ABSTRACT

LAWSON, DANIELLE FRANK. Intergenerational Learning and Climate Change: Empowering Children to be a Solution Now and in the Future. (Under the direction of Dr. Kathryn Stevenson and Dr. M. Nils Peterson).

As issues associated with climate change grow increasingly complex, the need for a citizenry prepared to address them cannot be overstated. Unfortunately, ideologically polarized contexts render climate change education and communication efforts challenging or ineffective among US adults. Promisingly, however, recent research suggests that adolescents are more capable than adults of separating climate science facts from their ideological contexts when forming perceptions. Novel communication and education strategies that leverage children’s unique perspectives may provide an opportunity to make inroads with adults where climate change communication efforts have previously failed. Intergenerational learning (IGL), a sub-theory of sociocultural theory, posits that interactions between two generations can result in the bidirectional transfer of knowledge, attitudes, and/or behaviors. For example, marketing specialists have long relied on the ability of children to influence parent purchasing decisions around food, toys, and other products. In this same vein, environmental education efforts around multiple subjects including recycling, farming technology, and water quality have been associated with the transfer of environmental learning from children to their parents. However, this phenomenon has not been tested with more controversial topics such as climate change.

This dissertation examines the potential of IGL from children to the parents in the climate change context through three separate studies: (1) a perspective establishing why IGL of climate change can be effective and how to implement IGL of climate change in environmental education settings, (2) a correlational study examining how climate change concern and behavior relate between children and their parents in individual households, and (3) an experimental
evaluation of a climate change-based, standards-aligned, wildlife curriculum designed to maximize the change of IGL occurring between children and their parents. Results from this study suggest the following: (1) IGL from children to their parents of climate change information may be possible based on theoretical and anecdotal evidence, provided certain best practices are followed during curricular design, (2) level of family climate change discussion, a parent’s choice to behave in climate friendly ways, and a child’s own climate change concern predict the likelihood for a child to behave in climate friendly ways, (3) a parent’s personal level of climate change concern is independent of child’s level of climate change concern when predicting the likelihood for a child to behave in climate friendly ways, (4) following participation in the IGL curriculum, a child’s increase in climate change concern fully mediates the relationship between the treatment and a parent’s increase in climate change concern, and (5) IGL of climate change concern from children to their parents is most effective among those who identify as politically conservative or male, particularly when the communication comes from their daughters. These results not only add to the IGL scholarship, but also help empower a generation of citizens to help reduce the impacts of climate change both now and in the future.
Intergenerational Learning and Climate Change: Empowering Children to be a Solution Now and in the Future

by

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A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the degree of Doctorate of Philosophy

Parks, Recreation & Tourism Management

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DEDICATION

To the teachers, family members, and friends who taught me the love of all things outdoors.
BIOGRAPHY

Danielle is a native North Carolinian, born in Charlotte, but spent her formative years being raised in the mountains of Asheville. It was living in Western North Carolina, visiting her family in Costa Rica, and a high school Advanced Placement Environmental Science course that helped guide her to her love of nature. Danielle would continue on to study Marine Biology from the University of North Carolina Wilmington (UNCW), where she would fall in love with the idea of helping building a bridge between science and the public. Through this love she would start volunteering at local environmental education centers, realizing that education was the way forward to a conservation friendly future. Danielle stayed on at UNCW to get a Master of Science in Environmental Studies with dual concentrations in Environmental Education and Coastal Management. From there she would serve a term as an AmeriCorps Member with the goal of increasing ocean literacy to Latinx communities across the North Carolina coast. It was after her AmeriCorps term that Danielle would continue on to work on her Ph.D. at NC State University (NCSU), with the hopes of increasing the number of diverse voices in solving environmental issues. Throughout her time at NCSU, she has had numerous opportunities to work with various communities – academics, research scientists, nonprofit leaders, government workers, and the general public to help solve wicked environmental problems like climate change. Danielle hopes to go on to get a faculty job at a university or work with environmental policy and advocacy groups in some capacity.
ACKNOWLEDGMENTS

There are a myriad people that deserve my thanks and a place on this page – without them, I would not have finished this degree. First, and foremost, a huge thank you to my committee for all their time, support, and effort. Sarah, thank you for always being my cheerleader and always believing in me – you helped me believe in myself. Erin, thank you for all of your time and constant encouragement when needed most. Renee, thank you for always having my back in all things – conferences, research, EENC, and more. Nils, thank you for being an incredible co-advisor, guiding me and pushing me when I needed it most. Finally, thank you Kathryn for being a wonderful mentor, teacher, and main advisor. Your dedication to helping me succeed, tough love when it was needed, never-ending support, and guiding hand helped get me here today. I will always appreciate it more than words can express.

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encouragement. Finally, to my husband and partner in life, Joshua. I could not have done this without you. Thank you for always keeping me smiling and laughing, and reminding me of what I was accomplishing on the crappiest of days.
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CHAPTER 1: Introduction

How is Climate Change Perceived in the United States?

Climate change is undoubtedly one of the largest modern environmental crises. Temperature-related mortality, extreme weather events, sea level rise, air pollution-related health problems, and water, food, vector, and rodent-borne diseases include only a few of the known problems that will exacerbate with the changing climate (IPCC, 2014; National Assessment Synthesis Team, 2001; Pátz et al. 2000). In response to these impacts, technological advances have generated solutions such as disease and drought resistant crops (Godfray et al., 2010), subsurface water desalinization techniques (Zuurbier, Raat, Paalman, Oosterhof, & Stuyfzand, 2016), and community smart grids (Stephens, Wilson, & Peterson, 2015). Similarly, individuals’ decisions about reduced meat consumption (Hedenus, Wirsenius, & Johansson, 2014), riding a bicycle for transportation (Peterson, Peterson, & Liu, 2013), and using energy saving options in the household such as the installation of Energy Star appliances (Jaffe, Newell, & Stavins, 2001) may mitigate the effects of climate change, but addressing the global challenge ultimately requires collective action of some form, such as carbon cap and trade and carbon taxes (Goulder & Schein, 2013).

Especially in the United States, broad societal support for climate change adaptation and mitigation measures is lacking, which is likely related to low levels of concern about the issue. In the United States, though 70% of Americans believe that climate change is occurring, only 42% of those acknowledge that humans are the primary cause. In fact, approximately 12% believe that natural variability is the main reason for climate change, which directly contradicts scientific consensus on the causes of climate change (Leiserowitz et al. 2018). Recent research shows that understanding the scientific consensus on climate change (van der Linden et al., 2015) and its
anthropogenic causes (Moser & Dilling, 2008; Moser, 2009) is a gateway belief that leads to increased climate concern and, ultimately, climate action (CRED, 2009; Moser & Dilling, 2007; Moser, 2009; van der Linden et al., 2015). Over half of Americans (57%) do not believe that climate change will personally affect them, their families, or neighborhoods; rather, it is believed the effects of climate change will be a problem just for developing nations (Leiserowitz, 2012; 2013; 2018). This is problematic because studies show that one of the first step to both individual and collective climate action behaviors is an increase in climate change concern on a personal level (Hornsey, Harris, Bain, & Fielding, 2016; Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007). These patterns are unsurprising as behavior theories (e.g., Theory of Planned Behavior [Ajzen, 1991]; Value-Belief-Norm Theory [Stern et al., 1995]) posit that beliefs and attitudes (e.g., concern) are key in predicting behaviors. Understanding how to increase acceptance and concern are key to ultimately building the societal support to adapt to and mitigate the effects of climate change.

**Why is Building Climate Change Concern and Action among Adults so Difficult?**

Among adults, building concern that results in action remains difficult for a variety of reasons, both cognitive and affective. For example, the complexity of climate science makes climate change difficult for many to grasp, including those who are scientifically literate (Cornforth, 2011; Sterman, 2011; Stoutenborough & Vedlitz, 2015). Further, although scientific understanding of climate change has been linked to climate change concern (Shi, Visschers, Siegrist, & Arvai, 2016), a robust body of research suggests political ideology and cultural worldview are the largest drivers of climate change perceptions (Hamilton, 2011; Hornsey, et al., 2016; Kahan, Jenkins-Smith, & Braman, 2011). Some research suggests increasing the public’s scientific literacy tends to further polarize climate change perceptions, both because individuals
tend to seek out information sources that fit within their personal ideologies (Hamilton, 2011) and because people who are scientifically literate are more adept at using new information to reinforce their worldview-driven beliefs (Kahan et al., 2012). Other studies highlight how climate change action is related to demographics (e.g., white males are more likely to deny or act on climate change, McCright & Dunlap, 2011) and sociocultural norms (e.g., socially identifying oneself as a conservative results in being less likely to support climate change action, Fielding & Hornsey, 2016). These barriers are particularly discouraging for those aiming to spur action on climate change because they are incredibly powerful and difficult to change.

Fortunately, climate change communicators have developed tools to navigate ideologically driven resistance to climate action, such as strategic framing (Nisbet, 2009) and the use of trusted messengers or popular icons (Moser, 2009) that are specifically designed to overcome psychological barriers to climate action. For instance, strategic framing is meant to package messages in a way that is compatible with the worldviews of receivers (Moser & Dilling, 2008; Nisbet, 2009). This technique has been successfully used in contexts such as vaccinations (Gerend & Shepherd, 2007), evolution (Long, 2011), and climate change (Nisbet & Mooney, 2007). Similarly, trusted messengers are utilized to signal that messages conform to group values (e.g., evangelical leaders talking about climate change action or evolution as consistent with conservative Christian values; Long, 2011; Wardekker, Petersen, & van der Sluijs, 2009). Although these climate change communication techniques have been successful in specific cases (Anderson, 2011; Spence & Pidgeon, 2010), polarization over climate change continues, particularly in the United States (Bolsen & Shapiro, 2018), indicating the need for novel communication strategies.
How Might Children Be the Answer?

Engaging with younger audiences provides a promising approach to overcoming social barriers to widespread adoption of climate change mitigation behaviors. Children are still developing cognitively, socially, and emotionally, including in forming ideologies and worldviews (Keating, 2004), which may explain why they approach climate change differently than older generations. For example, recent research with adolescents suggests that although worldviews may drive polarization at low levels of climate change understanding (Stevenson, Peterson, Bondell, Moore, & Carrier, 2014), climate change specific education results in a greater consensus in climate change beliefs and concern, regardless of worldview (Bofferding & Kloser, 2015; Flora et al., 2014; Reinfried, Aeschbacher, & Rottermann, 2012; Stevenson et al., 2014). This emerging research is encouraging because united climate action among future generations will be imperative, as recent studies have shown that the effects of climate change will be widespread by 2030, when today’s children will be entering adulthood (IPCC, 2014; McMichael, 2014).

Further, children’s acceptance of anthropogenic climate change seems robust to the potential influence of denial from the adults in their lives. For instance, teachers’ beliefs around the anthropogenic nature of climate change have no relationship to similar views of their students (Stevenson, Peterson, & Bradshaw, 2016), which is encouraging considering US science teachers are just as polarized on climate change as the general public (Plutzer et al., 2016; Plutzer & Hannah, 2018). Instead, if teachers accept that climate change is happening, their students are more likely to think it is both happening and human caused (Stevenson et al., 2016). Although children who think their friends and family accept anthropogenic climate change are more likely to be concerned about climate change, their own views on climate change are the strongest
predictor of their concern levels (Stevenson, Peterson, & Bondell, 2016). This trend continues when exploring dynamics between measured (rather than perceived) climate change perceptions between children and parents, with children’s climate change concern positively predicting behavior, independent of their parents’ levels of concern (Lawson et al., 2019).

