ONLINE LOCAL NATURAL HAZARDS EDUCATION FOR YOUNG ADULTS:

ASSESSING PROGRAM EFFICACY AND CHANGES IN RISK PERCEPTION

A Thesis

by

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ABSTRACT

During disaster events, people react depending on how they perceive a hazard or risk. An often-omitted impact of disasters is how children experience disasters and respond in their aftermath, including changes in risk perception. The curriculum in secondary schools does not typically cover local natural hazards or their impacts in sufficient depth. This thesis presents a formal, online, and youth-centric natural hazard and disaster educational program, specific to Texas. However, working with children in research is difficult as our Houston Independent School District (ISD) collaborators required a vetted program before testing it on a vulnerable population (children); therefore, a proxy community was utilized. By using local college students as proxies for high school adolescents in a pilot study, this research investigates how the curriculum impacts subject matter proficiency and risk perceptions.

Results suggest that the developed curriculum content and surveys effectively improve natural hazards subject matter proficiency in participants. The curriculum also influences risk perception; participants who ended the program with higher module scores were found also to have higher risk perception, post-curriculum. Although some hazards were perceived as more likely to directly impact participants than others, specific hazard fears were decreased in general. Our findings demonstrate how exposure to an educational program can also increase hazard awareness and coping capacity.

This study contributes to natural hazard and disaster risk perception literature concerning young adults. The integration of an online natural hazards education

curriculum into studying risk perception of children or young adults has not yet been attempted. This work also serves as a pilot study for developing an interactive online curriculum at a high school-level for local community partners that have been affected by Hurricane Harvey in Houston, Texas. The curriculum is currently accessible to the 11^{th} grade level on average on the Flesch-Kincaid grade level test and compatible with any learning management system, thus enabling future research with children.

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1. INTRODUCTION

During disaster events, people respond depending on how they perceive a hazard or risk. Although natural hazards cannot be prevented, effective natural hazards education has been found by numerous studies to reduce disaster impacts at individual and community scales (Dunbar, 2007; Fothergill & Peek, 2017; Mitchell et al., 2008; Peek, 2008; Ronan et al., 2001). An often-omitted impact of disasters is how children experience disasters and react in their aftermath, including changes in risk perception. The curriculum in secondary schools does not typically cover local natural hazards or their impacts in sufficient depth. Topics are often presented broadly as physical geography with no mention of the physiological effects or feasible preparedness and mitigation practices appropriate for their ages (Texas Education Agency, 2010).

In response to these limitations, this thesis presents a formal online and youth-centric natural hazard and disaster educational program developed to investigate how an online natural hazards curriculum for Texas hazards influences risk perceptions of local natural hazards. For the pilot study, young college students (primarily 18-20 years of age) are used as proxies for high school students due to their cognitive and developmental similarities to enable future studies with children (Arain et al., 2013; Arnett, 1994; Skulborstad & Hermann, 2016; Spano, 2003; Steinberg, 2005). The content produced will focus primarily on hurricanes and flooding, using Hurricane Harvey as a case study.

Subject matter proficiency is defined in this research as to how knowledgeable the student is about the subject of natural hazards and its related concepts such as physical geography and disaster impacts. Risk perception is defined in this study as to how people objectively identify and measure risk based on information they have about the risk, such as awareness and probability of direct impact, and is expressed as a high or low score. A high-risk perception score means the student perceives a higher likelihood of direct impact, risk, fear, or awareness. The objectives of this research include 1) developing an online natural hazards curriculum content and surveys, 2) determining the efficacy of the produced content on impacting risk-perception and subject matter proficiency in students, and 3) identifying changes in students' risk perceptions pre- and post-hazards education and influential cognitive and emotional factors.

Congruent with current literature, the hypotheses associated with this research objective are as follows:

- H_0: Students who have had previous hazard experience and live in areas prone to flooding and hurricanes will not have higher risk perception scores before interacting with the program than those who do not.

  H_A: Students who have had previous hazard experience and live in areas prone to flooding and hurricanes will have higher risk perception scores before interacting with the program than those who do not.
- H_0: Interacting with and completing the program will not result in increased risk perceptions.

H_A: An increase in risk perception score does occur after interacting with the program.

- H_0: Subject matter proficiency in natural hazards and disasters would not improve, especially when combined with additional classroom content.

  H_A: Subject matter proficiency in natural hazards and disasters would improve, especially when combined with additional classroom content.

- H_0: Previous experience, hometown location, gender, age, and race do not influence subject matter proficiency and risk perception at any stage (before or after completing the curriculum).

  H_A: Previous experience, hometown location, gender, age, and race do influence subject matter proficiency and risk perception at any stage (before or after completing the curriculum).

The research advances literature concerning hazards education and risk perception science by examining how local college students' subject matter proficiency and risk perception change after exposure to a structured, online local natural hazards education program.

First, the study and its motivations are introduced. Second, a literature review on risk perception in adults and children, natural hazards education, and online education is presented. Third, the data and methods for the study are described, which includes information on the study site and population, program content and surveys, and data analysis. Fourth, the results are presented, including sample population demographics, t-test results, and linear regression results. Fifth, the study results and their implications for improving online natural hazards education, and study limitations are discussed. Finally, the study conclusions are summarized.

2. LITERATURE REVIEW

2.1. Risk Perception in Adults

Risk perception describes how people identify and measure a specific hazard or risk and its potential impacts on themselves and those around them. Risk perception research has identified several factors that contribute to the formation of an individual's risk perception, as well as various ways used to measure and asses it (Ronan et al., 2001; Slovic, 1987, 2016; Sjöberg, 2000; Wachinger et al., 2013). Concerning hazards in general (i.e., natural, environmental, or human-made hazards), Babcicky and Seebauer (2017), Lo and Chan (2017), and Slovic (1987) reaffirmed that risk perception could be influenced by social groups such as friends, family, acquaintances, respected persons or agencies (e.g., public officials and news organizations), and social values.

Cultural theory is one theory used to explain how risk perception develops. Cultural theory is interpreting how and why individuals form attitudes about various threats with the understanding that opinions are not formed independently of social context. As such, individual perceptions or beliefs are shaped by the nature of social groups and cultures of which they take part and feel close to (e.g., organizations, peers, or authority figures) (Tansey & O'riordan, 1999). Social groups can function as a sort of peer pressure on an individual by downplaying or emphasizing specific hazards to maintain and control the group (Babcicky & Seebauer, 2017; Kasperson et al., 1988).

Perceptions can also be resistant to change due to the way the information may be interpreted by the individual, even when presented with strong evidence of the contrary by authority figures such as government agencies (Lo & Chan, 2017; Slovic, 1987). Thus, trust in authorities or institutions also plays a vital role in both individual and community risk perceptions, especially if their response to a previous disaster was seen by the public as insufficient. Bronfman et al. (2016) found that government authorities and state institutions responsible for disaster preparedness and response in Chile showed the lowest levels of public trust due to weaknesses and failings coming to light during a 2010 earthquake crisis, which can lead to an increase in risk perception of local hazards.

Slovic (1987, 2016) developed the psychometric paradigm, which found that hazard characteristics, such as potential dread, controllability, and number of deaths, contribute to risk perceptions. The psychometric paradigm quantitatively identifies similarities and differences in opinions and attitudes among groups. The model uses techniques like psychophysical scaling (usually Likert Scales) and multivariate analysis to create a "cognitive map" or a mental representation of the physical environment. The original model by Slovic (2016) classifies a range of factors under two labels, dread risk and unknown risk. Factors measured by the psychometric paradigm are categorized into three distinct characteristics: dread (level of severity is uncontrollable, could be catastrophic and fatal), new-old (whether the risk is observable and seen before or entirely new and unknown), and the number of people exposed (Paek & Hove, 2017; Slovic, 2016).

The psychometric paradigm has been adapted by various recent natural hazards studies to assess risk perception in communities. For instance, Adelekan and Asiyanbi

(2016) found that residents in Lagos, Nigeria felt that although flooding was not a new risk, it is considered to have disastrous consequences on the city and was causing considerable dread. Peng et al. (2017) found through the probability and unknown factors from the psychometric paradigm that residents were severely overestimating their risk of landslides in the Three Gorges Reservoir Area, China, thus also impacting their sense of attachment to a place and their local community bonds.

However, Sjöberg (2000) found that the psychometric method is limited in that it accounts for a low percentage (about 20%) of the variances of perceived risk or risk acceptance. The technique may be missing several important risk perception or judgment components, such as morality and interference with nature, due to its age in literature and because its main factors were originally based specifically on nuclear hazards (Sjöberg, 2000). Sjöberg (2000) also found that studies using the psychometric paradigm often used mean ratings instead of raw data, which can produce misleading results due to inflated levels of explanatory power. Both Bassarak et al. (2017) and Sjöberg (2000) proposed that a fourth factor based on morality be included, labeled as “Unnatural risk” or “Immoral risk.” Immoral risk was found to be a strong and distinctive predictor of perceived overall riskiness, thus improving the explanatory power for human-made hazards such as nuclear power or societal risks such as climate change (Bassarak et al., 2017). Siegrist et al. (2005) also express concerns using the psychometric paradigm as it does not account for individual differences in risk perception; as such, they recommend using three-way-component methods applied to specific hazard scenarios to account for these differences.

Direct experience is also an impactful factor in that it can heighten or lower risk perception. Wachinger et al. (2013) re-examined previous research and found that scientific natural hazard characteristics (e.g., likelihood, frequency, and magnitude) are not as strong a factor in risk perception as seen in technological hazards. Instead, factors such as personal experience (particularly direct experience), trust in authorities and experts (as mentioned before), and spatial association were more impactful on risk perceptions of natural hazards (Wachinger et al., 2013).

However, the influence of direct experience depends on the hazard, location, and direct impacts on the individual (Wachinger et al., 2013). Sullivan-Wiley and Gianotti (2017) found that residents in the Bududa and Manafwa districts of Uganda who had previously experienced landslides and flooding showed increased risk perception. Still, spatially homogeneous hazards, such as hailstorms and soil erosion, were not found to be influential. Therefore, different hazards yield different levels of experience and impact, indicating that the effect on risk perception varies.

Spatial proximity is another factor that can increase risk perception due to direct personal experience (Wachinger et al., 2013). O'Neill et al. (2016) found in Bray, Ireland, that the further away the residents were from the perceived flood zone, the lower their flood risk perception. The closer an individual is to the hazard impact area, the more likely they are to have had personal experience with severe impacts, which impacts (and likely increases) their risk perception. If residents are further away from the hazard, but still feel slight impacts, their risk perception may be lower. Indirect experience (education, media, or witnesses) also influences risk perception, but its impact is more significant on those with no previous direct hazard experience (Wachinger et al., 2013). Sullivan-Wiley and Gianotti (2017) saw that residents in Uganda who indirectly experienced landslides and floods through others in their village also had an increase in risk perception. Therefore, any personal experience gained from natural hazards, whether through direct or indirect means, will influence risk perception in some manner.

