opportunity to choose what was best for them, as long as they communicated their needs in a timely matter. This was important because all CR Ambassadors had a full-time high school schedule in addition to the FAU dual enrolment course. Many of them were also working part-time jobs and/or involved in extracurricular clubs and sports.

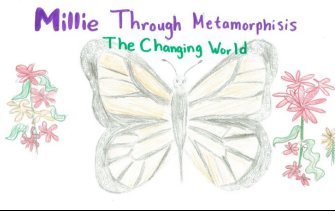
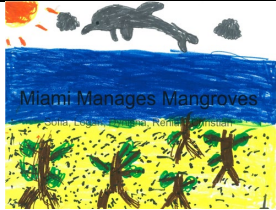
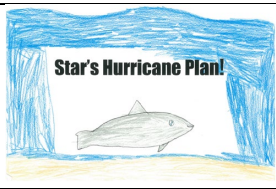
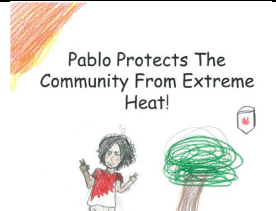
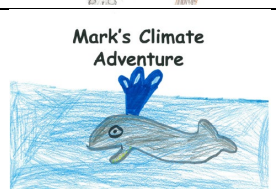
755

Master Schedule of Graded Outreach Events Spring 2023

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						Feb 25 (Class #4)
Feb 26	Feb 27 **Symphonia** 5pm - 8pm	Feb 28	March 1	March 2	March 3	March 4
March 5	March 6	March 7	March 8	March 9	March 10	March 11
March 12	March 13	March 14	March 15	March 16	March 17	March 18
March 19	March 20	March 21	March 22	March 23	March 24	March 25 (Class #5)
March 26	March 27	March 28	March 29	March 30	March 31	April 1 **WPB e4 Life @Cox Science** 10am - 4pm
April 2	April 3	April 4	April 5 **Summit Library** 6 - 7:30p	April 6 **Lantana Rd. Library** 6-7:30pm	April 7	April 8
April 9	April 10	April 11	April 12	April 13	April 14	April 15
April 16	April 17	April 18 **Boynton Beach Library** 5:30-7pm	April 19	April 20 **Max M. Fisher Boys & Girls Club** 4:30-6pm	April 21	April 22 **WPB in Okeeheelee** 10am - 3pm **Taco Fiesta in Lake Worth** 3-7pm **Boynton Earth Day** 10am-1pm
April 23	April 24	April 25	April 26	April 26	April 28	April 29 (Class #6) In person @ Pine Jog 8:30 to 5pm

Key

Anne Rachel Graduate Student	Adult Supervision Schedule
	Community Outreach Events
	Regular Class Time

Figure 11: Schedule of outreach events during semester 3 of the Climate READY Program (Spring 2023), Community Outreach.
760 Events began February 27 and ended on April 22 with the last class meeting on April 29. Note: Four of the 13 graded outreach events were not on this student schedule as they were planned and implemented prior to this Time Management assignment. Those events included 3 Urban Sustainability Directors Network (USDN) grant collaborations with the Palm Beach County Office of

Resilience (Amplifying Impact Community Partners of South Florida, 2023) and a Climate and Art event coordinated by the Delray Beach Office of Sustainability and Resilience (Climate and Art Delray Beach 2022, 2023).

765   Ten original stories were created by student authors during cohort 2 of Climate READY; 5 were created by the teen CR Ambassadors and 5 were created though the collaboration with the CR Ambassadors and the fourth and fifth grade students at 5 different Title 1 after school programs (Table 9). Each original storybook was printed using the self-publishing and book printing company, DiggyPOD (2023). Copies of each storybook were distributed to student authors and any remaining copies were given to the school's administrators to distribute to their main library or individual classroom libraries. Access to these storybooks (pdf)

770   can be made available upon request from the authors of this paper.