**Intergenerational Learning: A New Method to Bridge the Climate Communication Gap?**

The theory of intergenerational learning (IGL), a sub-theory of Sociocultural Theory, posits that the interactions between two generations can result in the bidirectional transfer of knowledge, attitudes, and/or behaviors (Bottery, 2016; Tempest, 2003; Franz & Scheunpflug, 2016). Although traditional research has focused on the older-to-younger generation direction of influence, more recent research has focused on the opposite direction. Children can indeed influence adults, with examples of support found in the areas of grocery purchasing decisions (Flurry & Burns, 2005), the use of newer technologies (Baily, 2009), and views of sexual orientation (LaSala, 2000). Focusing on the informal education literature, reveals a handful of studies that have examined IGL within the context of informal education experiences (Duvall & Zint, 2007). Current published IGL-based environmental education studies are detailed in Table 1.1. Although some impacts of climate change (i.e., flooding; Williams, McLean, & Quinn, 2017) and climate change mitigation behaviors (i.e., Boudet et al., 2016) have been studied in the IGL context, no study focuses on climate change perceptions specifically. Given children’s unique perspective on climate change and research supporting IGL, even in politicized contexts (e.g., sexual orientation), IGL from child to parent with climate change is promising. As such, there is an opportunity to fill in a large gap in the IGL literature while simultaneously finding newer climate change communication techniques through IGL-based climate change research.
**Dissertation Focus**

This Ph.D. dissertation will explore the use of IGL within the field of climate-change based environmental education by attempting to overcome parental cognitive and affective barriers to climate change concern and behaviors through their children, through an article-style dissertation. Specifically, all research will occur within the coastal area of NC, as it is imperative that climate literacy increase in the region, as explained earlier. The overall research question informing the study is: Does climate change education increase climate change concern and behaviors among children and their parents through intergenerational learning? The articles will 1) establish the theoretical argument for the study, 2) explore how children and parent’s climate change behaviors relate through multiple linear regression modeling, and 3) experimentally evaluate how a climate change-focused EE program fosters IGL related to climate change concern and behavior among middle school students and their parents.
REFERENCES


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CHAPTER 2: Intergenerational learning: Are children key in spurring climate action?

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**Abstract**

Complex environmental problems are typically resolved after the public is no longer willing to accept their risks and demands change (i.e., Reflexive Modernization). Notable examples include responses to the ozone hole and acid deposition. In the case of climate change, however, the politicization of the issue can result in adults ignoring the risks and accepting the status quo (i.e., Anti-Reflexivity). Although strategies such as strategic framing have seen some successes, new methods are needed to engage citizens in addressing climate change impacts. We argue that child-based climate communication is an understudied but promising pathway to incite climate action among children and adults alike. Children have unique perspectives on climate change, represent an audience that is easily reached through schools, and are arguably best equipped to navigate the ideologically fraught topic of climate change with older generations in ways that inspire action. We review research to support this novel communication approach and outline best practices for programmatic implementation and associated research.
Introduction

Technological solutions to many climate-related challenges exist, but social barriers to climate action stymie the scale of response needed to avoid the worst of projected impacts. Individuals’ decisions about reduced meat consumption (Hedenus, Wirsenius, & Johansson, 2014), riding a bicycle for transportation (Peterson, Peterson, & Liu, 2013), and using energy saving options in the household such as the installation of Energy Star appliances (Jaffe, Newell, & Stavins, 2001) may mitigate the effects of climate change, but addressing the global challenge ultimately requires collective action of some form, such as carbon cap and trade and carbon taxes (Goulder & Schein, 2013). As has been the case with other environmental challenges including ozone depletion (Mäder et al., 2010) or sulfur oxide related acid deposition (Brady & Selle, 1985; Stavins, 1998), we might expect participation in and support for these strategies as both the scientific and general communities become more informed about climate-related risks and refuse to accept them, a pattern described as reflexive modernization (Beck, 1992). In the case of climate change, however, individuals’ political ideologies and worldviews sometimes act as anti-reflexive forces, causing people to ignore risks, particularly within the United States (McCright & Dunlap, 2010). Accordingly, climate change communication efforts aimed at encouraging climate action (e.g., driving less, support for renewable energy) must address political ideologies and worldviews in tandem with scientific knowledge (Kahan et al., 2012; McCright & Dunlap, 2011).

Climate change communicators have developed tools to navigate ideologically driven resistance to climate action, such as strategic framing (Nisbet, 2009) and the use of trusted messengers or popular icons (Moser, 2009) that are specifically designed to overcome psychological barriers to climate action. For instance, strategic framing is meant to package
messages in a way that is compatible with the worldviews of receivers (Moser & Dilling, 2008; Nisbet, 2009). This technique has been successfully used in contexts such as vaccinations (Gerend & Shepherd, 2007), evolution (Long, 2011), and climate change (Nisbet & Mooney, 2007). Similarly, trusted messengers are utilized to signal that messages conform to group values (e.g., evangelical leaders talking about climate change action or evolution as consistent with conservative Christian values; Long, 2011; Wardekker, Petersen, & van der Sluijs, 2009). Although these climate change communication techniques have been successful in specific cases (Anderson, 2011; Spence & Pidgeon, 2010), polarization over climate change continues, particularly in the United States (Bolsen & Shapiro, 2018), indicating failure to overcome anti-reflexive forces (i.e., politically driven climate change skepticism) and the need for novel strategies.

We propose reaching adults through their children represents a productive but understudied communication pathway for climate communication. Several scholars have pointed out that because children will experience the brunt of projected mid-century impacts of climate change, there is a moral imperative to prepare future generations to address those impacts (Curren, 2007; Lombardi, Danielson, & Young, 2016; Schlottmann, 2012). We agree with this view, and offer that child-based communication may also spur action among current adults where other strategies have failed. We suggest children may be able to overcome anti-reflexive tendencies of adults through intergenerational learning (IGL) in the context of climate change. Indeed, communication pathways through children are uniquely positioned to combat the anti-reflexive nature of adult perceptions on climate change.
Why is Intergenerational Learning So Promising?

The bulk of IGL research has highlighted how older generations influence younger generations’ knowledge, attitudes, and behaviors, but emerging research suggests younger generations may influence their parents’ approach to a variety of controversial topics. Adults are known to influence children in a variety of ways, including student academic achievement (Davis-Kean, 2005), their approach to future marital relations (Axinn & Thornton, 1993), and the choice to stop smoking (Varcoe, Bottorff, Carey, Sullivan, & Williams, 2010). However, as adults are more prone to anti-reflexive thinking that clouds their judgement when forming perceptions on controversial subjects (Gifford, 2011; Kollmuss & Agyeman, 2002), relying on older generations to be the teachers may be counterproductive in the case of climate change. Fortunately, recent research finds that child to parent IGL is successful in a host of contexts. Children actively influence parental grocery shopping behaviors such as the purchase of high sugar cereals (Flurry & Burns, 2005), encourage their parents to use modern technology such as computers (Baily, 2009), and are capable of changing parental views on sexual orientation (LaSala, 2000). Environmental education (EE) programs directed at children, but designed with intergenerational learning in mind, also result in the successful transfer of environmental knowledge, attitudes, and behaviors to adults. Empirical research of such programming reveals successful child to adult IGL, including waste education behaviors (Maddox, Doran, Williams, & Kus, 2011), flood education knowledge (Williams, McLean, & Quinn, 2017), energy conservation behaviors (Boudet et al., 2016), and general environmental conservation knowledge (Leeming, Porter, Dwyer, Cobern, & Oliver, 1997). In summary, it is clear that child to adult IGL is possible, and provides an effective avenue to environmental change that engages both younger and older generations.
Not only is child to parent IGL a proven method for reaching older generations, it is especially promising for an ideologically fraught topic like climate change for two reasons. First, children seem more able than adults to parse scientific fact from political contexts. Among adults, political ideologies and worldviews are the primary drivers of polarization around climate change perceptions (McCright & Dunlap, 2011), with education seeming to drive viewpoints farther apart (Kahan et al., 2012). However, at high levels of climate change knowledge, children reach consensus on anthropogenic climate change, regardless of worldview (Flora et al., 2014; Stevenson, Peterson, Bondell, Moore, & Carrier, 2014). Further, children’s acceptance of anthropogenic climate change seems robust to the potential influence of denial from the adults in their lives. For instance, teachers’ beliefs around the anthropogenic nature of global warming have no relationship to similar views of their students (Stevenson, Peterson, & Bradshaw, 2016), which is encouraging considering US science teachers are just as polarized on climate change as the general public (Plutzer et al., 2016; Plutzer & Hannah, 2018). Instead, if teachers accept that global warming is happening, their students are more likely to think it is both happening and human caused (Stevenson et al., 2016). Although children who think their friends and family accept anthropogenic global warming are more likely to be concerned about climate change, their own views on global warming are the strongest predictor of their concern levels (Stevenson, Peterson, & Bondell, 2016). This trend continues when exploring dynamics between measured (rather than perceived) climate change perceptions between children and parents, with children’s climate change concern positively predicting behavior, independent of their parents’ levels of concern (Lawson et al. *unpublished results*).

Second, children are likely a more trusted and ideologically neutral pathway for climate change information than other commonly relied upon sources. For example, in the content of sex
education, parents reported being uncomfortable talking about sexuality generally but were more willing to talk to their children about the subject than other adults in their lives, independent of which party initiated the conversation (Morawska, Walsh, Grabski, & Fletcher, 2015). This suggests that the bond between parent and child helps facilitate conversations around uncomfortable topics. In the case of climate change, this unique relationship between parents and children may create a context in which children may be best positioned to overcome anti-reflexivity. For example, a former US Congressman and climate change denier, Bob Inglis, noted that his son was the reason that he chose to change his climate change perceptions, and now fights for effective climate policies (Sausser, 2018). In summary, children appear to be the ideal conduit for climate change communication to their parents, as they are capable of understanding and acting on the subject more effectively than parents and are more trusted by parents than other information sources.

**How Do We Leverage Intergenerational Learning to Combat Anti-Reflexivity?**

At least five key principles should guide efforts to promote child to adult intergenerational learning (IGL) of climate action. *Education efforts focused on local issues* (Ballantyne et al., 2001; Sutherland & Ham, 1992), *longer term and more in depth lessons* (preferably with repeated contact, lasting a few weeks or more), *hands-on projects*, *enthusiastic teachers*, and *encouragement of parental participation* (Percy-Smith & Burns, 2013) encourage child to parent intergenerational learning. For instance, (Ballantyne, Fien, & Packer, 2001) found that framing local Australian environmental issues from the perspective of Aboriginal tribes, over the course of a few weeks, promoted child to parent IGL. Because research with adults suggests framing climate change in a local context increases climate change acceptance (Moser & Dilling, 2008), using local scenarios in climate change education may be particularly useful in
encouraging IGL even among skeptical parents. Similarly, Sutherland & Ham (1992) revealed that hands-on exploration of a watershed led by enthusiastic teachers, that included parental participation in the form of a workbook completed at home, resulted in successful child to parent IGL. Other IGL studies also document the inclusion of a homework component that encourages parental engagement (e.g., parental interviews) as a key for successful child to parent IGL (Ballantyne, Connell, & Fien, 1998; Leeming et al., 1997; Uzzell et al., 1994; Vaughan et al., 2003; Williams, McEwen, & Quinn, 2017).