Demographic variables such as gender and age also influence risk perception (Bronfman et al., 2016; Cvetković et al., 2019; Sjöberg, 1998). Wachinger et al. (2013) found that gender yielded conflicting results in the literature, as some studies show gender is an influencing factor while others did not, which is an inconsistent pattern present in recent research. For example, Sjöberg (1998) had previously found in the Swedish population affected by Chernobyl; women reported much more worry than men, as well as those who were older for both genders. Bronfman et al. (2016) found that the female respondents in Chile showed a higher perception of risk than men in their multi-hazard study. Cvetković et al. (2019) found that female respondents in Turkey, Serbia, and Macedonia mentioned more fear intensity across all disaster types in comparison to males, even though the entire study population was college-educated (most aged 18-23 years) and in fields relating to natural hazards and emergency management. In contrast, Knuth et al. (2015) found that gender was not a significant factor in risk perception in a multi-hazard and emergency study in Germany that included natural and human-made hazards, concluding it may be due to their focus being on the likelihood of experiencing events rather than a focus on influential factors of risk perception. Sullivan-Wiley and Gianotti (2017) found in their multi-hazard study in

Uganda that gender was significant for only soil erosion, explaining that some people simply are more likely to perceive higher risks than others due to individual risk aversion rather than socio-economic reasons.

The degree to which socioeconomic factors or contextual factors (economic factors, vulnerability indices, homeownership, family status, area of living, etc.) influence risk perception depends on personal factors they are combined with, causing the strength of the effect to vary between studies (Wachinger et al., 2013). Further research is needed to isolate gender as an independent variable while taking into consideration that cultural differences may also cause results to vary (Lechowska, 2018).

2.2. Children and Adolescents in Natural Hazard Risk Perception Research

Most theory and research in the natural hazards risk perception literature centers on the demographics of adults. Children (and women) have only recently been recognized as a vulnerable demographic in vulnerability and resilience studies, and it is difficult to fully understand the magnitude and geographic extent due to a lack of consistent data (Cutter, 2017). Children and adolescents are a highly vulnerable group that tends to have neglected needs, hindered growth and development, and are more sensitive to separation during disaster events (Mitchell et al., 2008; Peek, 2008; Ronan et al., 2001). Peek (2008) found their exclusion from research and policy decision-making may be due to the assumption that disasters do not impact children as severely as adults.

Children and adolescents experience three types of vulnerability during a disaster event: psychological, physical, and educational (Cox et al., 2017; Peek, 2008). Children and adolescents typically have less control over their recovery behavior both during and after a disaster event because they depend on adults for decisions such as evacuation, safety, and protective actions (Fothergill & Peek, 2017). Their vulnerability increases their susceptibility to experiencing a range of social, psychological, physical, and health-related impacts, ultimately limiting their ability to recover quickly (Bearer, 1995; Fothergill & Peek, 2017; Peek, 2008). Children of all ages often have lowered adaptive capacity, as their lack of previous hazard experience reduces their ability to adapt to rapidly changing environments within a disaster context. Younger children (under the age of 5) often require additional guidance or assistance during hazard events because they lack the maturity to fully comprehend what is occurring, potentially leading to traumatization and other adverse psychological health impacts (Cutter et al., 2003; Morrow, 1999). Younger children are highly dependent on their parents/guardians or older siblings to help them through the hazard event. This dependency can cause both adults and older children in the family to have heightened vulnerability as they must react in a way that also allows them to care for the younger children as well as themselves. Therefore, both a child's age and hazards experience (or lack thereof) can influence and potentially impair the recovery process (Morrow, 1999; Cutter et al., 2003).

Natural disasters also impact normal functioning social relations for both adults and children; many of these adverse mental health effects are exacerbated by the loss of pre-existing social support, potentially leading to posttraumatic stress symptoms (Kanaisty & Norris, 1995; Lai et al., 2018). Existing social support for children and young adults can include their immediate family, relatives, neighborhood community, religious community, and school associates. Sources of social support may be temporarily cut-off as a result of a disaster event (Kanaisty & Norris, 1995; Lai et al., 2018).

Many of the characteristics that cause children to be more susceptible to disaster impacts, especially during the recovery process, are exacerbated by their inability to return to their everyday routine (Kanaisty & Norris, 1995; Peek, 2008). Routines include returning to an intact home and attending school, which are also relevant to young adults attending college. When children are relocated or their ability to return to child-safe places (e.g., playgrounds or schools) is affected, their vulnerability to adverse psychological, health, and social effects increases (Kanaisty & Norris, 1995). Such interruptions to their daily lives, especially when the duration of disruption lasts for a long time, can lead to children suffering emotional distress and other health impacts (Kanaisty & Norris, 1995; Peek, 2008).

Research into risk perception of natural hazards in adults is plentiful, but there is a dearth of research into children and adolescent natural hazard risk perception (Carone & Marincioni, 2019; Midtbust et al., 2018). By assessing what behaviors children would perform using a fictional flood story as a communicative instrument, Carone and Marincioni (2019) sought to forecast reactions before a flood event in their regional study of nine municipalities of Italy exposed to a flood hazard. Risk perceptions were measured based on whether the child chose the most or least dangerous behavior (swimming in the flood vs. reaching a high place) (feelings of fear could not be used due to the majority feeling scared or concerned). Carone and Marincioni (2019) found that the highest flood risk perceptions for children (6-14 years old) were in Senigallia, a coastal city, while the lowest flood risk perceptions were in Torino di Sangro municipality, a city on a hill. Children in Torino di Sangro had never experienced a flood emergency, nor had they heard about it from their parents, whereas Senigallia experienced a flood in 2014 that affected local schools (Carone & Marincioni, 2019). Carone and Marincioni (2019) theorize that the direct experience from the flood in Senigallia left an impression on the children, thus suggesting direct personal experience is also an influencing factor in risk perception in children, as it is with adults. However, younger children may not be able to distinguish specific protective actions from one another, as children in the region without the flood event had responded with an action for earthquakes, which occur more frequently and are practiced in their schools (Carone & Marincioni, 2019).

Trust and education were also shown as possible risk perception factors in teenagers' risk perception. Bosschaart et al. (2016) conducted a study on 15-year-olds in the Netherlands, where flooding education focuses on the cause of high-water flooding and protective efforts. They found the teenagers' trust in water safety and flood protection was high, and their risk perception of flooding low, even though their region was prone to flooding (Bosschaart et al., 2016). Bosschaart et al. (2016) created an educational program focused on the beliefs and attitudes surrounding flooding rather than the conventual knowledge and understanding of the existing curriculum. They found that the program helped increase their flood risk awareness and perception without affecting their trust in current protective systems (Bosschaart et al., 2016).

Finally, there exists an assumption that children do not contribute to research or policy, resulting in their exclusion from preparedness and response activities (Mitchell et al., 2008; Peek, 2008). Mitchell et al. (2008)'s examination of Hurricane Katrina response and recovery in local communities, however, found that children and adolescents contribute greatly to advocacy campaigns and risk awareness in their local environments. Adolescents and young adults (ages 16-26) of the Vietnamese community in New Orleans, Louisiana, were able to assist in evacuation and recovery as they were able to translate information from English sources to their non-English speaking family members in order to share locations of safe evacuation places, relief supplies and food distribution centers, and registration for FEMA assistance (Mitchell et al., 2008). During recovery, a Vietnamese youth group organized a protest and advocacy campaign to bring attention to plans by a private Waste Management company to locate a debris landfill in the middle of their neighborhood (Mitchell et al., 2008). Children and adolescents displayed the ability to bridge a gap between sources and households during and after a major disaster event.

Children can surpass barriers such as languages and trust to communicate risk to their families and communities from a formal authority such as schools (Webb & Ronan, 2014). For instance, parents in Zimbabwe reported they obtained risk information from their children (ages 8-18), and the children also helped their community by distributing disaster pamphlets and even chlorine tablets during a cholera outbreak (Fothergill, 2017). However, for children to provide any type of advocacy, they must first be exposed to natural hazards information, whether it is through informal brochures or formal education.

2.3. Natural Hazards Education and Impacts

Natural hazards education has been found by numerous studies to reduce disaster impacts at individual and community scales (Dunbar, 2007; Fothergill & Peek, 2017; Mitchell et al., 2008; Peek, 2008; Ronan et al., 2001). Hazards education programs provide knowledge and control during and after an event for dependents in families, specifically in the case of children, which include pre-adolescent and adolescents (Ronan et al., 2001). Ronan et al. (2001) explored the effect of no exposure versus previous exposure to hazards education had on children, ages 5-13, through surveys administered in the classroom of five different schools in Auckland, New Zealand. They found that the lack of education about a hazard or the inability to enact specific preparedness or recovery behaviors on their own can increase their susceptibility to experiencing psychological, physical, and educational impacts (Ronan et al., 2001). Hazard education programs provide children with more stable risk perceptions, reduced hazard-related fears, and much greater awareness of the most appropriate hazard-related protective behaviors compared to non-educated children (Ronan et al., 2001). In a similar study, Finnis et al. (2010) found that high school students (ages 13-18) in three different locations in the Taranaki Region of New Zealand who had participated in previous hazards education were more likely to choose correct protective behaviors and had more accurate risk perceptions of various natural and human-made hazards (except for flooding). However, the low numbers of students reporting having plans and participating in practices were unaffected by hazard education (Finnis et al., 2010).

A long-term study by Fothergill and Peek (2017) explored employing open-ended methods, such as youth focus groups or participatory interviews, using children and teens aged 3-18 who had been directly affected by Hurricane Katrina. They gathered or observed direct “material artifacts” such as drawings, songs, poems, and games, which expressed how individual children experienced and recovered from Hurricane Katrina. Fothergill and Peek (2017) demonstrated that children and teens process their emotional responses to hurricane Katrina in different creative ways (such as drawings, poems, and songs). However, cultural and social inequities and constraints still influence their ability to recover, as those characteristics affect their access to robust support systems. Cox et al. (2017), who examined factors of child recovery of respondents aged 13-22 from different hazards (wildfires, tornadoes, and floods) using youth workshops in three communities in Alberta, Canada, and one in Missouri, United States, had similar results that demonstrated that access to robust support systems that include key adults and youth-to-youth interactions are a critical part of successful youth disaster recovery.

2.4. Online Education Benefits

Thus far, educational programs in risk perception studies have been limited to paper and in-class materials instead of expanding to online platforms and programs. Online platforms allow easy access to information for the public and can provide more meaningful learning as students can select the information that is most relevant at the time and more easily organize and integrate it with their existing knowledge (Battersby et al., 2011). For example, Battersby et al. (2011) developed an online educational program about local natural hazards (South Carolina Atlas of Environmental Risks and Hazards) to address the need for a comprehensive source that can help improve public awareness. The benefits of an online platform versus a paper map or CD are that it can be easily distributed, maintained and updated, and can provide more multimedia and interactive abilities (Battersby et al., 2011). Dunbar (2007) found in their review of a National Oceanic and Atmospheric Association (NOAA) educational site, National Geophysical Data Center (NGDC), that exposure to convenient online educational resources results in increased public awareness of natural hazards and access to this information.