Table 26: Original community climate resilience stories created by teen Climate READY Ambassadors and fourth and fifth grade afterschool students in Title 1 schools during cohort 2.

Palm Beach County Community	Storybook Title	Student front cover art	Student Authors
Boca Raton	Sandy Saves the Sea Shore		Boca Raton CR Ambassadors
Boynton Beach /Delray Beach	Shelly's Surprisin Shore Story		Boynton Beach /Delray Beach CR Ambassadors
Lake Worth Beach	Oliver & Oat's First Hurricane		Lake Worth Beach CR Ambassadors
Riviera Beach	Sally's Sea Adventure		Riviera Beach CR Ambassadors

West Palm Beach	Millie Through Metamorphosis: The Changing World		West Palm Beach CR Ambassadors
Boca Raton	Miami Manages Mangroves		Boca Raton CR Ambassadors and the fourth and fifth grade afterschool students at Coral Sunset Elementary School
Boynton Beach /Delray Beach	Star's Hurricane Plan		Boynton Beach /Delray Beach CR Ambassadors and the fourth and fifth grade afterschool students at Galaxy E3 Elementary School
Lake Worth Beach	Pablo Protects the Community from Extreme Heat		Lake Worth Beach CR Ambassadors and the fourth and fifth grade afterschool students at Barton Elementary School
Riviera Beach	Mark's Climate Adventure		Riviera Beach CR Ambassadors and the fourth and fifth grade afterschool students at University Learning Academy
West Palm Beach	Joquin and Peanut B. Save the Coast		West Palm Beach CR Ambassadors and the fourth and fifth grade afterschool students at Pine Jog Elementary School

775   Climate READY Ambassador students answered free responses questions with more detail in the post 1 questionnaire and provided shorter more concise answers in the post 2 questionnaire (Table 5.12 and Table 8). The top three responses were (1) seal level rising, (2) extreme heat, and (3) stronger storms or hurricanes.

Table 27: Ranked tallies of repeated answers to the Climate READY Ambassador student free response question to "Can you identify some of the impacts of climate change that South Florida is likely to experience within the next 30 years? Please list them
780   here." Full responses are found in Table 5.12.

Rank	Tally	Post 1 Response	Tally	Post 2 Response	
1	20	rising sea levels	19	Sea level rising	

2	13	increasing to extreme temperature	15	extreme heat
3	11	hurricanes	13	stronger storms
	8	flooding	6	increased urban island effects
	6	beach erosion	6	Loss of habitat
	5	decline of native organisms	4	coastal erosion
	3	loss of habitats and ecosystems	3	flooding
	3	coral bleaching	3	extinction of native species
	3	more extreme natural disasters	2	greenhouse effect
	2	more urban heat islands	1	increased insurance prices
	2	the cost of living can increase	1	hotter summers and cooler winters
	2	ocean acidification	1	ocean acidification
	2	agriculture can be damaged	1	saltwater intrusion
	2	salt-water intrusion		
	2	overpopulation		
	1	toxic algae blooms		
	1	population decrease		
	1	melting glaciers		
	1	I don't know		
	1	human migration		
	1	extinction of certain species		
	1	heat-related illnesses		

Pre- and post- surveys were conducted before and after the afterschool 4-lesson program to fourth and fifth grade students during the fall semester. These were not matched pairs where 60 learners completed the pre survey and 53 learners completed the post; therefore, percent were used for discussion (Table 9). An optional single post survey was conducted after the community outreach

785 presentations in the spring semester. Twenty-four community members completed the survey across all presentations and mean responses were used for discussion (Tables 10.1 – 10.7).

Tables 28–34: Post presentation evaluation from community members in Palm Beach County (N= 24).

Table 28: Please rate the different aspects of today's presentation using a scale from 1-10 where 10=highest

	Mean Response (N=24)
Organization and clarity of the presentation	9.3/10
Quality of information shared	9.6
Relevance to my community	9.8
Provided community actions for extreme weather and other environmental hazards	9.0
Usefulness of resources	9.3

790

Table 29: Free response question on community perception of actions to address climate change.