Although observational studies suggest many of these practices may promote child to parent IGL in climate change contexts, experimental studies are needed to evaluate causality. Research on climate change perceptions in family settings indicates parents and their children share perceptions on climate change (Leppanen, Haala, & Lensu, 2012), suggesting that IGL could be occurring. Adolescent students who perceived their family members as concerned about anthropogenic climate change and discussed climate change with their families were more likely to be concerned themselves (Stevenson, Peterson, & Bondell, 2016) and engage in climate mitigation behaviors (Valdez, Peterson, & Stevenson, 2017). Similarly, children and parent engagement in climate change mitigation behaviors seems to be linked, with a parents’ choice to participate in climate mitigation behaviors predicting a child’s likelihood to participate in those same behaviors (Lawson et al. unpublished results), along with information seeking behaviors concerning climate change (Mead et al., 2012). These studies demonstrate that parents’ and children’s climate change perceptions and behaviors are related, but no empirical research has been undertaken to test for directionality of influence.

Limited research on IGL, particularly in the context of climate change, may reflect challenges associated with conducting education-based research with children and in family
units. Research with children is generally harder to get approved than research with adults given human subjects concerns of research review boards, and the need to secure permission from school administrators, and parents in addition to children themselves adds additional logistical barriers (Kilngner, Ahwee, Pilonieta, & Menendez, 2003; Swauger, 2009). Similarly, collecting data from paired groups of parents and children requires steps not typically associated with survey research, such as data collection protocols where teachers collect data from students, and students from parents. This approach invariables reduces response rates, and communication between children, parents, and sometimes teachers is difficult to coordinate (Wellington, 2015). Challenges developing equivalent and comparable instruments that both parents and children understand (Greig, Taylor, & MacKay, 2012) creates another barrier to IGL research. Finally, research with adults and children is typically conducted by scholars from different fields creating a need for collaboration in interdisciplinary research teams - something long advocated for within research circles, but admittedly difficult to achieve in practice (Youngblood, 2007). These barriers may explain why research exploring IGL from children to parents that began decades ago (e.g., Sutherland and Ham, 1992) has been so slow to develop. These barriers, however, are not insurmountable. For example, studies in the fields of family exercise habits (Solomon-Moore et al., 2016), adolescent substance abuse therapy (Boustani, Henderson, & Liddle, 2016), and child educational achievement (Davis-Kean, 2005), to name a few, has overcome them. Key elements include funding agencies and journals recognizing and rewarding the extra work, administrators and research institutions supporting efforts to build interdisciplinary teams needed to conduct the research.

Beyond overcoming these challenges related to IGL research, we offer several suggestions for scholars interested in contributing to this work. First, as much research around
climate change communication and education focuses on behavior change (e.g., Hall, Lewis, & Ellsworth, 2018; Ojala & Bengsston, 2018), climate change IGL research should utilize and contribute to behavior theories. This work would build understanding of the role of IGL in predicting behavior among children and adults help discover which factors are particularly effective at fostering IGL. For instance, children may be particularly influential in activating parents’ attitudes toward certain behaviors but not others (Ajzen, 1991; Boudet et al., 2016). Secondly, research is needed to understand under what contexts IGL occurs. For instance, IGL may be more common in multi-generation households (e.g., grandparents, parents & children together), among families whose children act as the primary language translators (Knafo & Galansky, 2008), or in countries outside of the United States, as the United States is unique in its political framing of climate change (McCright & Dunlap, 2011). Third, IGL research may contribute to understanding how family-level communication may contribute to community-wide change (North American Association for Environmental Education, 2017). Research directions such as these will help build the theoretical knowledge of IGL in informal education contexts, and how it can be leveraged by researchers and practitioners alike. The field of climate change education research is rapidly emerging (see Busch & Roman, 2017; Henderson, Bieler, & McKenzie, 2017; Hestness, McGinnis, Riedinger, & Marbach-Ad, 2011; Ojala & Bengsston, 2018; Shea, Mouza, & Drewes, 2016), including several projects prioritizing outreach strategies that bring together individuals from multiple generations (e.g., The Power of Conversation Project [ACE, 2017]; MADE-CLEAR Project [Made Clear, 2018]). We look forward to these and other researchers working to understand the potential of children to catalyze proactive responses to climate change.
Research on IGL of climate action would provide insight to a particularly promising and novel climate communication strategy as well as dovetail with emerging efforts by younger generations to combat climate change. Although some may argue that IGL-based approaches inappropriately burden children (e.g., Thompson, 2014), both research (Stapleton, 2017), and recent child-led efforts offer a counterpoint (e.g., Wells, 2014). Although younger generations cannot vote, numerous examples show they are working toward solutions to make large political impacts. Across the United States, movements such as Black Lives Matter (Black Lives Matter, 2018) and the March for Our Lives protests (The New York Times, 2018) echo other youth-led social movements around child labor laws or civil rights (Center for Community Change, 2018). In environmental contexts, a Change.org petition on the behalf of fourth and fifth graders successfully convinced Dunkin’ Donuts, Inc. to stop selling Styrofoam coffee cups on Earth Day 2015 (Wells, 2014). At the time of this paper, 21 adolescents aged 10 to 21 from Oregon are suing the United States government for failure to address climate change in the landmark court case, *Juliana v. US* (Our Children's Trust, 2018). Children’s voices are also calling for solutions to environmental degradation and taking active roles in advocacy based endeavors globally (United Nations Children’s Fund, 2007), including on climate change (Plan International Australia Youth Ambassadors, 2015). These examples suggest children are eager and able to take an active role in combating climate change, and are poised to transform society in ways that will be necessary to avoid the most catastrophic impacts of climate change (Center for Community Change, 2018). This change may not be smooth or immediate, but as history has shown, change can and will result from these youth-based efforts. IGL research can highlight their success and uncover ways to ensure they are given the best chance to lead us into a future that overcomes challenges posed by climate change.
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CHAPTER 3: Evaluating climate change behaviors and concern in the family context

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Abstract

Although research suggests that family dynamics likely play a role in shaping children’s behaviors, few studies focus on environmental behaviors, and none to our knowledge investigate how parents shape climate change mitigation behaviors among their children. We begin to fill this gap through a quantitative case study using matched household level survey data from 182 coastal North Carolina families (n = 241 parents aged 29-77; n = 182 students aged 11-14) associated with 15 middle school science teachers. Family climate change discussions, parent behaviors, and children’s climate change concern levels predicted the degree to which children will participate in individual-level climate mitigation behaviors. These results provide evidence that promoting climate-related conversations within households may promote climate action even when parents are apathetic about climate change. Similarly, parental behaviors, but not their concern levels, were important predictors of adolescent behaviors. This study highlights novel ways that family dynamics may promote climate change mitigating behaviors and a new pathway to promoting climate mitigation at familial, and ultimately, societal levels.
Introduction

Recent technological advances have generated solutions to many climate-change related challenges, but social barriers to action continue to prevent a collective response to climate change. Although innovative strategies such as disease and drought resistant crops (Godfray et al. 2010), subsurface water desalinization techniques (Zuurbier et al. 2016), and community smart grids (Stephens, Wilson, and Peterson 2015) continue to make important contributions to future adaptations, the success of these approaches hinges on broad societal support. Among adults, building support remains difficult for a variety of reasons. The complexity of climate science makes climate change difficult for many to grasp, including those who are scientifically literate (Cornforth 2011; Sterman 2011; Stoutenborough and Vedlitz 2015). Further, although scientific understanding of climate change has been linked to climate change concern (Shi et al. 2016), a robust body of research suggests political ideology and cultural worldview are the largest drivers of climate change perceptions (Hamilton 2011; Hornsey et al. 2016). Some research suggests increasing the public’s scientific literacy tends to further polarize climate change perceptions, both because individuals tend to seek out information sources that fit within their personal ideologies (Hamilton 2011) and because people who are scientifically literate are more adept at using new information to reinforce their worldview-driven beliefs (Kahan et al. 2012). Combined with the prevalence of climate communication efforts designed to foster climate change denial (Boykoff 2013; Medimorec and Pennycook 2015), climate communication efforts among adults have largely failed to encourage a collective response to climate change.

Climate change perceptions among young adults

Engaging with younger audiences provides a promising approach to overcoming social barriers to widespread adoption of climate change mitigation behaviors (heretofore “climate
behaviors”), such as energy conservation. Children are an age group that is particularly important as they are developing cognitively, socially, and emotionally (Keating 2004), which may explain why they approach climate change differently than older generations. For example, recent research with adolescents suggests that although worldviews may drive polarization at low levels of climate change understanding (Stevenson et al. 2014), climate change specific education results in a greater consensus in climate change beliefs and concern, regardless of worldview (Bofferding and Kloser 2015; Flora et al. 2014; Reinfried, Aeschbacher, and Rottermann 2012; Stevenson et al. 2014). This emerging research is encouraging because collective climate action among future generations will be imperative, as recent studies have shown that the effects of climate change will be widespread by 2030, when today’s children will be entering adulthood (IPCC 2014; McMichael 2014). Collective action on climate change among voters, decision makers, and consumers will be critical to generating adaptive strategies and mitigating future impacts.

Research on climate behaviors among adolescents suggests that impacts of interactions with others is a key factor to investigate. Communication from trusted messengers, such as scientists and teachers (Arnold, Cohen, and Warner 2009; Feldman et al. 2010), or those within a close social circle, such as friends and family (Arnold et al. 2009; Vreede et al. 2017), seems to encourage adolescent engagement with climate change issues. For instance, teachers are noted to not only raise awareness about issues such as climate change but also provide examples for their students about ways to take action in their day-to-day lives (Arnold et al. 2017). Although teachers seem to shape climate change perceptions, their influence may be somewhat limited. While Stevenson, Peterson, and Bradshaw (2016) found that teachers who believe that climate change is happening predicted students’ beliefs that it is both happening and anthropogenic, they
also found that teachers’ views on anthropogenic causes had no relationship with the views of their students. Additionally, Feldman et al. (2010) found that although adolescents trusted scientists as a source of scientifically accurate information about climate change, adolescents did not expect scientists to be responsible for taking action and instead placed that charge on the government. In terms of their social circles, children who perceived their friends and family accepted anthropogenic climate change were more likely to be concerned themselves (Stevenson, Peterson, and Bondell 2016), and those who discussed climate change with their friends and family were more likely to be concerned (Mead et al. 2012; Stevenson et al. 2016) and engage in climate behaviors (Valdez, Peterson, and Stevenson 2017).

Potential of family dynamics in shaping climate change perceptions

Unique familial characteristics may play a pivotal, yet understudied, role in explaining climate behaviors among adolescents. There is a large body of research showing clear links between parent and child behaviors in the developmental psychology literature, with notable examples including eating behaviors (Scaglioni, Salvioni, and Galimberti 2008), sexuality (Slater and Tiggemann 2016), and academic habits (Hofferth and Sandberg 2001). However, less research has related parent and child behaviors within the realm of the environment or climate change. Studies highlight links between perceived parental climate change beliefs and adolescent climate change concern (Stevenson et al. 2016), and find that children appear to mirror parents’ information-seeking behaviors when gathering information on climate change (Mead et al. 2012). Looking broadly to literature on general environmental engagement, parents seem to play a significant role in shaping their children’s environmental perceptions (Corner et al. 2015). Yet, to our knowledge, none of these studies have explored how parental climate concern or behaviors related to climate change predict children’s behaviors. Further, only one study of
which we are aware utilized matched household level data of both parents and children (Mead et al. 2012), and this study did not directly address climate behaviors. More research investigating familial influences within the realm of climate change is needed, particularly with matched household level data, as it will allow researchers to begin understanding the relative importance of variables that cannot be easily changed (e.g., family dynamics) compared to those variables that may be changed through education interventions with children (e.g., climate change knowledge and concern).