Online platforms are more easily accessible to the public, and the internet may be a powerful tool in shaping disaster knowledge and perceptions (Houston et al., 2015). Houston et al. (2015) advocate that mass-mediated disaster communication such as television, radio, and the internet may be quite powerful in influencing and shaping individual disaster knowledge, attitudes, and behaviors through indirect experience.

Online platforms may also provide a way to increase social capital and experiential learning while addressing interruptions or constraints during hazard events to accessing strong support systems in children and young adults. According to an Ofcom (2017) report on media use and attitudes, 3% of children between the ages of 5-7 have a social networking profile. In children between the ages of 8-11 years, that number increases to 23%. However, between the ages of 12-15, the average jumps to 74% (Ofcom, 2017). Adult-oriented social media platforms that children use varies from standard sites like Facebook to picture and video sharing apps like Instagram and Snapchat. Parents may or may not be aware of their child's usage of these platforms, as Ofcom's (2017) study showed only 38% of parents, whose children of the ages 5-15 used Facebook or Facebook Messenger, are aware that 13 years is the minimum age requirement for setting up a profile. This awareness drops with each newer app, such as with Instagram at 21%, Snapchat at 15%, and WhatsApp at 7% (Ofcom, 2017). The evolution of new communication technologies, such as social media, offers the possibility of faster and more accessible disaster communication and has captured the attention of disaster communicators (Houston et al., 2015). This larger use of new communication technologies has recently been exemplified, to some extent, in Houston during Hurricane Harvey (Epstein, 2017). News sources documented several residents using platforms such as Snapchat to identify locations of relief centers and people in need of rescuing (Epstein, 2017; Seetharaman & Wells 2017). However, current popular social media platforms do not provide an ideal platform for delivering educational content to children and adolescents in a safe environment. In addition, if online material such as the NGDC module is not actively utilized by teachers in class activities or assignments, children are unlikely to find and use this specialized hazard education material on their own.

2.5. Pilot Studies and Proxy Populations

Although conducting risk perception research on children would help address the current need for these types of studies, working with children is incredibly difficult when developing new educational content due to Human Subjects Research policies and requirements set forth by the recipients of the program. Difficulties working with minors in research include obtaining a large study population, following any additional requirements set forth by the governing body of the population (e.g., schools, church-lead youth groups, or private organizations), and participation of parents or guardians (e.g., obtaining signatures or providing help to their children during the study). However, using proxy populations for when obtaining the target population is problematic is a common practice in research (Lu & Franklin, 2018). As such, this study uses students in their early college years as the proxy population for high school students in their junior or senior year, as new college students (i.e., freshman or sophomores aged 18-19 years old) are in a similar place mentally and cognitively as their high school counterparts. Arnett (1994) conducted a study of 18-21-year-old college students that suggests that young college students do not fully consider themselves adults even though they are legally considered adults. This perception was found to be due to the general societal criteria that characterize an adult such as completing their education, entering the labor force, establishing their independent household and finances, of which the respondents in the age group between 18-25 (identified as "emerging adults") tend to feel they have not fully obtained yet (Arnett, 1994; Skulborstad & Hermann, 2016). Therefore, young college students are similar to high school seniors in which they may consider themselves no longer adolescents but not yet adults.

Furthermore, during the time between puberty and adulthood, the part of the brain responsible for self-control, risk judgment, emotions, and organization (frontal lobe) are still developing (Spano, 2003). The brain may not be totally mature in these areas until the early 20's (Spano, 2003; Steinberg, 2005). Adolescence has been considered to last into early adulthood, the span being from age 11-24 years old, supported by the general acceptance that the brain reaches full maturity around age 25 (Arain et al., 2013). Thus, young college students and senior high school students are cognitively similar in the context of risk perception in that the region of the brain responsible for judgment is still developing during late adolescent and young adult ages.

When developing educational content intended to be delivered to a stakeholder such as the Houston ISD, it is preferred that the material be tested for effectiveness before deployment. As such, pilot studies allow researchers to assess the efficacy and effectiveness of new curriculums on similar populations. Pilot studies can be very useful, especially if published, as they offer insight into methods and instruments of a planned study, such as collecting preliminary data, identifying any issues with instruments such as survey questions, assessing the feasibility of a survey, and even training the researcher in the research process (Van Teijlingen & Hundley, 2001). Conducting pilot studies in qualitative and social science research also ensures that appropriate cultural engagement is considered from a phenomenological perspective (Kim, 2011).

Based on these limitations, this research is a pilot study that develops and assesses the efficacy of a natural hazard education program for high school youth using college students as a proxy population.

3. METHODS AND DATA

This research is a pilot study that develops and assesses the impact of a natural hazard education curriculum for high-school youth on risk perceptions and awareness using college students at Texas A&M University in College Station, TX, as a proxy population.

3.1. Study Site and Population

The goal of the presented curriculum is to increase local hazard awareness levels, especially for students who have not received formal natural hazards education in K-12 schools. College Station, Texas, serves as the study site due to the large young student population (18-25 years old) at Texas A&M University, many of whom are Texas residents. This population was chosen for three reasons.

First, Texas high school students are not required to receive in-depth local natural hazards education as part of the state standardized curriculum (Texas Education Agency, 2010). When natural hazards are covered in the high-school-level curriculum, they are presented broadly with more emphasis assigned to geologic hazards (e.g., earthquakes or volcanoes) than climatological ones (e.g., floods) (Texas Education Agency, 2010). The depth of the topic also varies between schools. Teachers may choose to briefly introduce concepts to accomplish surface knowledge of a wide variety of concepts or deeply delve into chosen topics to accomplish mastery of one or a few concepts (which is shown to aid in success in college courses later on) (Schwartz et al., 2009). For these reasons, using students that are Texas residents addresses the rationale for testing the curriculum on students who are from the state but may have lowered local hazard awareness. College students also have the freedom to choose their courses and may elect not to take a course that would have otherwise introduced natural hazards and disaster impacts.

Second, the student population at Texas A&M is likely to have some previous experience with Hurricane Harvey, which hit the Texas coast in August 2017 and affected an estimated total of 59 counties in Texas (U.S. Census Bureau, 2017). It is expected that most of the student population was at least aware of or directly impacted by the disaster, and the depth of knowledge about the event as well as how influential it was on risk perception could be explored in this study.

Finally, due to the difficulty in working with children and implementing such a curriculum in a public-school setting without previous testing mentioned in the previous section, the study recruited college student participants as a proxy population for high school students from two introductory Geography courses at Texas A&M University, GEOG 305: Geography of Texas and GEOG 201: Introduction to Human Geography in the Spring 2019 semester. Both courses were selected for recruitment due to their tendency to have younger students in their freshman or sophomore years (Table 3.1), allowing for a study population with similar stages of learning cognition and brain development to high school-aged children. The courses were also used to test for differences in knowledge with populations whose existing curriculum includes topics on local natural hazards (GEOG 305) versus a control group the does not (GEOG 201). This methodology allowed for the exploration of the impact of in-course supplemental information versus just the participant’s breadth and depth of knowledge.

Table 3.1 Demographics of Undergraduates Spring 2019, Texas A&M University

Ethnicity	Male	Female	Total
White	15,203	13,510	28,713
Hispanic	5,866	5,681	11,457
Asian	2,227	1,578	3,805
Black	766	818	1,584
Multi-racial excluding Black	642	595	1,237
International	448	223	671
American Indian	60	39	99
Native Hawaiian	17	18	35
Unknown/Not Reported	48	31	79
Age			
<18	55	49	104
18-21	19,632	19,106	38,738
22-25	4,970	3,130	8,100
26-30	415	118	533
31-39	170	52	222
>39	35	38	73
Total	**25,277**	**22,493**	**47,770**

Data from: Data and Research Services (n.d.)

3.2. Program Content and Surveys

The educational content for the curriculum was compiled using a published textbook on natural hazards and credible online sources (e.g., government agency, university, non-profit, and educational sites) to support information and visual or interactive portions (images and videos). The program was also designed to simulate being given as a semester-long supplemental course since the long-term goal is to deliver the developed content to local high schools to integrate into their curriculum. The entire program consisted of a pre- and post-risk perception survey and five modules that cover various aspects of local natural hazards and disasters, such as physical geography, social vulnerability, and planning and mitigation.

3.2.1. Module Content Development

The curriculum was outlined to first introduce the students to basic concepts of hazards and Texas physical geography to establish the framework needed to reach the case study at the end. More complex and detailed information about natural hazards was then covered, such as the earth's natural processes that cause natural hazards, disaster impacts such as social vulnerability and resilience, and planning and mitigation for all hazards. These concepts were then combined and used to tell the story of Hurricane Harvey in a case study. An overall risk perception survey was administered before students engaged with any of the course module content to determine pre-program risk perceptions (Tables D.6-9). After the completion of the curriculum, a post-risk perception survey was conducted to identify any changes in risk perception and influential factors.

The topics and the order in which they were introduced were modeled after a college-level natural hazard and disaster textbook used in Geography courses at Texas A&M University (Hyndman & Hyndman, 2017). Typically, these textbooks begin by introducing basic concepts of hazards and some disaster impacts like vulnerability in the first chapter to establish the human-environment type of geography and relationship the book is analyzing. The remainder of the chapters then focus on climatological hazards or geologic hazards, each with details on physical geography and contributing earth systems, some planning and mitigation strategies, and a case study on a specific disaster or human impact. Since only five learning modules were planned, topics had to be combined; however, the five modules still follow this general order of organization to build a foundation of physical and human-environment geography concepts so that a case study can be fully examined and discussed.

Five learning modules examining natural hazards and disasters with a focus on Texas physical geography and a case study of Hurricane Harvey were developed, each with its student learning outcomes to assess module efficacy and student subject matter proficiency (Table A.1).

3.2.2. Learning Modules

Each module contained a pre- and post-test to assess how well the students achieved the learning outcomes and to investigate the efficacy of each module. Questions consisted of multiple-choice, true/false, and short essay formats and were scored based on correctness (Tables D.1-5). Half the question bank per module was used for pre-test, and the rest were used in combination on the post-test to simulate a full-length quiz while allowing for comparison. Each chapter contained one or two short activities that included reading articles, comparing maps, and playing games, then had the participants complete a discussion write-up post-activity. The modules together averaged an 11^{th} grade level on the Flesch-Kincaid grade level test, indicating the program is currently accessible to junior or senior high school students. The modules were organized in the following manner:

Module 1: Hazards. This introductory module started by defining and distinguishing human-made hazards from natural hazards. The module then introduced physical geography and defined the regions of Texas to establish a locational context for the remainder of the program. The module closed with how physical geography impacts which hazards occur in specific regions and not others.