Did the interaction with the students change your thinking about community actions to address climate change? If so, how? Yes = 23/24 (96%)

- YES because usually I don't think about things unless they affect me directly, so having people talk about it to us really opened my perspective.
- Yes, it opened my perspective to our local vulnerabilities.
- Yes, it made me more aware of the environment that I live in.
- Yes, I learned a lot about my area's relationship to the climate.
- Yes by making me realize I can be doing more to prevent pollution.
- Yes, it gave me more clarity on what my community is doing to help climate change and what they should do conversely.
- Yes, I learned more about what we can do
- I like how they presented ways to live sustainable such as through transportation and using energy efficiently
- I do, I had a more in-depth understanding
- No, because I already knew all of the information.
- Yes, I think that having a younger person presenting gave us a better perspective
- Yes, more ideas about how to be environmentally conscious
- Yes, I didn't realize the aspects our community had on the overall climate and the way all the parts fit together are really interesting
- Though the PowerPoint was very thorough, I already have these things on my mind however, the one fact about the potential loss of jet streams was extremely insightful and worrying
- Yes, I became more aware of how my community is helping climate change, inspiring me to get involved.
- They were fantastic!
- Yessir did it inspired me to talk and find more information on the subject
- Yes, I learned about the importance of planting trees
- Glad to see youth so engaged.
- Yes there is more local initiatives than I thought
- Yes, I learned about legislation and landscaping.
- Yes more urgent

Table 30: Please state your level of agreement with the following statements.

	Mean Response	% Agree and Strongly Agree
I have a stronger understanding of the causes and impacts of climate change.	4.4/5	92%
I have a better understanding of our community's vulnerabilities to extreme weather events and other environmental hazards.	4.4	96%
I am more aware of our community's strengths and potential solutions in response to extreme weather events and other local environmental hazards	4.5	100%
I am more aware of local and regional efforts to assess our community vulnerabilities and make our community more climate resilient	4.5	96%
I feel I can contribute to helping our community be more resilient	4.5	100%

795 **Demographics of community members**

Table 31: Respondent age

	N	%
Under 10	0	0
10-15	6	25%
16-20	12	50%

	N	%
21-30	0	0
31-40	2	8%
41-50	3	13%
51-60	1	4%
61-70	0	0
71-80	0	0
81-90	0	0
>90	0	0
Prefer not to say	0	0

Table 32: Gender

	N	%
Male	23	96%
Female	1	4%
Other	0	0
Prefer not to say	0	0

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Table 33: Highest level of education

	N	%
Middle school	1	4%
High school	17	71%
Community College	0	0
2 Year Degree	0	0
College	1	4%
Master's Degree	4	17%
Doctorate	1	4%
Other	0	0
Prefer not to say	0	0

Table 34: Race/Ethnicity (check all that apply)

	N	%
American Indian or Alaska Native	1	4%
Asian	4	17%
Black	0	0
Hispanic or Latino	7	29%
Native Hawaiian or Other Pacific Islander	0	0
White	17	71%
Some other race or ethnicity	1	4%
Prefer not to say	0	0

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Figure 12: FAU Pine Jog Original Community Resilience Storybook Outline assignment for dual enrolled CR Ambassadors and fourth and fifth grade students in the Climate READY Program.

Ethical Statement

810 The research in this study is novel, representing the authors' analysis, experience, and perspectives. There was no intent to cause harm to others. The pre- and post- questionnaires were managed by the program evaluator, Technology for Learning Consortium, and used as part of course material. Care was taken to keep responses anonymous. The Florida Atlantic University Social, Behavioral and Educational Research IRB determined that this program did not meet the definition of human subjects research according to federal regulations (24 March 2021). Therefore, it was not under the purview of an IRB.

815

Competing interests

The contact author has declared that none of the authors has any competing interests.

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840 **Data Availability**

The authors confirm that data collected for this study support their findings and are found within the article and in supplementary materials.

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