Study objective

In this study, we address the need for research linking climate change related views and behaviors within families through a case study in North Carolina (NC), USA, using matched parent and child level data. We examined a random sample of 182 unique families consisting of one or two parents and one child in early adolescence (i.e., 11-14 years old). For the purposes of this paper, “parent” refers to parents, parental figures, and/or guardians (e.g., grandparents, foster parents). We hypothesized: 1) Child climate change concern would be positively related to child climate behaviors, 2) parent climate change concern would be positively related to child climate change behaviors, and 3) parent climate behaviors would be positively related to child climate behaviors. As research supports the importance of climate change discussions among families for influencing family engagement in climate issues (Corner et al. 2015; Mead et al. 2012; Stevenson et al. 2016), we also predicted 4) a positive relationship between child and parent behaviors strengthens when families discuss climate change with greater frequency, and 5) a positive relationship between parent climate concern and child behaviors strengthens when families discuss climate change with greater frequency. In addition, we controlled for sex, ethnicity, and political identity of both children and parents; as all three variables have been
positively associated with belief in anthropogenic climate change (Brownlee, Powell, and Hallo 2012; McCright 2010; McCright and Dunlap 2011; Stevenson et al. 2014).

**Methods**

**Sampling**

We chose to focus on early adolescents as this age group is developmentally capable of understanding complex topics such as climate change (Mason and Scirica 2006) while also still forming opinions on controversial topics and constructing their worldviews (Vollerberg, Iedema, and Raaijmakers 2001). We used a hierarchical sampling design (Ericson and Gonzalez 2003) through public schools, as this affords access to a diverse sample of children. First, we sampled middle school teachers (grades 6-8) and then students (ages 11-14); and through the students, we were able to gain access to and sample their parents. To begin, we compiled a sample frame of all middle school science teachers in a region that included the 20 coastal counties in North Carolina (NC), and confirmed the accuracy of the sample frame by phone calls to each school to ensure teacher employment. We chose to use the coastal counties for this study as they are particularly vulnerable to climate change impacts such as sea level rise, storm surges, and salt water intrusion (Riggs et al. 2011). We randomly selected 200 of the 432 teachers to recruit through email invitation. Of those 200 teachers, 43 responded as interested (21.5% response rate), and 20 committed to the study (46.5% compliance). Over the course of the project, five teachers withdrew from the study, citing missed instructional time because of lost school days from Hurricane Matthew in October 2016, which resulted in 15 participating teachers. The participating teachers’ students were included in the study based on their assignment to consenting teachers by school administrators following standard methods. Similarly, we invited
parents to participate in the study through distributing invitation letters distributed from the teachers through their students.

Our child sample consisted of 284 sixth-grade students, 353 seventh-grade students, and 328 eighth-grade students. Children respondents’ ages ranged from 11-14 years of age, and were 49.1% male, and 56.5% Caucasian. Our parent sample consisted of 241 responses, representing a 24.9% response rate assuming a possible sample of at least one parent per child (n = 965). In most households, only one parent responded, although 61 households had two parents respond, resulting in 180 unique family units. Parent respondents ranged from 29 to 77 years of age, were 30.9% male, and 78.3% Caucasian.

**Questionnaire Development and Deployment**

In creating our parent and child instruments, we relied on previously published scales that have been used with adolescents. To measure concern for global climate change on both the child and parent instruments, we drew on scales utilized in the 2011 nation-wide climate change adolescent survey (Leiserowitz, Smith, and Marlon 2011). Our climate behaviors scales for both parents and children were modified from the Climate Change Behavior scale utilized by Stevenson and Peterson (2015) and contained both individual (e.g., “I turn off the lights at home while they are not in use”), and collective action behaviors (e.g., “I talk with my family about how to do something about environmental problems”). We asked both children and parents the same questions, except for one question concerning a child’s behaviors in school (i.e., “I choose an environmental topic when I can choose a topic for an assignment in school”), which we omitted for parents. Lastly, family level of climate change discussion was measured through a single item used in past studies (Leiserowitz, Smith, and Marlon 2011; Valdez, Peterson, and
We pilot tested the child and parent instruments with two classes of coastal NC middle school students (n = 62) and a group of adults accessed through social media (i.e., Facebook) and email (n = 83), respectively. For middle school students, we sent a Qualtrics survey link to three middle school teachers who agreed to administer the online survey to their students. For adults, we posted the link to the survey on social media outlets managed by the researchers and sent individual invitation emails to gather responses. On the Qualtrics surveys, both children and parents were given the opportunity to comment on which questions or parts of questions they felt were confusing, through open-ended guided questions (e.g., “Did any parts of this question not make sense to you?” and “In your opinion, what is this question asking?”). We conducted follow-up cognitive interviews (Desimone and Le Floch 2004), with 11 children and 12 adults to further refine items to improve clarity and face validity. We analyzed each scale within the pilot test, and found each to have acceptable internal consistency (Cronbach 1951) (\( \alpha = .90 \) for parent climate concern, \( \alpha = .77 \) for parent climate behaviors, \( \alpha = .79 \) for child climate concern, \( \alpha = .76 \) for child climate behaviors), and be single factor scales (all items in each of the four scales had factor loadings of at least 0.4 (Comrey and Lee 2009)).

Following the pilot testing, we collected child and parent responses from September to November 2016. We provided teachers with a detailed data collection protocol and links to the survey through Qualtrics, and teachers administered the survey to students during class time. We asked teachers to email all parents invitation letters with a URL and QR code that linked to the parent survey. Two weeks after teachers contacted parents by email, we followed up with parents who had not responded by sending a paper version of the survey. We provided teachers with
sufficient copies of a paper survey along with addressed stamped return envelopes, and teachers sent home these survey packets with students.

Analysis

We used multiple linear regression analyses to model child climate behaviors as a function of child climate concern, parent climate concern, parent climate behaviors, and discussion of climate change in the family setting. We tested for an interaction between family discussions and parent behaviors, as well as an interaction between discussions and parent concern. We also included control variables of sex (male vs. female), race/ethnicity (white vs. people of color), and political identity of both parents and children. Prior to statistical analysis, we collapsed both child and parent ethnicity into dichotomous variables (white = 1, people of color = 0) due to small sample size. We included school level development status (rural = 1, non-rural = 0), and Title 1 Status (Title 1 = 1, Non-Title = 0) as a measure of income level. Title I status is a commonly used measure in the United States of school-level socioeconomic status. Title I schools receive additional funding from the federal government based on a high percentage of students that fall into low-income categories (107th Congress 2002). We conducted data analysis using STATA 14.2.

Results

Climate behavior scales and climate concern scales for both children and parents represented a spectrum of concern and behavior from unconcerned (-8) to concerned (8), and climate unfriendly behaviors (-15) and climate friendly behaviors (15). All scales displayed acceptable reliability and validity, with Cronbach’s alpha levels at acceptable levels (child behavior: 0.76; parent behavior 0.76; child concern at 0.70, parent concern at 0.90; Tables 3.1-3.3, respectively) and loaded to one factor as expected (Tables 3.1-3.3). On average, children
were found to be somewhat unconcerned with climate change overall with a mean score of -0.957 and a standard deviation of 3.352. Child climate behaviors had a mean of 0.717, and a large standard deviation of 5.967. Parent’s climate concern was found to be similar to children, with a mean of -0.188 and a standard deviation of 4.050. Parents were found to act more climate-friendly in their behaviors, with a mean of 5.594, and a standard deviation of 4.336. Political orientation of parents and parent climate concern were related \( (r = .45, p < .001) \), as were political orientation of the children and child climate concern \( (r = .11, p = .03) \). Although the correlations between these variables were statistically significant, the magnitude of the correlations were below the threshold for autocorrelation \( (r = .80) \), so we chose to leave both in the model (Keith 2015). Furthermore, VIF tests were considered acceptable (variable levels less than 1.5, and total variance inflation factor of less than 1.5) (Keith 2015).

Results from hypothesis testing are displayed in Table 3.4. We found support for hypothesis one that children’s climate change concern was positively related to children’s climate behaviors. We rejected hypothesis two as parents’ climate change concern was not related to children’s climate behaviors. We found support for hypothesis three, as parents’ climate behaviors were positively related to children’s’ climate behaviors. We found partial support for hypothesis four. Although children in families who discuss climate change were more likely to engage in climate behaviors, we did not find an interaction effect between parent behaviors and discussion of climate change. Hypothesis five was similarly only partially supported, as we did not find an interaction effect between parent climate concern and discussion of climate change. Frequency of climate change discussion was positively related to children’s climate behaviors regardless of the behaviors or climate concern of the parents. Frequency of
discussion was the strongest predictor of child climate behaviors, followed by parent climate behaviors and child climate concern ($\beta = .269, .268, .240$, respectively; See Table 3.4).

**Discussion**

This research builds on previous studies of how parent and adolescent climate change behaviors may relate to one another in two ways. First, our findings provide the first evidence of household effects on adolescent climate change related behaviors measured using input from adolescents and their parents. These findings support previous work identifying household level relationships in environmental attitudes based on parental guesses of attitudes among their adolescent children (Clark et al. 2017). Similarly, research using adolescents to guess parental attributes identified shared household level climate change concern, from the perspective of the children (Stevenson, Peterson, and Bondell 2016). In this study, children’s climate change concern predicted their own behavior independent from parent concern levels, but there were multiple household level effects. Family level of climate change discussion was found to be the strongest predictor of children’s climate behaviors, followed closely by a parent’s likelihood to engage in those same climate behaviors. Previous research has found that during adolescence, a child’s attitudes and norms start to become more engrained, and resistant to the influence of a parent or other family member (Vollerberg, Iedema, and Raaijmakers 2001). This may help explain why although children are able to apply their concern levels to behavior independently of parents, their behaviors are influenced by those of their parents.

Second, this study begins unraveling the relative importance of factors explaining parental influence on adolescent climate change perceptions and behaviors with levels of family discussion being more important than parent climate behaviors and child climate concern, respectively. This hierarchy may be explained by Socio-Cultural Theory (SCT), which posits that
learning occurs through socialization and interaction with others, and learned behaviors are many times copied from those that are closest to an individual in their social network (Vygotsky 1978). As parents are typically among the closest individuals in a child’s personal network, SCT would predict parental climate change behaviors directly relate to those of their children. This is reflected in our results, because family discussions on climate change and parent climate behaviors are the two biggest predictors of child climate behaviors, and are more important than demographics. Demographic predictors of climate change perceptions and behaviors (i.e., race, sex), are likely a result of gender socialization and racial/ethnic culturalization (see below), processes which are only beginning among children. Parental behaviors being more important than demographic attributes of children seems reasonable given the nascent stages of gender socialization and culturalization at adolescent ages (Carter 2014) as compared to the immediate and daily interactions between children and parents. This new understanding contributes to the greater literature on SCT and climate change, and can be used in future climate change education programs, focusing on promoting familial conversations on climate change as well as continuing to encourage appropriate climate behaviors. Future research is needed to better understand which climate behaviors are likely to be emulated by adolescents, and how the influence varies by parental figure (e.g., mom vs. dad, or parent vs. grandparent).

Although family level variables are important predictors of child climate behaviors, our results suggest children’s concern about climate change is a second and independent factor. Research by Stevenson et al. (2016) suggests that adolescents’ personal climate change concern was more powerful than the descriptive norms modeled by friends and family members. Furthermore, recent studies suggest family discussion of climate change was key for increasing the climate literacy of youth, and personal climate change concern is a critical secondary factor
(Shealy et al. 2017; Valdez, Peterson, and Stevenson 2017). By controlling for parental views and testing for potential interactions with them, which were not found, our study adds to this research by suggesting adolescent concerns operate on climate behaviors independently from parental drivers. This independent effect may be explained by adolescent cognitive developmental changes reflecting the development of a more self-directed and self-regulating mind (Keating 2004). Similarly, we did not detect interactions between levels of discussion and parent concern or behavior, suggesting family discussions of climate change prompt behavior change among adolescents regardless of the climate change views of parents. These two findings together may point to adolescents’ abilities to both form and act on their own perceptions of climate change independently of the views of their closest, and likely most important role models, parents. Future research is needed to understand the specific nuances of how a child’s perceptions on climate change are formed in family settings, particularly at different ages.