Module 2: Natural Hazards of Texas. This module is divided into climatological/meteorological and geologic hazards to mimic how geography textbooks usually approach organizing these topics. Basic weather processes such as fronts are explained, then climatological and meteorological hazards are identified with accompanying short videos from the National Geographic site (severe storms, tornadoes, flooding, hurricanes, extreme heat, fire, and drought). Then, the earth's structure and physical processes are explained, such as the layers of the earth and plate tectonics. Immediately following is identifying geological hazards (earthquakes, volcanoes, sinkholes, and landslides). The module finishes with a discussion on natural hazards frequency and magnitude, such as tornadoes.

Module 3: Disasters. This module starts by distinguishing the definitions of hazard from risk, then discusses natural disasters with various historical examples from both Texas (flooding in 2017 and 2018) and globally (Hurricane Katrina's impact on New Orleans, the 1931 China floods, and the 2010 earthquake in Haiti). The module then defined and discussed topics of social impacts, such as vulnerability (social and physical) and resilience, closing with a discussion on adaptive capacity. Risk perception was not included in this module due to concerns with making students hyper-aware of the concept, thus potentially affecting their risk perception in ways that would be difficult to distinguish without also interfering with the program's post-risk perception survey.

Module 4: Planning and Mitigation. This module starts by defining planning and mitigation. For planning, general guidelines for how to start planning for various aspects such as how to handle planning with pets, children, and the elderly/disabled. For mitigation, structural and non-structural types of strategies were distinguished in a general manner. Then the remainder of the module is dedicated to planning, response, and mitigation strategies for multiple hazards and situations (wildfire, severe weather and storms, tornadoes, hurricanes, and flooding). Each hazard is supported with links to sites (such as ready.gov, The Red Cross, FEMA, the CDC, etc.) to encourage planning, and contain various topical stories from news sites and examples of what to do and not to do in each scenario. The module closes with a discussion on disaster impacts, specifically the psychological impacts on both adults and children, as well as linked resources for help.

Module 5: Hurricane Harvey: A Case Study. This module sought to tie all the concepts learned in previous chapters into a real-life example that most of the students could relate to Hurricane Harvey. The modules started by setting the scene of the event, such as how to storm first formed and the processes that encouraged its development. Then the module discusses how the storm stalled and how that contributed to the flooding and extent of the flooding damage and deaths. From there, how locals and government agencies responded was discussed, including many rescue efforts, and the status of recovery. The module closes with planning and mitigation strategy considerations for the Houston area.

3.2.3. Risk Perception Survey

The pre- and post-risk perception survey was developed by adapting the survey used in Ronan et al. (2001) to assess levels of awareness, risk perception, and preparedness of multiple hazards (flood, severe storm, wildfire, sinkhole, hurricane, tornado, volcano, and earthquake). Questions on previous experience, vulnerability, and coping capability specifically about hurricanes and their associated hazards were added. Both pre- and post-risk perception surveys consisted of the same three-to-five-point Likert scales and yes or no questions, and only the pre-risk perception survey contained demographics. The following list is an overview of each component of the survey:

1. *Demographics*. Age, gender, race, hometown location, and living situation (i.e., living with roommates, at home, or alone). Age was listed as ranges, such as 18-20 and 21-24.
2. *Risk perceptions.* Students were asked various questions consisting of aspects that contribute to risk perception:
    a. Previous Knowledge and Experience. Students were asked if and how they had previously learned about natural hazards, which hazards they had experienced in their lifetime, list any named hurricane they had experienced, and if their homes had been previously flooded.

   b. Hazard Risk. Students were asked to identify the three most likely hazards to affect them at home, identify the likelihood of each hazard directly affecting them in the future, and whether they think the risk of hurricanes over the past five years had increased or decreased.
   c. Fear. Students were asked whether thinking or talking about hazards scared them and which specific hazards scared or upset them the most.
3. *Vulnerability and Coping.* Students were asked questions on how vulnerable to direct hurricane impacts affecting them personally, their families, their possessions, and their home accessibility. Coping questions focused on if students felt capable of recovering psychically and psychologically from hurricanes and their associated hazards such as flood and wind damage.
4. *Planning.* Students were asked various questions regarding planning and preparatory actions, such as how motivated they were to learn about planning and mitigation practices, whether they had an emergency plan or had practiced what to do in the event of a hazard or disaster, where to shut off water and gas if needed and where to meet their families or loved ones in an emergency.

3.3. Online Platform and Curriculum Deployment

The program was deployed using two different online platforms: eCampus and KidGab. eCampus is the learning management system currently used by Texas A&M for in-person courses. The content was set up on the platform similarly to how an e-book would look, such as having a table of contents and only allowed content (a survey or reading) to become available once the student completed a task (consent or module pre-test) to encourage program completion in the correct order (Figure 3.1). Each module reading was formatted as a Portable Document Format (PDF) that was uploaded to the platform, and the surveys and activities were integrated using eCampus's internal quiz and assignment features.

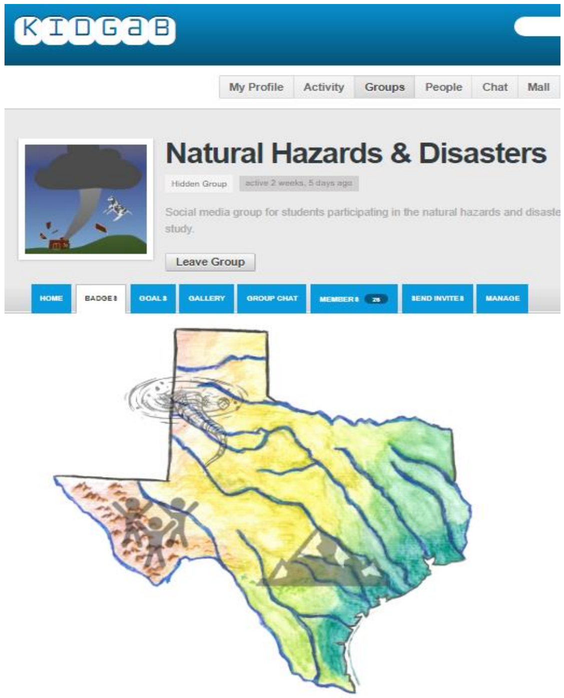
Figure 3.1 eCampus Program Layout

The online program was organized in the following format:

1. Information Sheet and Consent to participate
2. Pre-risk perception survey
3. Module# pre-test
4. Reading
5. Activity

6. Module# post-test (repeat through Module 5)
7. Post-risk perception survey
8. Feedback Survey

KidGab is a child-friendly social media site created by Dr. Stephanie Valentine and Dr. Tracy Hammond of Texas A&M's Sketch Recognition Lab. KidGab's original purpose was educational, as it sought to teach children about cyber-citizenry and cyberbullying, thus it established itself primarily as an educational platform with gamified components (Valentine & Hammond, 2016). Instead of an e-book format, users interact with graphical content (images) that link to the host site of the content (Qualtrics, an online survey software service) in an automatically opened new window in the browser (Figure 3.2). The content was uploaded into Qualtrics using its internal features, such as plain text boxes for reading and surveys for both surveys and activities (Figure 3.3). The content order was identical to eCampus. To complete modules, students had to click each image that represented a module and complete each piece of content in the Qualtrics web application window. When participants reach the end of the module (completed the post-test), the window closes, and the module is marked as complete, with the students earning a digital reward (badges, which were additional images). KidGab is a social media platform to allow for discussion amongst the members and the sharing of their answers and experiences. These features were not used in this experiment.

a) 

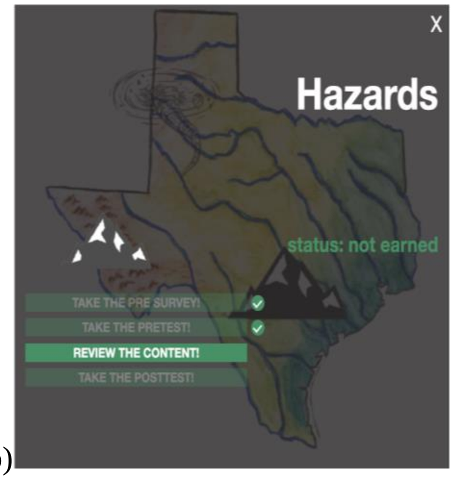
b) 

Figure 3.2 KidGab Program Layout (a) and KidGab Module Image Interaction (b)

Which are the three most likely hazards that could affect you at home?

- ☐ Flood
- ☐ Hurricane
- ☐ Severe storm
- ☐ Tornado
- ☐ Wildfire
- ☐ Volcano
- ☐ Sinkhole
- ☐ Earthquake

How well informed are you about the potential impacts of a natural hazard event (i.e. hurricane, tornado, wildfire, flooding)?

Uninformed	Not well informed	Neither informed nor uninformed	Well informed	Very well informed
○	○	○	○	○

Tornadoes: spinning columns of air that have reached the ground, usually as part of a larger severe storm system and are most common during the spring and summer. Most of north Texas lies in "Tornado Alley", a region within the Central U.S. where tornadoes are most common. "Tornado Alley" encompasses nearly all of the Central Plains states. Tornadoes occur there more often than anywhere else on Earth. This happens because of two geographic factors; topography and air masses (click here to see the formation of a tornado). Recall from the previous lesson that the topography for this region is generally flat, so the air can move quickly and relatively unobstructed by features such as mountains or hilly areas. This is also why you typically won't find tornadoes in cities. When warm and moist air masses (which have low pressure) come up from the Gulf and the cold and dry (which have high pressure) down from Canada, they meet in the "Tornado Alley" region and cause storms that can spawn tornadoes. However, tornadoes can occur anywhere outside of this specialized region and are very localized events.

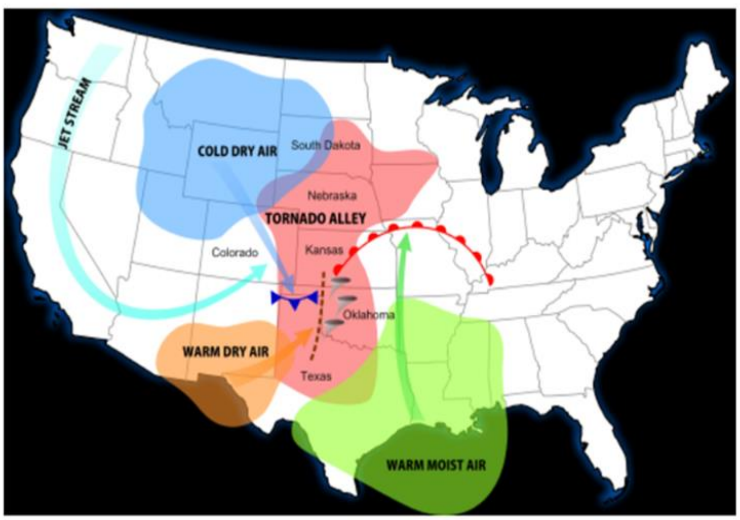


Figure 3: The components that contribute to Tornado Alley. Source: Dan Craggs

Figure 3.3 Qualtrics Module 2 Quiz and Content

For deployment in specific courses, eCampus was solely selected for GEOG 305, while GEOG 201 allowed for participants to choose between using either eCampus or

KidGab. Students using eCampus were able to access content immediately as soon as the study period began. In contrast, those who chose to use KidGab were delayed, as user accounts must be created individually by the research team, which required obtaining emails from the participants. Additionally, the user accounts had to be set up in such a way where the participants could not interfere with other non-participating users of the site (which consisted of minors) and vice-versa. Thus, the participants were isolated in a private group, required to keep all personally identifiable information off their profiles, and instructed not to engage with other users.