This study suggests previously identified relationships between a child’s sex and climate change behaviors may emerge from underlying family dynamics. Previous research on adolescents suggests that females are more likely to be concerned about climate change than males (Christensen and Knezek 2018; Stevenson et al. 2014). However, our results seem to suggest otherwise. Children’s sex was not related to climate change concern in this study after accounting for how often families discuss climate change and the degree to which parents engage in climate change behaviors (See Table 3.4). This suggests that other factors, such as family dynamics (e.g., level of conversation with children of different sexes), may provide an intuitive causal mechanism for associations found between sex and environmental behaviors in other studies. The Cycle of Socialization (which begins in families [Harro 2000]) likely explains this
phenomenon, as children are socialized to act according to their demographics (e.g., gender) in the family setting. This socialization process extends from and is reinforced by societal norms (MacGregor 2017). In the case of climate change and environmental perceptions in general, socialization into the female role through familial interactions may manifest in higher concern among female children, and subsequently women (McCright and Dunlap 2011). Explanations for this dynamic include that through a life-long process of socialization, women often perceive or experience lower positions of power (Carli and Eagly 2002), which can lead to perceiving more risk in general (Finucane et al. 2000; Sundblad, Biel, and Garling 2007). Similarly, gender socialization practices often encourage girls to recognize and address threats to safety (Harris and Jenkins 2006), and this eventually emerges with women coordinating and leading environmental justice efforts (Bell 2016). Because socialization begins in families, it is possible that family dynamics associated with gender socialization account for differences in climate concern and behaviors as opposed to one’s gender itself. Future research is needed to determine how this relationship varies at different ages (e.g., elementary age (4 – 10) vs. adolescence (10 - 15)), or potentially different patterns of gender socialization in families (e.g., intentional gender-neutral parenting [Martin 2005]).

Similarly, previous research suggesting different levels of climate change engagement among individuals of different races or ethnicities (McCright and Dunlap 2011) may not hold when accounting for familial interactions. As with gender, child and parent race were not significant predictors of climate change behaviors after accounting for family dynamics (e.g. discussion), even though other research indicates people of color typically have higher levels of climate change concern than their white counterparts (Kreslake et al. 2018; Stevenson et al. 2014). Some scholars have pointed out that people of color are more likely to experience the
actual risks of climate change (e.g., diminished air quality, flood risk [Akerlof et al. 2015; Crimmins et al. 2016]), which likely makes greater levels of personal concern reasonable. If concern is driven by actual risks, these risks are likely felt at the family level, which may help explain why family dynamics (e.g., discussion, parent behavior) are more predictive of adolescents’ behavior than race or ethnicity. As in the context of gender, differences in climate change perceptions and behaviors may be less about the demographics themselves (e.g., being a person of color) and more about the shared family experience with climate change. As such, our study not only supports the tenets of the Cycle of Socialization, but also suggests that experimental studies are needed to identify causal relationships among these correlations, as well as consider family dynamics when exploring links between demographics and climate change engagement.

Conclusions and future research

In summary, this study highlights novel ways that family dynamics may promote climate change mitigation behaviors and points to a new pathway toward promoting more responsible climate behavior at familial, and ultimately, societal levels. It must be acknowledged that there are potential weaknesses of a self-report survey (e.g., threats to external validity) and a case study design (limited generalizability), and future research would be improved through direct observations of behaviors and studies that cover a wider area (e.g., national scale). However, this study makes several key contributions. First, we add to studies suggesting climate change education may be effective at fostering climate change concern among young audiences (Aksit et al. 2017; Flora et al. 2014; Stevenson et al. 2014), by suggesting climate change education may foster climate change action among adolescents. Second, more family-based climate change discussion predicted more climate change mitigating behaviors among children.
regardless of parents’ levels of concern. Thus, encouraging discussions among individuals who either accept or deny the science of climate change is likely a beneficial strategy for impacting engagement in climate change issues among adolescents. Although parent and child behaviors are linked, it may be possible that they influence one another; from parent to child or from child to parent through intergenerational learning (Lawson et al. 2018). Third, we found these family discussions may hold the potential to overcome barriers to climate change engagement such as political ideology, as political affiliation was not predictive of climate change concern despite having relatively strong relationships in previous studies that did not account for family discussions (Valdez et al. 2017). Education efforts that aim to promote intergenerational learning from child-to-parent through parent engagement in activities and family-level conversations, have proven effective at building environmental engagement among parents through their children (Boudet et al. 2016; Duvall and Zint 2007; Williams et al. 2017). Based on the results of this study, suggesting similar strategies with climate change may prove to be an avenue for greater societal level engagement with climate change mitigation. Especially as children have been shown to influence parent perceptions around controversial topics (e.g., views on sexual orientation [LaSala 2000]), education efforts aimed at influencing children’s climate concern and behaviors may prove to be a pathway for overcoming significant ideological barriers to climate change engagement among adults. Targeting behavior changes and increased conversation through intergenerational learning will go beyond the call of increasing knowledge, and instead will increase the collective climate action needed to help mitigate the growing effects of climate change (IPCC 2014).
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<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
<th>Factor Loadings</th>
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<td>Talk with my family about how to do something about environmental problems.</td>
<td>-0.29</td>
<td>0.96</td>
<td>.61</td>
</tr>
<tr>
<td>Turn off the lights at home when they are not in use.</td>
<td>1.50</td>
<td>0.69</td>
<td>.41</td>
</tr>
<tr>
<td>Ask my family to recycle some of the things we use.</td>
<td>0.98</td>
<td>1.11</td>
<td>.86</td>
</tr>
<tr>
<td>Research things that I can do about environmental problems.</td>
<td>-0.51</td>
<td>1.04</td>
<td>.61</td>
</tr>
<tr>
<td>Ask the people in my family to turn off the water when it is not in use.</td>
<td>1.59</td>
<td>0.73</td>
<td>.42</td>
</tr>
<tr>
<td>Close the refrigerator door while I decide what to get out of it.</td>
<td>1.40</td>
<td>0.90</td>
<td>.40</td>
</tr>
<tr>
<td>Recycle at home.</td>
<td>0.92</td>
<td>1.20</td>
<td>.82</td>
</tr>
</tbody>
</table>
Table 3.2. Item factor loadings for the child climate behavior scale (n = 180, α = .76). Each item associated with a 5-point Likert scale ranging from (-2) never to (2) always.

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
<th>Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talk with my parents or guardians about how to do something</td>
<td>-0.75</td>
<td>1.03</td>
<td>.54</td>
</tr>
<tr>
<td>about environmental problems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ask others about things I can do about environmental problems.</td>
<td>-1.09</td>
<td>0.99</td>
<td>.46</td>
</tr>
<tr>
<td>Turn off the lights at home when they are not in use.</td>
<td>0.87</td>
<td>1.17</td>
<td>.55</td>
</tr>
<tr>
<td>Ask my family to recycle some of the things we use.</td>
<td>0.11</td>
<td>1.48</td>
<td>.80</td>
</tr>
<tr>
<td>Ask other people to turn off the water when it is not in use.</td>
<td>0.45</td>
<td>1.47</td>
<td>.46</td>
</tr>
<tr>
<td>Close the refrigerator door while I decide what to get out of it.</td>
<td>0.54</td>
<td>1.52</td>
<td>.50</td>
</tr>
<tr>
<td>Recycle at home.</td>
<td>0.59</td>
<td>1.54</td>
<td>.64</td>
</tr>
</tbody>
</table>
Table 3.3. Item factor loadings for the child & parent climate change concern scale (Child: n = 180, α = .79; Parent: n = 241, α = .90).
Numbers beside each answer choice represent coding used.

<table>
<thead>
<tr>
<th>Question</th>
<th>Child Mean</th>
<th>Child SD</th>
<th>Child Factor Loadings</th>
<th>Parent Mean</th>
<th>Parent SD</th>
<th>Parent Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>How worried are you about climate change?</td>
<td>-0.817</td>
<td>0.998</td>
<td>.71</td>
<td>-0.483</td>
<td>1.120</td>
<td>.79</td>
</tr>
<tr>
<td>a) Not at all worried (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) A little worried (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Moderately worried (0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Very worried (-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Extremely worried (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much do you think climate change will negatively affect you personally?</td>
<td>-0.739</td>
<td>1.099</td>
<td>.67</td>
<td>-0.406</td>
<td>1.170</td>
<td>.81</td>
</tr>
<tr>
<td>a) Not at all (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) A little (-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Somewhat (0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) A lot (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) A great deal (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much do you think climate change will negatively affect people in the United States?</td>
<td>0.213</td>
<td>1.012</td>
<td>.70</td>
<td>0.114</td>
<td>1.147</td>
<td>.89</td>
</tr>
<tr>
<td>a) Not at all (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) A little (-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Somewhat (0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) A lot (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) A great deal (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much do you think climate change will negatively affect future generations of people?</td>
<td>0.387</td>
<td>1.146</td>
<td>.67</td>
<td>0.587</td>
<td>1.189</td>
<td>.79</td>
</tr>
<tr>
<td>a) Not at all (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) A little (-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Somewhat (0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) A lot (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) A great deal (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.4. Regression Results of Model Predicting Child Climate Behavior Based on Climate Scales and Control Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Climate Change Discussion</td>
<td>1.070***</td>
<td>0.278</td>
<td>0.269</td>
</tr>
<tr>
<td>Parent Climate Behavior</td>
<td>0.370***</td>
<td>0.088</td>
<td>0.268</td>
</tr>
<tr>
<td>Child Climate Concern</td>
<td>0.479***</td>
<td>0.119</td>
<td>0.240</td>
</tr>
<tr>
<td>Parent Climate Concern</td>
<td>-0.037</td>
<td>0.107</td>
<td>-0.025</td>
</tr>
<tr>
<td><strong>Control Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child Sex</td>
<td>0.631</td>
<td>0.703</td>
<td>0.053</td>
</tr>
<tr>
<td>Parent Sex</td>
<td>0.274</td>
<td>0.752</td>
<td>0.021</td>
</tr>
<tr>
<td>Child Race</td>
<td>0.368</td>
<td>0.866</td>
<td>0.031</td>
</tr>
<tr>
<td>Parent Race</td>
<td>-0.008</td>
<td>1.055</td>
<td>-0.001</td>
</tr>
<tr>
<td>Child Political Identity</td>
<td>0.382</td>
<td>0.316</td>
<td>0.073</td>
</tr>
<tr>
<td>Parental Political Identity</td>
<td>-0.488</td>
<td>0.358</td>
<td>-0.092</td>
</tr>
<tr>
<td>School Rural/Urban Status</td>
<td>0.301</td>
<td>0.754</td>
<td>0.025</td>
</tr>
<tr>
<td>School Title I Status</td>
<td>-0.644</td>
<td>0.814</td>
<td>-0.048</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-4.255</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 241
R² = .272

*Note. Data were collected between October and November 2016 from coastal NC middle school students. Sex was coded 0 = Female and 1 = Male. Race was coded 0 = People of Color and 1 = White. School Title 1 Status = 1, Non-Title 1 Status = 0.*** p < 0.001
N = 229
CHAPTER 4: How children can foster climate change concern among political conservatives and men

This article is in review in *Nature Climate Change*:


**Introductory Paragraph**

Collective action required to mitigate and adapt to climate change is extremely difficult to achieve, largely due to socio-ideological biases that perpetuate polarization over climate change\(^1,^2\). As children are better than adults at parsing out scientific fact from its political context\(^3\), it may be possible to leverage children’s perspective to inspire adults to collective action. Child-to-parent intergenerational learning (IGL)—that is, the transfer of knowledge, attitudes, or behaviors from children to parents\(^4\)—may be a promising and novel, but previously unexamined, pathway to overcoming socio-ideological barriers to climate action\(^4\). Here we present the results of a pre-post, treatment-control evaluation of an educational intervention designed to build climate change concern among parents indirectly through their adolescent children. Parents of children in the treatment group expressed higher levels of climate change concern than parents in the control group. Effects were strongest among male parents and conservative parents, who, as consistent with previous research\(^1\), displayed the lowest levels of concern in the pretest. Female children appeared to be especially effective in influencing parents. Our results suggest that IGL may overcome barriers to collective action on climate change that decades of social science research have identified as nearly insurmountable.
Main Text

Minimizing losses from climate change impacts requires immediate widespread collective action, thus far prevented by lack of a global collective political will. The most recent International Panel on Climate Change report suggests that swift collective action (e.g., at least a 45% decrease in global carbon emissions over the next decade) is necessary to avoid a greater than 1.5°C increase in global temperatures and associated catastrophic impacts, including more than 2.5 feet of sea level rise that will virtually erase some island nations, 10% loss of available land for farming and livestock production, and increased storm frequency and intensity causing projected hundreds of trillions of dollars in damage and untold loss of human life. However, widespread collective action that mitigates these impacts is lacking, polarization over climate change persists (particularly in the United States), and climate change concern levels do not seem to match the severity of eminent impacts. For instance, only 54% of people globally believe in anthropogenic climate change, although anthropogenic causes are accepted scientific fact. Similarly, 28% of Americans still believe there is a high degree of uncertainty around climate change causes and impacts and that the effects of climate change will be isolated to developing nations. This apathy and disbelief is alarming, as one of the key predictors for both individual and collective climate change action is climate change concern.

Several socio-ideological drivers help explain the lack of climate change concern and associated collective action. Political ideology is consistently one of the major drivers of climate change perceptions, regardless of direct personal experiences (e.g., with extreme weather) or scientific literacy. Scholars posit that political ideology influences both the information received about climate change (e.g., ideologically framed news casts or political messaging) as well as how it is interpreted (e.g., accepting only ideologically compatible information).
McCright and Dunlap\textsuperscript{13} refer to a conservative male effect in which conservative males are consistently less concerned about and skeptical of climate change. Like political ideology, gender is relatively stable once formed, and reflects cultural constructs that can shape how individuals interact with the world\textsuperscript{13}. As these characteristics that influence one’s climate change perceptions are engrained in personal identity, they are difficult, if not impossible, to change. In turn, it is logical that historical patterns of climate change concern found in research, do not mirror the increasing threats of climate change to the socio-ecological system.

A suite of strategic communication tools have emerged to increase levels of climate change concern among ideologically diverse audiences, but new strategies are needed to build the political will needed to avoid catastrophic climate change impacts. Strategic framing\textsuperscript{14} has been frequently used to create climate change messages that are ideologically compatible with even conservative audiences. For example, stewardship frames have been used among evangelical Christian groups to align mitigation efforts with core Christian values\textsuperscript{15}. Similarly, popular icons and trusted messengers are used to indicate that climate change mitigation conforms to social norms\textsuperscript{14}. Celebrities like Leonardo DiCaprio are commonly seen in climate change messaging in hopes that those who like the specific celebrity will agree with their climate change views\textsuperscript{12}. Although these communication strategies are helpful, their impacts are isolated to relatively narrow contexts\textsuperscript{12,14,15}, suggesting a need for additional communication strategies – ideally ones that are able to engage all citizens irrespective of their personal ideology or identity.

Intergenerational learning (IGL) represents an understudied but promising pathway for building climate change concern among citizens irrespective of their underlying socio-ideological differences. Adolescents learn about climate change relatively unhindered by socio-ideological baggage carried by their parents\textsuperscript{3}. Although climate change communication and
education campaigns have mixed or even polarizing results among adults\textsuperscript{12}, climate change-based education promotes climate change concern and mitigation behaviors among children\textsuperscript{16}. Further, children influence their parents on a range of ideologically fraught topics (e.g., sexual orientation\textsuperscript{17}), therefore children may be able to make similar inroads in the context of climate change\textsuperscript{4}. Given the special relationship children have with parents, they may even be able to transcend socio-ideological barriers to climate change concern\textsuperscript{4}. However, little is known about the potential of IGL in a climate change-specific context, or how characteristics of families (e.g., family dynamics, gender make-up, political orientation of parents) may moderate this process.

In this study, we investigated the ability of children to overcome the socio-ideological barriers to climate change concern among their parents, through an experimental study in coastal North Carolina. We trained 21 teachers in a climate change curriculum specifically designed to promote IGL over two years and measured impacts on students and their parents (See Supplemental Information). We used matched household level data of 238 families consisting of one or two parents (referring to biological parents, foster parents, grandparents, and/or guardians), and middle school children (aged 10-14 years old). We examined changes in parents’ climate change concern as a function of membership in the treatment group as mediated by changes in children’s concern using sequential multiple linear regression modeling. Additionally, we controlled for how much families talked about climate change, child and parent gender, child and parent race, and parent political ideology to understand how IGL may operate across diverse family dynamics and demographics among both adults and children.

Our results include four major findings. First, children who participated in our curriculum showed increased climate change concern (Table 4.1). Second, children in the treatment group fostered more climate change concern among their parents than was the case for the control
group across both years (Table 4.2). The curriculum did not include any direct interactions with adults, suggesting transfer occurred through children. Third, changes in parents’ climate change concern were most pronounced among the groups typically most resistant to climate change communication. Specifically, politically conservative parents pretested at the lowest concern levels, but displayed the biggest gains in climate change concern associated with IGL facilitated by their children (Table 4.2, Fig. 4.1), and fathers displayed greater gains in climate change concern than mothers (Table 4.2, Fig. 4.2). Fourth, girls were more effective than boys in fostering climate change concern among their parents (Table 4.2, Fig. 4.3).

The success of climate change education with adolescents may reflect an age-related window of influence. Although children are capable of understanding complex subjects like climate change\textsuperscript{18}, they still retain a level of plasticity in their opinions as they make sense of the world around them\textsuperscript{19}. For instance, it is only at low levels of climate change understanding that worldviews function as a filter of information for children when forming climate change perceptions\textsuperscript{3}. Furthermore, recent research has demonstrated a causal link between climate change education targeted at adolescents and knowledge gain, which in turn was linked to behavior change\textsuperscript{16}. As adult climate change perceptions appear to be stable across multiple decades despite climate communication efforts and likely has resulted in little to no action\textsuperscript{1}, climate change education focusing on adolescents may prove essential for the adoption of mitigation behaviors.

Our results also suggest that climate changed-based environmental education curricula designed for IGL can successfully reach parents. Children’s increase in climate change concern fully mediated the relationship between the curricular treatment and parents’ increase in climate change concern. This mediation follows similar patterns in the literature where an environmental
education curriculum did not directly target parents, but still led to measurable changes in knowledge, attitudes, and behaviors in parents (e.g., energy education\textsuperscript{20}, flood education\textsuperscript{21}). Curricula that successfully promoted change among parents included a focus on local issues, hands-on approaches, and encouragement of parental participation\textsuperscript{4}. Our curriculum included each of these characteristics (see Supplemental Information), and these curricular aspects have been shown to support child-to-parent IGL. Specifically, our curricula focused on North Carolina, including a robust field-based service learning project, and embedded ongoing conversations between students and parents throughout the year. As framing climate change in a local context leads to increased climate change acceptance among skeptical audiences\textsuperscript{12,14}, local examples in the curriculum may have boosted learning among children and parents alike, including those skeptical of climate change. The field-based service-learning portion of the curriculum likely supported the sense that climate change impacts local areas\textsuperscript{22}, as well as increased engagement among children\textsuperscript{22}. The increased engagement among children potentially extended the learning with their parents. In IGL research around community knowledge of a Costa Rican watershed, researchers found that promoting familial conversation about the topic through a workbook completed by parents with their children at home was critical to increases in knowledge of both children and their parents\textsuperscript{23}. As our findings show increased family discussion around climate change was a key factor in predicting changes in parents’ concern levels (Table 4.2), it is probable that the adolescent-conducted parent interview embedded in our curricula helped foster the child-to-parent IGL observed here.

Successful climate communication from children to their parents documented in this study may reflect the robustness of the parent-child relationship to socio-ideological threats typically associated with climate change perceptions among adults. Contrary to trends in CC
research, parents who identified as male or conservative more than doubled their concern levels between pre- and post-tests – a larger increase than their female and liberal counterparts. This is surprising, as our own pre-test results and decades of research suggest conservatives and men are typically the least concerned about climate change and most resistant to interventions designed to promote concern\textsuperscript{13}. However, high levels of parental trust in their children often leads to parents being willing to listen to or accept their child’s views on complex topics\textsuperscript{24}. IGL research reflects this pattern, with a study by LaSala\textsuperscript{18} documenting children influencing their parents’ knowledge and attitudes about sexual orientation. Child-to-parent IGL of climate change information has been anecdotally documented in popular press, with a conservative past US Congressman switching his views on climate change due to his son’s influence\textsuperscript{25}. We believe our study documents the first empirical evidence of child-to-parent IGL associated with climate change concern, especially among those expected to be most resistant. As such, leveraging children as a neutral communication pathway capable of overcoming longstanding socio-ideological barriers to climate change action should be a key strategy in future climate literacy efforts.

Girls seem particularly effective at building climate change concern (more so than boys), which may be linked to parents’ perceptions that girls vulnerable, and need to be protected\textsuperscript{26}. This dynamic is reflected in popular press, with a male reporter insisting on hearing stories of distress from the perspectives of females instead of males, for female’s stories evoke more emotion among readers\textsuperscript{27}. The tendency for parents’ pretest concern levels to be lower when surveys came from daughters than sons, as well as posttest concern levels in the control group, is troubling. This may be explained by parents’ tendency to talk less with girls than boys about science\textsuperscript{28}. Boys delivering the survey may trigger parents to think more about the topic as they associate science more with boys than girls. Together, these findings suggest that in the context
of IGL and climate change, empowering girls to communicate about climate change with their parents may serve the dual purpose of working against typical gender roles that exclude girls from science and being particularly effective at building climate change concern among parents.

Mitigating the projected impacts of climate change requires widespread collective action, and our results suggest that children may be key spokespersons needed to create change now and in the future. As reflected in our study between year one and two, as well as through national surveys, climate change concern may be rising incrementally, but strategies are needed to accelerate this process. The compulsory nature of K-12 education, particularly in the United States, make children an easily accessible captive audience for climate change outreach. Furthermore, the children of today will experience the brunt of climate change impacts and, as such, collective action to minimize those impacts is needed now. In addition to preparing children to address the unavoidable climate challenges they will face, child-to-parent IGL provides children means to promote collective action needed to safeguard their future.

Methods

Ethics Statement

Data collection procedures were approved by North Carolina State University’s Institutional Review Board (Protocol #7793).

Curriculum Design

The curriculum developed for this project leveraged previously tested, “Weather, Wildlife, Climate, and Change,” which included four separate activities, modeled after Project WILD, an internationally-distributed, wildlife-based, environmental education curriculum (see go.ncsu.edu/wwcc). The original curriculum was created through an iterative process with climate change experts, wildlife biologists, and formal educators, and we modified it to
maximize IGL. The original activities included focused on: 1) the difference between weather and climate, 2) how climate and weather relate to wildlife habitat, 3) how wildlife managers can make use of adaptive management to deal with climate change, and 4) how individual actions can impact climate change’s effect on wildlife. We added three characteristics: 1) engagement with parents through an interview conducted by students, 2) a field-based service-learning project in conjunction with a community partner, and 3) a reflective blog post (see Supplemental Information for further detail).

**Sampling**

We chose middle school children as the target age group for this study because early adolescence represents a developmental stage where children are capable of understanding complex topics, such as climate change, and are still in the process of forming their own opinions on controversial subjects. We chose to focus on the North Carolina coastal counties, as this area is disproportionately vulnerable to climate change and its impacts, including sea level rise and saltwater intrusion. We used a hierarchical sampling design, first creating a sample frame of all middle school science teachers (grades 6-8) in the North Carolina coastal counties, and randomly selecting 100 to invite via email for participation. Of the 100 invited teachers, 43 responded as interested (43% compliance), and 26 committed to the entire study (46.5% compliance). We randomly assigned teachers to treatment and control groups (n = 13 control teachers, n = 13 treatment teachers). Over the course of the project, five teachers chose to withdraw from the study citing lost instructional time due to impacts from Hurricane Matthew in October 2016, resulting in 21 participating teachers (n = 9 treatment teachers, n = 12 control teachers). Through the participating teachers, we gained access to our student sample, which were the students assigned to consenting teachers by school administrators for the school year.
We invited parents to participate in an online and paper survey questionnaire distributed to children directly, to be sent home. Parents associated with only 15 of the 21 classrooms choose to participate during both data collection time periods (n = 7 control teachers, n = 8 treatment teachers).

Child and parents samples were assigned treatment or control groups based on association with the teachers. Our final treatment child sample consisted of 105 sixth-grade students, 153 seventh-grade students, and 99 eighth-grade students. Children in the treatment sample ranged in age from 10 to 14 years, and self-identified as 52.0% female and 55.9% Caucasian. Our final control child sample consisted of 101 sixth-grade students, 121 seventh-grade students, and 102 eighth-grade students. Children in the control sample ranged in age from 10 to 14 years, and identified as 51.6% female and 54.0% Caucasian. Our final parent sample consisted of 292 respondents (n = 199 treatment parents, n = 93 control parents), representing a 42.9% total response rate, assuming at least one parent per household. The total parent sample ranged from 29 to 84 years old, were 67.2% female, and 79.1% Caucasian. In most households, only one parent responded, however 54 households had two parent responses, resulting in 238 individual families.

Teacher Training

We trained all teachers in the curriculum (see Curriculum Design) following a delayed treatment model in Summer 2016 (Year 1 Treatment Teachers) and Summer 2017 (Year 1 Control Teachers), and used an in-person format allowing for discussion and reflection, which follows best practices for teacher professional development. We designed the curriculum to maximize the chance of child-to-parent intergenerational transfer. We asked the treatment teachers to integrate the lessons during the school year after pre-testing, and control teachers
were asked to teach their regularly planned curriculum during year one, and all teachers integrated the curriculum lessons into their regular classrooms during year two.

Questionnaire and Development and Deployment

To create our parent and child questionnaires, we utilized previously published scales that are validated for use with adolescents. Both child and adult climate change concern was measured using a scale developed from the 2011 nation-wide climate change adolescent survey and used in several subsequent studies. Level of family climate change discussion was measured through a single question, “How often have you discussed climate change at home with your family?”. We also translated both the child and parent surveys into Spanish using Qualtrics translation services.

We collected child and parent responses twice each academic year, once at the beginning of the 2016-2017 academic school year from October to November 2016, and a second time at the end of the school year, from May to June 2017. Responses were also collected during the 2017-2018 during the same time frames. All teachers were provided with a survey protocol and access to the student survey link through Qualtrics. On the same day that students were surveyed, we asked teachers to email all parents an online invitation letter with a URL and QR code that accessed the parent survey. Two weeks after the online survey letter was sent to parents, a paper survey packet was sent home with students of those parents that had not yet responded. The paper packets contained a pre-address stamped envelope to facilitate easy and anonymous survey return to the researchers.

Data Analysis

We used multiple linear regression analyses to model change in child climate change concern as a function of child climate change concern pretest scores (to control for a ceiling
effect\textsuperscript{34}) and presence in a treatment group, while controlling for student race and gender, as well as treatment year. We also used multiple linear regression analyses to model change in parent climate change concern as a function of parent climate change concern pretest scores, child’s presence in a treatment group, and student change in climate change concern. We also controlled for level of family climate change discussion, parent and child gender (male vs. female), parent and child race/ethnicity (white vs. people of color), parent political ideology, school-level Title I status (a measure of socio-economic status\textsuperscript{35}), school development level (urban vs. rural), and a random effect for teacher. We collapsed both child and parent ethnicity into dichotomous variables (white = 0, people of color = 1) due to small sample size. We tested all interactions between student change in climate change concern and family dynamics variables including level of family climate change discussion, parent and child sex, parent and child race/ethnicity, and parent political ideology. Only those interactions that were statistically significant were left in the model. Sobel-Goodman mediation tests were also run to test for the mediating effect of student change in climate change concern between treatment and parent change in climate change concern. Similarly, we excluded development status, Title I status, and teacher random effects from the final models, as all were non-significant.
REFERENCES


5. IPCC. Global warming of 1.5°C: Summary for policy makers. Intergovernmental Panel on Climate Change, (2018).


Table 4.1. Regression results of child change in climate concern on pretest scores, treatment, and control variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest Child Climate Concern Score(^a)</td>
<td>-0.375***</td>
<td>0.070</td>
<td>-0.299</td>
</tr>
<tr>
<td>Treatment(^b)</td>
<td>1.55**</td>
<td>0.475</td>
<td>0.134</td>
</tr>
<tr>
<td>Year(^c)</td>
<td>-0.802</td>
<td>0.505</td>
<td>-0.093</td>
</tr>
<tr>
<td>Child Sex(^d)</td>
<td>0.269*</td>
<td>0.562</td>
<td>0.131</td>
</tr>
<tr>
<td>Child Race(^e)</td>
<td>-0.070</td>
<td>0.479</td>
<td>-0.008</td>
</tr>
<tr>
<td>Constant</td>
<td>0.998</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 292

R\(^2\) = 0.109

Note. Year one data were collected during Fall 2016 and Spring 2017 from coastal NC middle school children. Year two data were collected during Fall 2017 and Spring 2018 from coastal NC middle school children.

\(^a\) Climate change concern was coded -8 = least concerned to 8 = most concerned.

\(^b\) Treatment was coded 1 = treatment and 0 = control.

\(^c\) Year was coded 1 = year two and 0 = year one.

\(^d\) Sex was coded 1 = female and 0 = male.

\(^e\) Race was coded 1 = people of color and 0 = white.

\(* p < 0.05\)

\(** p < 0.01\)

\(*** p < 0.001\)

\(N = 292\)
Table 4.2. Regression results of parent change in climate concern on pretest scores, treatment, child change in climate concern, and control variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parent Change in Climate Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td>Pretest Parent Climate Concern Score&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.245***</td>
</tr>
<tr>
<td>Treatment&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.567</td>
</tr>
<tr>
<td>Child Change in Climate Concern&lt;sup&gt;a,c&lt;/sup&gt;</td>
<td>0.815**</td>
</tr>
</tbody>
</table>

Control Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Family Climate Change Discussion&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.399*</td>
<td>0.040</td>
<td>0.120</td>
</tr>
<tr>
<td>Year&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.123**</td>
<td>0.024</td>
<td>0.103</td>
</tr>
<tr>
<td>Child Sex&lt;sup&gt;f&lt;/sup&gt;</td>
<td>0.268*</td>
<td>0.101</td>
<td>0.108</td>
</tr>
<tr>
<td>Parent Sex&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.676*</td>
<td>0.335</td>
<td>-0.104</td>
</tr>
<tr>
<td>Child Race&lt;sup&gt;g&lt;/sup&gt;</td>
<td>0.014</td>
<td>0.124</td>
<td>0.006</td>
</tr>
<tr>
<td>Parent Race&lt;sup&gt;g&lt;/sup&gt;</td>
<td>0.371</td>
<td>0.181</td>
<td>0.047</td>
</tr>
<tr>
<td>Conservative Parents&lt;sup&gt;h&lt;/sup&gt;</td>
<td>-0.310</td>
<td>0.153</td>
<td>-0.062</td>
</tr>
</tbody>
</table>

Family Dynamics Interactions

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Change in Climate Change Concern *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservative Parents</td>
<td>0.126*</td>
<td>0.068</td>
<td>0.097</td>
</tr>
<tr>
<td>Child Change in Climate Change Concern *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent Sex</td>
<td>-0.107*</td>
<td>0.102</td>
<td>-0.073</td>
</tr>
<tr>
<td>Child Change in Climate Change Concern *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child Sex</td>
<td>0.238*</td>
<td>0.173</td>
<td>0.062</td>
</tr>
</tbody>
</table>

Constant                                      2.486

N                                           289
Table 4.2 (continued)

| R² | .297 |

Note. Year one data were collected during Fall 2016 and Spring 2017 from coastal NC middle school children and parents. Year two data were collected during Fall 2017 and Spring 2018 from coastal NC middle school children and parents.

Climate change concern was coded -8 = least concerned to 8 = most concerned.

Treatment was coded 1 = treatment and 0 = control.

Sobel-Goodman results of treatment and change in parent climate change concern by child climate change concern: Complete mediation, 21% of the direct effect, p < 0.05.

Level of family climate change conclusion was coded from 1 = never to 5 = three times or more.

Year was coded 1 = year two and 0 = year one.

Sex was coded 1 = female and 0 = male.

Race was coded 1 = people of color and 0 = white.

Conservative parents was coded 1 = conservative 0 = moderate or liberal

* p < 0.05

** p < 0.01

*** p < 0.001

N = 289
Figure 4.1. a) Control parent mean climate change concern scores based on political ideology, pre- and post-test comparison. b) Treatment parent mean climate change concern scores based on political ideology, pre- and post-test comparison. 95% confidence interval error bars included on each bar graph.
Figure 4.2. a) Control parent mean climate change concern scores, separated by fathers and mothers, comparing pre- and post-test scores. b) Treatment parent mean climate change concern scores, separated by moms and dads, comparing pre- and post-test scores. 95% confidence interval error bars included on each bar graph.
Figure 4.3. a) Control parent mean climate change concern scores, for those with sons and those with daughters, comparing pre- and post-test scores. b) Treatment parent mean climate change concern scores, for those with sons and those with daughters, comparing pre- and post-test scores. 95% confidence interval error bars included on each bar graph.
Supplementary Materials

Supplemental Note 1. Study Area

All research was conducted within the coastal region of North Carolina, including the twenty counties identified by the 1974 NC Coastal Area Management Act (CAMA) (See Fig. S1), and are under jurisdiction by the NC Coastal Resources Commission¹. We chose the CAMA counties because the area is expected to experience disproportionate effects of climate change, including but not limited to sea level rise, beach erosion, and extreme weather events². All middle schools and teachers that participated in this study were from this area.