Once the study period was completed, responses were collected in batch downloads from eCampus and Qualtrics and organized into tables using Microsoft Excel for analysis.

3.4. Data Analysis Methods

3.4.1. Paired and Unpaired t-tests

To determine whether participants had knowledge gain or improvement in subject matter proficiency about natural hazards from the program, t-tests were used to compare pre- and post-module test scores to identify any significant changes in test scores. T-tests are a common statistical analysis used to compare the means of two groups to detect statistically significant ($p \leq .05$) differences. They are often used to determine whether a new program or method of learning is effective by comparing pre- and post-test scores or scores between a test group and control group (Çifçi, 2016; Falode et al., 2016; Filgona et al., 2017; Jo et al., 2016; Ramadhan et al., 2018). Paired sample t-tests were utilized to compare the pre- and post-test module scores of the total population, GEOG 201, and GEOG 305 to identify if there was an improvement in scores overall and per course, and to determine which modules were more or less effective. Paired t-tests were also performed for each module pre- and post-test question to identify any question with which students may have struggled. Welch's t-tests were used to compare module scores between the two courses to determine if supplemental natural hazards information in GEOG 305 would result in higher scores than GEOG 201. Scatterplots were also created using the pre- and post-module test scores to identify the direction of any trends.

Additional t-tests comparing module scores were performed between groups of gender (female and male), race (white and minority), and hometown location (coastal and non-coastal) to determine if demographics that appear significant in linear regression models and influencing factors in risk perception and module scores could be validated. Every variable except scores and age were coded as binary (0 or 1) for this analysis. Hometown location was defined as a region being near a coast and not a land-locked county.

T-tests were also used to analyze the pre- and post-risk perception survey results. Each Likert-scale question was tested with the entire population and the two courses to identify specific risk perception, vulnerability and coping, and planning questions that exhibited significant changes, indicating if the program had an influence on any of these particular aspects of overall risk perception.

All t-tests were performed using Microsoft Excel.

3.4.2. Linear Regression Modelling

To identify any factors significantly influencing risk perception, as well as how strongly or in which direction those factors are trending, multiple linear regression models were used. Linear regression models are used in many studies relating to identifying factors influencing the risk perception of various topics and hazards (Ardaya et al., 2017; Demuth et al., 2016; Huang et al., 2013; Osazuwa-Peters et al., 2017; Ronan & Johnston, 2001; Vyncke et al., 2017).

The regression models used three different types of dependent variables: 1) pre-risk perception scores, 2) post-risk perception scores, and 3) percentage change between pre- and post-risk perception scores. For the pre- and post- risk perception dependent variables, flooding and hurricane risk perception questions were combined using principal components analysis (PCA) and Cronbach's alpha test ($\alpha > 0.7$) (Table 3.3) to create a numerical score to represent hurricane and flooding-specific risk perception pre- or post-program (Huang et al., 2013; Ronan & Johnston, 2001).

Table 3.2 Cronbach's α of Hurricane and Flooding Risk Perception Questions

Questions	pre	post
How likely is it that you might be directly affected by a flood in the future?	0.85	0.82
How likely is it that you might be directly affected by a hurricane in the future?	0.86	0.81
How vulnerable do you feel in terms of hurricane impacts directly affecting the accessibility of your home or possible isolation from damage/debris?	0.84	0.79
How vulnerable do you feel in terms of hurricane impacts directly affecting you?	0.84	0.78
How vulnerable do you feel in terms of hurricane impacts directly affecting your family?	0.84	0.79
How vulnerable do you feel in terms of hurricane impacts directly affecting your property and/or possessions?	0.83	0.79
Does thinking or talking about any hazards scare or upset you?	0.87	0.83
In the past five years, do you feel the risk from hurricanes has:	0.86	0.83
How concerning are natural hazards to you?	0.86	0.81
Entire Set	0.87	0.82

Hurricane and flooding risk perception was chosen for several reasons: 1) to simplify the analysis, 2) adding other hazard questions when running PCAs and Cronbach's alpha tests resulted in $\alpha \leq 0.7$, which would be below the minimums expressed in other literature (Ronan & Johnston, 2001; Webb & Ronan, 2014), and 3) hurricane impacts and effects on hazard-specific risk perception and module score were of particular interest due to the population most likely having been affected by Hurricane Harvey. Independent variables included demographic characteristics, previous experience with hazards, and module subject matter proficiency.

Due to results indicating gender and specific modules were influencing factors in risk perception score, other regression models using gender and total module scores as dependent variables were completed. For the risk perception regression models, three different sets of measures for the independent variables were applied: 1) sociodemographic measures, 2) demographics and previous flooding or hurricane disaster experience, and 3) demographics, previous experience, and total and individual module scores. In the regression models where gender was the dependent variable and module scores as the dependent variable, the only set of measure tested was with demographics, previous experience, and risk perception or module score.

Additional t-tests were completed to compare flooding and hurricane risk perception scores for groups of gender (female and male), hazard experience (flooding and hurricanes), and the pre and post for the total population, GEOG 201, and GEOG 305. All PCAs, Cronbach's alpha tests, and regression models were performed using JMP from the SAS Institute.

4. RESULTS

4.1. Course Development and Analysis Sample

4.1.1. Course Deployment

Before the full program was deployed, Module 1 was pilot tested in GEOG 305 during Fall 2018 as a preliminary test of the content and module layout on eCampus. The preliminary test ran for two weeks during the middle of the semester. A total of 35 students participated in full completion (two did not complete the post-test). No demographic data were collected from this test. Contingency tables on the pre-and post-dataset showed improvement in subject matter proficiency and influence on risk perception with significant changes ($p \leq 0.05$) (Figures 4.1-4.3).

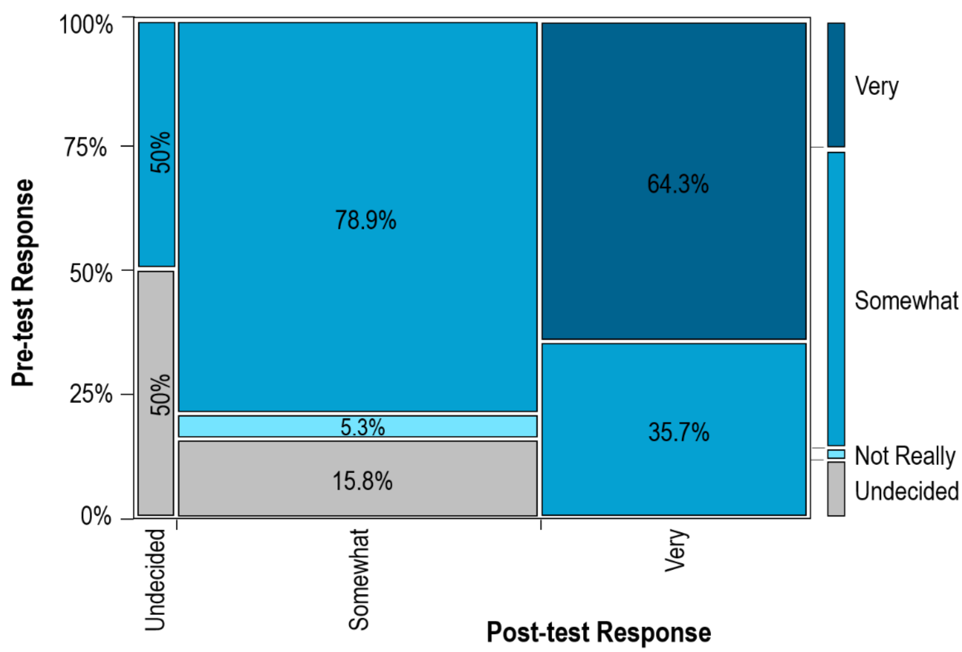


Figure 4.1 Changes in Pre- and Post-Risk Perceptions for Q1: How Concerning are Natural Hazards to You?

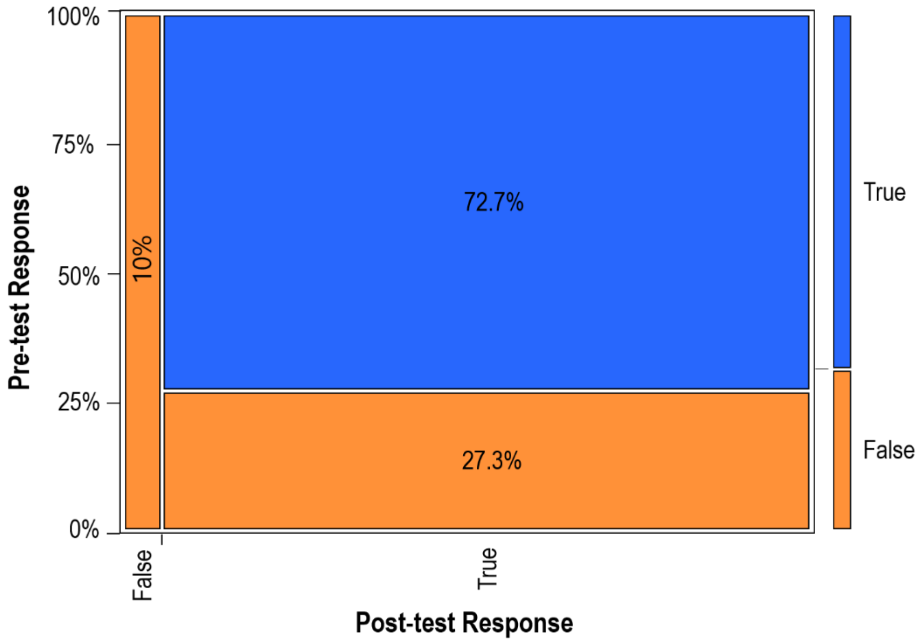


Figure 4.2 Changes in Pre- and Post-Risk Perceptions for Q2: At Least One Natural Hazard Exists Locally at Any Point and Time. (T/F)

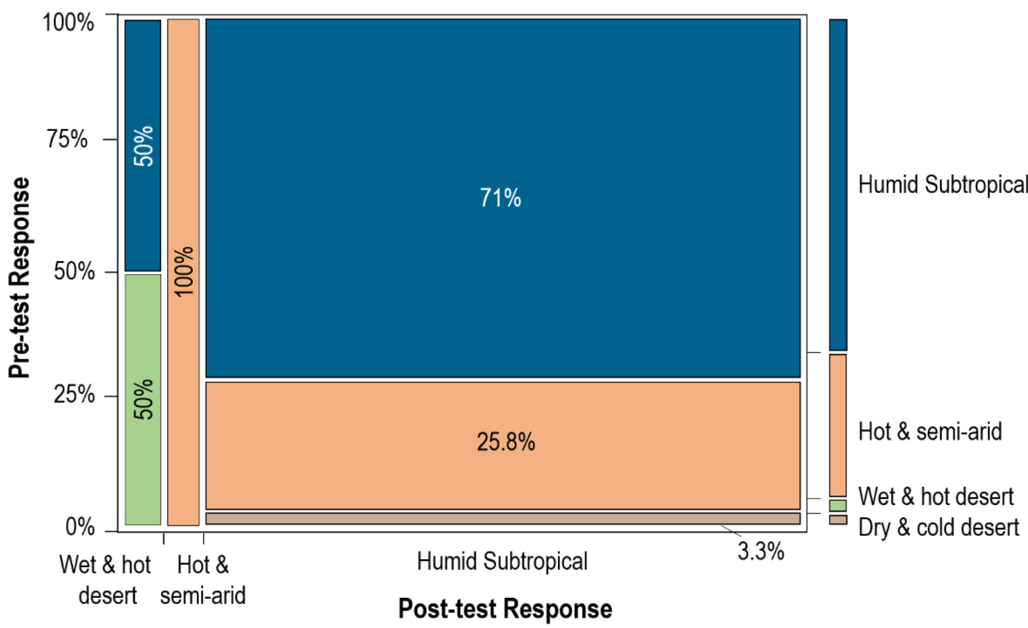


Figure 4.3 Changes in Pre- and Post-Risk Perceptions for Q3: What Type of Climate Exists around Texas A&M University in College Station, TX?

The feedback survey included after the module post-test conveyed mostly positive feedback, the participants remarked they would have liked more interactive and visual components as well as some non-repetitive questions. Once multimedia components and additional questions were added to each module's content, the modules were then organized on both the eCampus and KidGab platforms.

4.1.2. Sample Participants

For the Spring 2019 full launch, a total of 120 students participated in the curriculum, with 47 from GEOG 201 and 73 from GEOG 305. However, only a total of 77 fully completed the program with quality answers (GEOG 201 n=23 and GEOG 305 n= 54). Most participants fell between the ages of 18-20 (75%) and were White (66%) (Table 4.1). Most participants were native Texans (86%), 0.08% were from out-of-state, and 0.05% were international students. Of the native Texans, 39% were from the Southeastern region, 23% from Central, 23% from North, 12% from South, and 0.03% from West (Figure 4.4). When asked about their living situation, 71% stated they live with roommates, 21% live at home with family, and 0.05% live alone.

Table 4.1 Study Population Demographics

	GEOG 201		GEOG 305		Total	
Gender	#	%	#	%	#	%
Male	11	14.29	34	44.16	45	58.44
Female	12	15.58	20	25.97	32	41.56
Racial Groups						
White	9	11.69	42	54.55	51	66.23
Hispanic/Latino/Spanish	6	7.79	4	5.19	10	12.99
Asian or Asian American	5	6.49	0	0.00	5	6.49
White/Other	1	1.30	0	0.00	1	1.30
White and Hispanic/Latino/Spanish	0	0.00	4	5.19	4	5.19
White and Native American	0	0.00	2	2.60	2	2.60
Other	2	2.60	0	0.00	2	2.60
Did not answer	0	0.00	1	1.30	1	1.30
Total	23	29.87	54	70.13	77	100

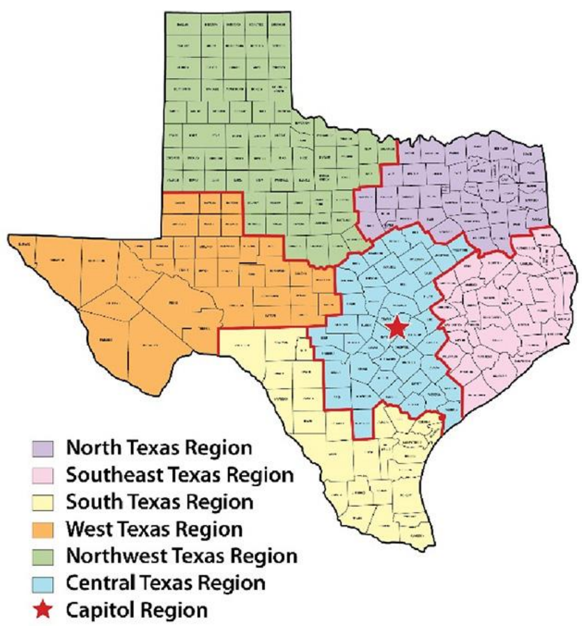


Figure 4.4 Regions of Texas, USA. Source: Texas Department of Public Safety, 2018

4.2. Paired and Welch's t-tests

4.2.1. Individual and Total Module Scores

The paired and Welch's t-tests of module scores show significant ($p \leq 0.05$) changes in overall subject matter proficiency. Individual module scores for the entire population (Table B.1) show significant changes in scores for Modules 1 and 3-5 (p=0.00). All module scores improved in the post-test, except for Module 2 (p=0.50), which showed an increase in proficiency but was not significant (Table B.1). Scatterplot graphs further support a general upward trend for each module across both courses (Figures A.1-6). However, when each course was tested, the GEOG 201 mean for the paired t-test shows a significant decrease from 6.48 to 5.96 in the post-test of Module 2 (p=0.03) (Table B.1). Module 2 was the only module and course t-test to show a decrease in module scores. When broken down into each scored question, most modules had at least four questions that showed significant changes; however, Module 4 showed the least amount of questions with significant changes (Table B.2).

The t-tests comparing scores between the two courses showed that participants in GEOG 305 had consistently higher total scores than those in GEOG 201 (Total Pre, p=0.00 and Total Post, p=0.02). The most significant change in scores between the two courses occurred in the pre-tests rather than the post-tests. The modules with significant differences between the two courses were Modules 1 and 5 (p=0.01 and p=0.00, respectively) in the pre-tests and Module 2 (p=0.00) in the post-tests (Table B.3). Overall, these results indicate that the program does mostly appear to improve subject matter proficiency, but there are portions where participants struggled in the pre-tests.

Gender also demonstrates significant changes in pre-and post-module tests for both individual and total scores. Individually, males and females experience significant increases in content proficiency scores (except Module 2) (Table B.4). When comparing female and male scores, females typically score less than males both in individual modules and total scores in the pre-tests (Table B.5). However, the gap in overall scores between genders closes in the total module post-score, with females having slightly higher scores, resulting in no significant difference. Females scored higher in the Module 3 pre- and post-test, but only the post-test shows significant differences (p=0.04). Males scored higher in Module 2; however, only the pre-test had a significant difference (p=0.04) (Table B.5).

4.2.2. Multi-Hazard Risk Perceptions (Likert Questions)

Paired t-tests show significant changes in various Likert-scale questions relating to risk perception, vulnerability, coping, and planning. When looking at the overall perceived fear of hazards, t-tests show that increases or decreases in rating depended on the type of hazard (higher Likert ratings = more scared) (Table B.6). Tornadoes, earthquakes, and volcanoes showed significant increases in fear from pre- to post-tests (p=0.03, p=0.02, and p=0.04, respectively). Interestingly, fewer participants listed hurricanes and wildfires in the post-test than in the pre-test, but the changes were not significant. When looking at the overall perceived likelihood of direct impact, each hazard demonstrated significant increases except for volcano hazards (p=0.11)(Table B.6). In addition, how informed the participants felt about the impacts of a natural hazard event in general increased significantly (p=0.00) (Table B.7).

When asked about feelings of vulnerability of themselves, their families, their property, and their accessibility to impacts from hurricanes, significant increases were observed (p=0.00, p=0.01, p=0.00, and p=0.00, respectively) (Table B.7). However, the perceived capability to recover in terms of property damage/loss, physical injury/loss, and psychologically also significantly increased (p=0.00, p=0.00, and p=0.01, respectively) (Table B.8). These results indicate that although participants felt more vulnerable to hurricane impacts post-program, they also felt they could better cope with those impacts. Furthermore, results show significant increases in planning knowledge and motivation (Table B.9). The number of participants that had an emergency plan for a natural hazard or disaster increased significantly (p=0.01). Results also show significant increases in participants who had practiced what to do in a natural hazard event (p=0.01) or knew where to meet their friends or family in the event of an emergency (p=0.02) increased in the post-test. Thus, participants felt more prepared for hurricane impacts after the program.

When looking at each course individually, GEOG 201 experienced significant increases in fear of tornado (p=0.00). GEOG 305 only saw a significant increase in fear of earthquakes (p=0.03). Participants in the course with additional hazards information do not demonstrate significantly lower ratings of fear. For their perception of likelihood of direct impact, GEOG 201 saw significant increases in severe storm (p=0.00), hurricane (p=0.00), tornado (p=0.00), wildfire(p=0.04), and earthquake (p=0.02). GEOG 305 saw significant increases in flood (p=0.00), severe storm (p=0.00), hurricane (p=0.00), tornado (p=0.00), wildfire(p=0.01), and sinkhole (p=0.00) (Table B.10).

Participants in both courses became more aware of the potential hazards that could directly impact them, regardless of which course they were enrolled. When comparing the two courses, fears for volcano show significant differences in the pre-test (p=0.03) and in the post-test (p=0.01). Tornado also saw a significant difference in the post-test (p=0.01). Students in GEOG 201 started and ended the program with much higher fears of volcanoes and tornadoes than those in GEOG 305, which may be a result of the additional hazard information provided as well as the difference in population size. No significant results were seen in the pre and post-test comparison for the perception of the likelihood of direct impact (Table B.11).

For feelings of vulnerability for themselves, their families, their property, and their accessibility to impacts from hurricanes, both courses saw an increase in all four questions; however, only GEOG 305 showed significant increases in each (p=0.01, p=0.01, p=0.00, and p=0.01, respectively) (Table B.12). Furthermore, GEOG 305 experienced a significant increase in general hazard concern (p=0.01) (Table B.12), though the comparison shows GEOG 305 had lower concern than GEOG 201 in both the pre and post-test, with the pre-test being significant (p=0.02) (Table B.13). Additionally, GEOG 201 had significantly higher fear or upset when talking or thinking about a hazard in the pre-test than GEOG 305; however, GEOG 305 ended the program with a higher fear score (not significant). The additional information supplied in GEOG 305 may have had an impact on vulnerability and fears by increasing awareness, but it also caused less concern than GEOG 201.