Figure 4.4. North Carolina CAMA counties¹
Supplemental Note 2. Curriculum Development

For this project, we leveraged a previously developed curriculum, “Weather, Wildlife, Climate, & Change³” (WWCC). It was co-developed through relying on experts including the State Climate Office of North Carolina (SCONC), the North Carolina Wildlife Resources Commission (NCWRC), North Carolina State University (NCSU) faculty, and formal educators. This process of expert elicitation was used to ensure that the climate change information was not only factually-accurate, but also useable for science teachers. The curriculum focused on species local to both North Carolina and the Southeastern United States (Table S1), as individuals tend to engage with climate change more readily when it is framed in local as opposed to global contexts⁴. Research suggests that individuals are less influenced by personal ideologies when climate change is presented from the frame of biodiversity and wildlife⁵,⁶, a wildlife-based curriculum offers an ideologically-neutral context in which to teach about climate change. We augmented this curriculum to maximize the change of intergenerational learning (IGL) occurring, through following all published best practices of IGL curriculum development⁶,⁷ (Table S2). The final set of activities focused on 1) the difference between weather and climate, 2) how climate and weather relate to location of habitats and wildlife, 3) how wildlife managers can are planning for climate change, 4) how individual actions impact climate change, and in turn, wildlife, and 5) engagement with parents through a student-directed interview, a service learning project with a local community members (see Table S3), and a reflective blog post (see go.ncsu.edu/wwcc for more information).
Table 4.3. Summary of the Weather, Wildlife, Climate, & Change Activities.
Table modified from Stevenson, K. T., Peterson, M. N., & Bondell, H. D. Development of a causal model for adolescent climate change behavior. *Climatic Change*, (2018). Permission was received from authors prior to submission.

<table>
<thead>
<tr>
<th>Activity Title</th>
<th>Objectives</th>
<th>Brief Description</th>
</tr>
</thead>
</table>
| Weather, Climate, & Wildlife   | 1. Collect and graph local weather and climate data  
2. Describe the difference between weather and climate  
3. Explain that daily weather is highly variable compared to long-term climate data  
4. Describe how weather is more variable than climate  
5. Identify ways in which weather and climate events may affect local wildlife species. | Students collect and graph local weather data and overlay it with 30-year average temperatures for that location. They then play a game to understand the difference between weather and climate and the impacts of each on local wildlife species. |
| Climate and Habitat            | 1. List key factors that contribute to regional climate  
2. Describe the links among precipitation, vegetation and habitat, using maps as supporting evidence.  
3. Describe the relationships among climate, habitat, vegetation types and wildlife species.  
4. Hypothesize how changing regional climates may affect wildlife. | Students create maps for average temperature and rainfall in their state. They then overlay these with vegetation and wildlife range maps and use the comparisons to consider factors that affect regional climate and how these determine wildlife habitat |
| Adapting to Change             | 1. Identify both natural and human-caused reasons for climate change.  
2. Identify three key impacts climate change will have on wildlife.  
3. Identify three ways in which wildlife managers are planning for climate change.  
4. Identify potential climate change impacts on local species and create an action plan for helping protect these species. | Students engage in a jigsaw activity in which student groups become experts on one major climate-related impact on wildlife (sea level rise, transforming habitats, and changing seasonal cues) or a management response (adaptive management, collaboration, or habitat conservation and restoration). Teachers then shuffle these groups so that a representative from each expert group is represented in a new small group. These groups are then asked to consider what likely impacts will affect a local wildlife species and what a good management response would be. |
| Doing our Part                 | 1. Identify their impacts on the planet.  
2. List at least five specific ways they can take action on climate change.  
3. Connect the actions they can take to benefits for society, individuals or local communities and wildlife.  
4. Communicate with others the importance of “doing our part” to reduce impacts on the planet. | Students complete an online ecological footprint calculator and complete an activity to connect personal actions to building wildlife resilience to climate change. |
| Bringing it all Together       | 1. Participate in a service-learning project with a community partner  
2. Reflect on the experiences of the curriculum, parent interview, and service learning project using critical thinking skills  
3. Think of ways that they can help mitigate and adapt to the impacts of climate change. | Students interview their parents about changes in their local weather and environment. Students then participate in a service learning project (see Table S3) focused on a coastal climate hazard, and finally blog about the experience. |
Table 4.4. Curricular alignment with Intergenerational Learning Best Practices. These best practices are derived from several key review papers focusing on IGL\textsuperscript{7,8}

<table>
<thead>
<tr>
<th>IGL Best Practices\textsuperscript{7,8}</th>
<th>Activity 1</th>
<th>Activity 2</th>
<th>Activity 3</th>
<th>Activity 4</th>
<th>Activity 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of schools</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Parent involvement in student activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Community involvement in student activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Hands-on, action oriented, activities for students</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Hands-on, action oriented, activities for parents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Long-term for in-depth exploration</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>A focus on local issues</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Enthusiastic teachers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
### Table 4.5. Examples of Service-Learning Projects Completed by Students

<table>
<thead>
<tr>
<th>Community Partner</th>
<th>Project</th>
<th>Climate Change Coastal Hazard Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Carolina Coastal Federation</td>
<td>Oyster Reef Restoration</td>
<td>Sea Level Rise</td>
</tr>
<tr>
<td>University of North Carolina Wilmington’s MarineQuest</td>
<td>Citizen Science-based Plankton Monitoring</td>
<td>Ocean Acidification</td>
</tr>
<tr>
<td>Albemarle-Pamlico National Estuary Partnership</td>
<td>Sea Turtle Monitoring</td>
<td>Habitat Degradation</td>
</tr>
<tr>
<td>North Carolina State Parks System &amp; The Nature Conservancy</td>
<td>Beach Erosion Surveys</td>
<td>Sea Level Rise</td>
</tr>
<tr>
<td>North Carolina Wildlife Resources Commission</td>
<td>Rain Garden in Schoolyard</td>
<td>Flooding</td>
</tr>
<tr>
<td>National Estuarine Research Reserve</td>
<td>Spartina Restoration</td>
<td>Sea Level Rise</td>
</tr>
</tbody>
</table>
Table 4.6. Item factor loadings for the child & parent pre-test climate change concern scale (Child: n = 238, α = .79; Parent: n = 292, α = .89). Numbers beside each answer choice represent coding used.

<table>
<thead>
<tr>
<th>Question</th>
<th>Child Mean</th>
<th>Child SD</th>
<th>Child Factor Loadings</th>
<th>Parent Mean</th>
<th>Parent SD</th>
<th>Parent Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>How worried are you about climate change?</td>
<td>-0.781</td>
<td>0.762</td>
<td>0.73</td>
<td>-0.428</td>
<td>1.117</td>
<td>0.79</td>
</tr>
<tr>
<td>f) Not at all worried (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) A little worried (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Moderately worried (0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>i) Very worried (-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j) Extremely worried (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much do you think climate change will negatively affect you personally?</td>
<td>-0.726</td>
<td>1.101</td>
<td>0.63</td>
<td>-0.402</td>
<td>1.023</td>
<td>0.80</td>
</tr>
<tr>
<td>f) Not at all (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) A little (-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Somewhat (0)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>i) A lot (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j) A great deal (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much do you think climate change will negatively affect people in the United States?</td>
<td>0.223</td>
<td>1.120</td>
<td>0.71</td>
<td>0.165</td>
<td>1.143</td>
<td>0.87</td>
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<tr>
<td>f) Not at all (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) A little (-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Somewhat (0)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>i) A lot (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j) A great deal (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much do you think climate change will negatively affect future generations of people?</td>
<td>0.411</td>
<td>1.048</td>
<td>0.60</td>
<td>0.582</td>
<td>1.172</td>
<td>0.78</td>
</tr>
<tr>
<td>f) Not at all (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) A little (-1)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>h) Somewhat (0)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>i) A lot (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j) A great deal (2)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Table 4.7. Item factor loadings for the child & parent post-test climate change concern scale (Child: n = 238, α = .91; Parent: n = 292, α = .90).
Numbers beside each answer choice represent coding used.

<table>
<thead>
<tr>
<th>Question</th>
<th>Child Mean</th>
<th>Child SD</th>
<th>Child Factor Loadings</th>
<th>Parent Mean</th>
<th>Parent SD</th>
<th>Parent Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>How worried are you about climate change?</td>
<td>0.147</td>
<td>0.562</td>
<td>0.86</td>
<td>0.360</td>
<td>0.892</td>
<td>0.73</td>
</tr>
<tr>
<td>k) Not at all worried (2)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l) A little worried (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m) Moderately worried (0)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>n) Very worried (-1)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o) Extremely worried (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much do you think climate change will negatively affect you personally?</td>
<td>0.616</td>
<td>0.762</td>
<td>0.85</td>
<td>0.300</td>
<td>1.021</td>
<td>0.81</td>
</tr>
<tr>
<td>k) Not at all (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l) A little (-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m) Somewhat (0)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n) A lot (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o) A great deal (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much do you think climate change will negatively affect people in the United States?</td>
<td>0.287</td>
<td>0.458</td>
<td>0.83</td>
<td>0.764</td>
<td>0.879</td>
<td>0.89</td>
</tr>
<tr>
<td>k) Not at all (-2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l) A little (-1)</td>
<td></td>
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<td>How much do you think climate change will negatively affect future generations of people?</td>
<td>0.564</td>
<td>1.012</td>
<td>0.85</td>
<td>1.068</td>
<td>1.078</td>
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<td>k) Not at all (-2)</td>
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REFERENCES


CHAPTER 5: Conclusion

Reflection

Reflecting on this dissertation, the results, and the process of research has made me realize how much growth has happened in me as a researcher and early-career academic over my time here at NC State. I am incredibly proud of, and excited about, the results that I found. They will not only add to the scholarship of intergenerational learning, but will also have a significant impact on climate change education and communication. Knowing that children can help make an impact on climate change today and in the future gives me hope in the face of the eminent impacts of climate change. Furthermore, knowing that they can have an impact with those groups that decades of research has suggested are unreachable, is even more hopeful. Attempting to further understand the mechanisms occurring in child-to-parent intergenerational learning will be key in future endeavors if I truly want to see intergenerational learning make an impact in the climate change context.

As a researcher, I have grown tremendously -- in particular, understanding firsthand how difficult research of this nature can be to conduct. Through this work, I have realized that research methods books are in many ways, a guide. Truly trying to understand the community in which you are working may provide more answers than a book can. For example, finding ways to increase my survey response was difficult. It took realizing that the people of the area in which I was conducting research were not going to fit the mold of preferring online surveys. It was only through providing a paper survey that I was able to significantly increase my response rate (from 1% to 46.5% survey response). However, I did not come to this realization on my own. It took the work of the teachers that agreed to participate in the research with their student and parent communities. Finally, I have learned that impactful research takes the collaboration of multiple
groups. Without the teachers, students, parents, researchers, community partners, and governmental organizations that agreed to help with this process, it would not have been successful.

**Next Steps and Future Directions**

Although the results of this intergenerational learning are promising, more work needs to be completed in the future. This particular study only focused on coastal North Carolina (see Figure 4.4). Future research should aim to expand this focus - to regional or nationwide efforts - to see how different geographic contexts change the results. Understanding how intergenerational learning of climate change information functions in different cultural contexts will be key (e.g., how do agricultural communities respond to intergenerational learning of climate change?; Does intergenerational learning have different impacts in families comprised of non-native English-speakers?; How does intergenerational learning of climate change information different in child-to-community or politician contexts?). Intergenerational learning has the potential to increase the number of diverse voices in the conservation conversation, and as such, understanding its use in various contexts is needed. Furthermore, follow up qualitative research and social network analysis would be useful to help researchers continue to understand how and why intergenerational learning occurs. Although the quantitative methods used in this dissertation provided the groundwork for understanding that child-to-parent IGL is successful in the climate change context. However, we do not understand the mechanisms behind this type of communication. Additional methods could help clarify this. Finally, future intergenerational learning research should bring in the use of widely known behavioral theories such as Value-Belief-Norm Theory or the Theory of Planned Behavior. A theoretical grounding can help make sense of what is occurring in intergenerational learning, and how it can be used in multiple
contexts. It will also help researchers understand how certain aspects (e.g., personal values, control beliefs) change or support IGL. Overall, much more work is needed to understand intergenerational learning as an educational tactic, particularly in the realm of controversial issues. These unknowns will help guide my future work as an environmental education and intergenerational learning scholar.