For coping capability in terms of property damage/loss, physical injury/loss, and psychologically, GEOG 201 showed significant increases (p=0.00, p=0.00, and p=0.01, respectively). GEOG 305 only showed an increase in coping in terms of property damage/loss (p=0.00) (Table B.14). When comparing the courses together, GEOG 305 had started the program with a significantly higher coping capability to injury/loss of life (p=0.00), and started and ended with a higher capability of recovering psychologically (Pre-test, p=0.00 and Post-test, p=0.03) (Table B.15). Although GEOG 201 by itself showed significant gains in coping, GEOG 305 still had higher scores resulting from exposure to additional information given in class. For planning, the courses varied in which aspect was more significant. For GEOG 201, participants showed increased responses for having a plan (p=0.00), practicing what to do (p=0.04), where to find family/loved ones (p=0.04), and general motivation to learn (p=0.00). GEOG 305 experienced an increase in having a plan (p=0.00) and whether they knew specifically where to turn off utilities (p=0.00) (Table B.16). No significant differences were found between the two courses (Table B.17). These results indicate that participants in each course did experience improvements in planning, but GEOG 201 participants may have been more impacted by the program than GEOG 305.

4.2.3. Hurricane and Flood Risk Perception Score

The t-tests show that risk perception scores in both courses and overall significantly increased in the post-test (Table B.18), indicating that the program had a significant influence on risk perception of hurricanes and flooding.

The t-tests also demonstrate that previous experience does significantly impact risk perception. Participants whose hometown was in coastal regions had higher pre-risk perception scores (p=0.00), though most participants were from coastal regions (n=53). Participants with previous experience with flooding in general or whose houses had previously flooded also had higher pre-risk perception scores (p=0.00 and p=0.02, respectively). Participants who experienced Hurricane Harvey (p=0.00) had higher pre-risk perception scores than those who had not. Similarly, those who had experienced any named hurricane before Hurricane Harvey had higher pre-risk perception scores than those who either experienced Harvey or no major hurricane (p=0.04) (Table B.19). For post-risk perception scores, previous experience with flooding (p= 001), Hurricane Harvey (p=0.01), and lived in a coastal region (p=0.00) had higher scores than those who had not (Table B.20).

Gender also influences pre- and post-risk perceptions. Although both genders demonstrated increased in fear when thinking or talking about hazards and how well-informed they felt about hazards in the post-test, how well informed they felt had significant changes (p=0.00 for both male and female) (Table B.21). The t-tests show that females start and end the program feeling more scared or upset when talking or thinking about hazards compared to males (Pre, p=0.01 and Post, p=0.00), whereas males start and end the program feeling they are more knowledgeable about natural hazards than females (Pre, p=0.01 and Post, p=0.04) (Table B.22). In addition, all genders did experience increases in risk perception score post-program (females, p=0.02 and males, p=0.00) (Table B.23). Following the same trend as fear and upset, females started and ended the program with higher risk perception scores (Pre, p=0.00 and Post, p=0.01) compared to males (Table B.24). Therefore, females experienced more fear and higher risk perceptions while males felt more knowledgeable (and scored higher in the pre-tests, as mentioned earlier with Table B.5).

4.3. Regression Models

The multiple linear regression models were used to explore what factors were influencing dependent variables such as hurricane and flooding risk perception scores, module scores, and gender. Each model was run with a different previous hazard experience (Harvey, Any Named Hurricane excluding Harvey, All Hazards, Hurricane, and Flooding), thus why each dependent variable was organized into groups of pre risk perception, post-risk perception, and percentage changes.

4.3.1. Total and Individual Module Score Regression

The Total Module Pre-Test Score group of models indicate that race was a significant influencing factor on pre-test scores in the Harvey (p= 0.04), Hurricane (p=0.04), and Flood (p=0.02) models, with all parameter estimates leaning towards White (Table C.1). In the Total Module Post-Test Score group of models, only race was a significant factor in the Harvey (p= 0.4), Any Named Hurricane (p=0.4), Hurricane (p=0.4), and Flood (p=0.3) models with parameter estimates leaning towards White (Table C.2). The regression results suggest that most participants were White (66.23%), possibly resulting in its presence as an influencing factor. The Total Module Pre-Test Score group of models also indicate that previous hazard experience influences pre-test scores in the All Hazards (p=0.05) and Hurricane (p=0.05) models (Table C.1). All significant previous hazard experiences show positive parameters, indicating that previous experience influences on how knowledgeable a participant was on natural hazards before starting the program, and continued to have an influence throughout the program.

When looking at each individual module's pre-test models, the Module 1 Pre-Test Score model group, race was consistently an influencing factor on the score per each hazard experience model, following the same parameter estimate trend found in the total models (which continues throughout all model groups). This model group also indicated that previous hazard experience was an influence in the All Hazards (p=0.05) model (Table C.3). Module 2's pre-test models consistently yielded no significant results. The Module 3 Pre-Test Score model group also showed race was an influencing factor per each hazard experience model. This group also indicated that previous hazard experience was an influence in the Any Named Hurricane (p=0.03) model (Table C.4). In the Module 4 Pre-Test Score model group, whether the participant's hometown location became significant with a negative parameter estimate with every hazard experience model (Table C.5) demonstrating that participants whose hometown was not near a coast, which were also considered a low risk for hurricane impacts, tended to score higher in this particular module (multi-hazard planning and mitigation). In the Module 5 Pre-Test Score model group, only previous experience with All Hazards (p=0.03) and Flood (p=0.02) had significant influences on scores (Table C.6). All significant previous hazard experiences show positive parameters, indicating that previous experience influenced the participants' scores in some modules.

When looking at the post-test models for individual modules, both Modules 1 and 4 yielded no significant results. In the Module 2 Post-Test Score model, race was an influencing factor for each hazard experience model (Table C.7). The Module 3 Post-Test Score model indicated that gender was a significant influence for each hazard experience and had positive parameter estimates, suggesting that females had higher Module 3 post-test score than males (Table C.8). This result is supported by those found in previous t-tests where males scored higher overall, but females appear to be more heavily influenced by this particular module (Tables B.4-5). The Module 5 Post-Test Score model indicated previous hazard experience was an influence in Any Named Hurricane (p=0.05), All Hazards (p=0.02), and Flood (p=0.05) (Table C.9).

When the percentage change in module score measure was used as the dependent variable, Modules 1, 2, and 5 yielded no significant results. In the Module 3 Score Percentage Change model, previous hazard experience with Any Named Hurricane (p=0.04) was shown to have influence, specifically with a negative parameter estimate (Table C.10). For the Module 4 Score in Difference Percent model, only hometown location with a positive parameter estimate was of significant influence (p= 0.04); previous experience with Any Named Hurricane was no longer significant (Table C.11).

4.3.2. Risk Perception of Hurricanes and Flooding Regression

The risk perception regression models applied three different sets of measures for the independent variables were applied: 1) sociodemographic measures, 2) previous flooding or hurricane disaster experience, and 3) total and individual module scores. Although indirect hazard experience, such as previous hazards education, has been shown to impact risk perception (Sullivan-Wiley & Gianotti, 2017; Wachinger et al., 2013), previous education was disregarded as an independent variable in these regression models due to lack of significant influence in early regression models and a t-test showing those who had not had previous education scored higher than those who had in the pre-tests.

For the first set of measures, only sociodemographic variables were used as independent variables. Both pre- and post-risk perception regression model groups indicated that gender (Pre, p=0.00 and Post, p=0.03) and hometown location (Pre, p=0.00 and Post, p=0.03) were significant influencing factors (Tables C.12 and C.13, respectively). Both factors had positive parameter estimates, indicating that females and those whose hometowns are in coastal regions were associated with higher pre- and post-risk perception scores. Gender and hometown influences, specifically in favor of females or those from coastal areas reporting higher risk perception scores, is supported by previous t-tests results (Tables B.23-24).

In the second modeling phase, previous hazard experiences with Harvey, Any Named Hurricane, All Hazards, Hurricane, and Flood were added as independent variables. The pre-risk perception model group showed gender remained an influencing factor with positive parameter estimates regardless of which hazard experience was tested. Additionally, coastal hometown location with positive parameter estimates remained significant when combined with Harvey (p= 0.03), Any Named Hurricane (p=0.02), All Hazards (p=0.01), and Hurricane (p=0.04) as previous hazard experiences variables. Previous experience with Harvey (p=0.01), Any Named Hurricane (p=0.02), All Hazards (p=0.01), and Flood (p=0.00) also presented as significant factors in each of their respective models, all with positive parameter estimates (Table C.14).

In the post-risk perception model group, the gender trend remained consistently significant in each hazard experience model. Previous experience with Harvey (p= 0.04), All Hazards (p=0.00), Hurricane (p=0.03), and Flood (p=0.01) also remained significant factors (Table C.15). These results are comparable to the pre-tests, where females and those with previous hazards experience exhibit higher risk perceptions.

In the third phase, total and individual module scores were added along with demographics and previous hazard experience variables. Gender remained a significant factor throughout for both the pre- and post-risk perception model groups, indicating females had higher pre-and post-risk perception than males at the start and end of the program (Tables C.16 and C.17). In the pre-risk perception group, coastal hometown location was significant with the Harvey (p= 0.04), Any Named Hurricane (p=0.02), All Hazards (p=0.01), and Hurricane (p=0.05) previous experience models (Table C.16). Previous hazard experience with Harvey (p= 0.01), Any Named Hurricane (p=0.02), All Hazards (p=0.01), and Flood (p=0.00) also became significant (Table C.16). In the post-risk perception group, gender remained significant for all models. Coastal hometown location was only significant with the Any Named Hurricane (p=0.05) and All Hazards (p=0.05) previous experience models, and Harvey (p= 0.04), All Hazards (p=0.01), Hurricane (p=0.02), and Flood (p=0.01) were significant in their respective models (Table C.17).

For the individual score models, gender remained a significant factor throughout both the pre- and post-risk perception groups (Tables C.18 and C.19). In the pre-risk perception model group, coastal hometown location was significant for all models regardless of the previous hazard experience tested. Harvey (p= 0.02), Any Named Hurricane (p=0.03), All Hazards (p=0.05), and Flood (p=0.00) were significant in their respective models (Table C.18). In the post-risk perception model group, coastal hometown location was significant for the Harvey (p= 0.03), Any Named Hurricane (p=0.01), All Hazards (p=0.02), and Flood (p=0.02) previous experience models. Only All Hazards (p=0.0) and Hurricane (p=0.0) previous experiences were significant in their respective models. Additionally, Module 4 became significant in the Harvey (p= 0.02), Any Named Hurricane (p=0.03), and Hurricane (p=0.03) models (Table C.19).

The total and individual model results illustrate that gender, previous hazard experience, and exposure heavily influence risk perception of hurricanes and flooding. Furthermore, females maintain higher risk perceptions than males in both the pre- and post- risk perception surveys. Module 4 became a significant factor in the post-risk perception score, indicating that those who scored higher on the module post-test also had higher risk perception scores.

For the Percentage Change of Risk Perception score models, the total score percentage change variable indicated that those who experienced a higher percentage change in their total module scores also experienced a higher percentage change in their risk perception score, regardless of hazard experience (Table C.20). The individual percentage change model only indicated that those who did not experience Any Named

Hurricane (p=0.03) (or those who either experienced Hurricane Harvey or no hurricanes) reported higher percentage changes in risk perception (Table C.21). These results suggest that those who improved their module scores throughout the program also ended reported increased hurricane and flooding risk perceptions.

4.3.3. Gender Regression

After finding that gender was a significant influence in determining risk perception scores in both the t-tests and most of the previously discussed regression models, gender was used as a dependent variable to validate the models. The remaining demographics, hazard experiences, module scores, and risk perception scores served as the independent variables. In both the pre-test and post-test model groups, risk perception was significant regardless of the previous hazard experience (Tables C.22 and C.23). For the post-test model, only those with no previous experience with All Hazards (p=0.00) (Table C.22) were identified as having significant influence.

Furthermore, in the models with the individual module test scores, risk perception was present as an influencing factor in each of the pre-test models, but not at all in the post-test models (Tables C.24 and C.25). In the post-test models, Any Named Hurricane (p=0.04) and All Hazards (p=0.01) experienced became significant, with All Hazards showing negative parameter estimates. Additionally, Module 4 became significant in the Harvey (p= 0.0), Any Named Hurricane (p=0.0), Hurricane (p=0.0), and Flood (p=0.0) hazard experience models (Table C.25). These results support that gender and risk perception score are related, in that females experience higher risk perception scores, even when males also experienced an increase.

To further explore how gender influences risk perception, two Likert-scale questions were used as dependent variables in a simple linear regression, “How well informed are you about the potential impacts of a natural hazard event (e.g., hurricane, tornado, wildfire, flooding)?” and “Does thinking or talking about any hazards scare or upset you?” (Tables C.26 and C.27). Reflecting previous t-tests (Table B.22), the regression models show that males start the program feeling significantly more knowledgeable about natural hazards than females (p=0.02) and continue feeling more knowledgeable about hazards than women in the program post-test (p=0.05) (Table C.26). In contrast, females reported in the pre- and post-test feeling significantly more scared when they think or talk about natural hazards than males (Pre and Post both p=0.01) (Tables C.27).

4.4. Feedback Surveys

At the end of the program, participants were asked to fill out a feedback survey with six questions pertaining to the program. When asked if they felt they had learned valuable information, 95% of participants responded yes, and 5% responded no (all of whom were in GEOG 305). When asked if there was any specific information in the program that surprised them or stood out to them, 31% of participants responded to learning new information about Hurricane Harvey in some way, such as the extent of damage, extent of impacts, and various statistics. This result is interesting, given 45% of participants had personal experience with Hurricane Harvey. Otherwise, participants mentioned they enjoyed the interactivity and information the program provided but did not like how lengthy some portions were, some activities, and how repetitive some information got across modules.

5. DISCUSSION

The online local natural hazard program created was shown to be able to improve students' subject matter proficiency and hazard awareness, as well as having an influence on risk perception.

5.1. Total and Individual Module Scores

The statistical analysis results indicate that the online hazards curriculum significantly improved subject matter proficiency and hazard awareness overall. Our findings are consistent with those in Ronan et al. (2001) and Finnis et al. (2010), where participants gained more hazard awareness and knowledge post-curriculum. However, our analyses also revealed that not all the modules were entirely effective. In particular, the first two modules showed that students struggled with the content and did not perform well on some of the questions. Module 1 had the most questions in which the average score significantly decreased, whereas decreases in Module 2 scores were not significant (Table B.2). These findings may indicate either issues with grading open-ended questions or the module questions themselves.

Participants in GEOG 201 had lower scores than GEOG 305 for Module 2 (how hazards are formed) (Table B.3), which may be due to GEOG 201 serving as a control group since their curriculum does not explicitly address natural hazards. In contrast, GEOG 305 delves into the physical geography of Texas and includes natural hazards, providing more in-depth concepts than the module itself. GEOG 305 did not experience a significant change in scores in the post-test for Module 2 (Table B.1), suggesting they already knew much of the content in the pre-test. GEOG 305 also started and ended the program with higher scores. The relationship between the courses and module scores suggests that the addition of topics covered in-class may have a positive influence on scores. Overall, the program significantly increased subject matter proficiency in both courses, as evidenced by the overall increase in scores and upward trends from the scatterplots.

As evidenced by the statistical analyses and feedback surveys, the online program also significantly raised awareness about Hurricane Harvey and the extent of its impacts. Not only did the entire population's average score increase for Module 5 (Table B.1), but participants singled out the topic of Hurricane Harvey as something that surprised them or interested them the most in feedback surveys. Our findings suggest that while participants may have been directly or indirectly impacted by Hurricane Harvey, they might not have previously considered one of three things: 1) that they themselves to have been directly impacted, 2) they did not truly realize the extent of the damage if their home was not severely impacted, or 3) they had simply not been interested in exploring the event further post-disaster. As such, an online natural hazards curriculum can provide context to disaster events that individuals may not fully comprehend at a personal level.

The statistical analyses also revealed that demographics and hazard experience influence total program and individual module scores. For example, race was significantly negatively associated with individual pre- and post-modules scores, meaning Whites tended to score higher on both overall and individual module tests

(Tables C.1-11). However, 66% of the study population are White (Table 4.1); the lack of diversity in the study population may bias results toward white students, meaning inferences about differences in race could not be made.

Previous experience with hazards also significantly influences both pre- and post-test scores. Experience with any hurricane, flood, or any other general hazard influenced both total and individual module pre-test scores (Tables C.1 and C.3-6), indicating that experience does increase pre-curriculum hazards knowledge. In the overall total score regression models, hazard experience appeared more in the pre-test score than the post-tests. This relationship is more pronounced in Module 5, where both pre and post scores indicated hazard experience as influential in the individual module regression models (Tables C.6 and C.9). This finding suggests that previous personal experience with natural hazards not only influences risk perception, as stated in previous literature (O'Neill et al., 2016; Sullivan-Wiley & Gianotti, 2017; Wachinger et al., 2013), but also hazards subject matter proficiency. Participants with personal hazards experience may be more likely to have higher than baseline knowledge, allowing them to score higher than those with no personal experience with certain hazards (Carone & Marincioni, 2019). Those who had previous experience with flooding and hazards, in general, were reported to earn higher scores in Module 5's pre-test (Table C.6). Those who had experiences with a hurricane, flooding, and general hazards also scored higher in Module 5's post-test (Table C.9), indicating the material may also have resonated more strongly for those with previous experiences.

Regarding hometown location, the Module 4 regression model showed those who did not live in a coastal region scored higher in the pre-tests (Table C.5). Although initially confounding, these results may occur due to those not living in a coastal region having broader experience with planning and mitigation due to exposure to a variety of hazards, such as tornadoes, wildfires, and earthquakes. Thus, previous experience potentially impacts subject matter proficiency.

Gender is also an influencing factor in pre- and post- individual and total module scores. Males and females both experienced significant changes in total and individual module scores. However, males tended to score higher overall than females in the pre-tests, and the females tended to score higher in Module 1 and 3 in the post-test (Table B.4-5). This finding suggests that females come into the program with less knowledge than males, but this gap closes at the end of the program with females obtaining a slightly higher average score in the total program score with was particularly influenced by how well females performed on Module 3. The statistical analyses also suggest that females particularly resonated with Module 3's content, as Module 3 covered more social and emotional topics such as disaster impacts and case studies, social vulnerability, and capability. These results are reflected in previous literature with similar outcomes, which found that females may be more sensitive to fears, concerns, and feelings of vulnerability than males (Bronfman et al., 2016; Cvetković et al., 2019; Sjöberg, 1998; Wachinger et al., 2013). Although these results are not present in other module score regression models, this pattern does persist in the risk perception regression models and is discussed further in the next section.

5.2. Risk Perception of Hurricanes and Flooding

In addition to improved subject matter proficiency, the curriculum also resulted in increased hazard awareness and influenced overall hurricanes and flooding risk perception. It is important to discuss influencing factors on risk perception before the introduction of the program, before discussing the curriculum's overall influence on changes in risk perception.

The pre-risk perception statistical analyses demonstrate that participants from coastal areas, with previous hazards experience, and who are female had consistently higher pre-curriculum risk perception scores. Those with previous personal experience with hazards, especially flooding and hurricane-related hazards, resulted in higher risk perception scores than those who have had no direct experience or had previous indirect experience through previous education on natural hazards (Tables B.19, C.14, C.16, and C.18). These results reflect other literature that suggests direct experience with hazards has exceptionally higher impacts on risk perception than knowledge gained in the classroom or from media such as television as the events experienced in person leave more of an impression (O'Neill et al., 2016; Sullivan-Wiley & Gianotti, 2017; Wachinger et al., 2013).

Similarly, originally being from coastal areas also results in higher pre-risk perception scores (Tables 15 and 16), which reflects previous literature, as closer proximity to the coast (and consequently regions more prone to flooding and hurricanes) typically results in more exposure to flood and hurricane hazards (Fuchs et al., 2015; Luke et al., 2016). The greater the exposure to such hazards, the more likely it is that participants have experienced similar hazards in their lifetime (Bukvic et al., 2018; Koks et al., 2015). As such, our results are expected as the majority of the study population reported prior experience with Hurricane Harvey (45%) or other previously named hurricanes like Rita or Ike (30%) and the majority of participants' hometown was located in the Southeast region of Texas (39%). Living in or near a coastal region results in higher exposure to hurricane and flooding related hazards, thus imparting previous experience and an increased risk perception, which is also validated by previous t-tests (Tables B.19-20) and supported by literature (O'Neill et al., 2016; Sullivan-Wiley & Gianotti, 2017; Wachinger et al., 2013).

As seen in previous studies, gender also influences pre-curriculum risk perceptions, specifically that females experienced higher pre-risk perception scores than males (Tables B.25, C.14, C.16, C.18, and C.22) (Bronfman et al., 2016; Cvetković et al., 2019; Sjöberg, 1998). Our findings suggest that females were more fearful or concerned when thinking or talking about natural hazards more than males in the pre-tests, and females started with higher pre-risk perception scores than males (Tables B.22, B.24, and C.27). Furthermore, males in the pre-tests reported feeling more well-informed on natural hazards than females, and males obtained higher scores overall in the pre-tests (Tables B.22 and C.26). Therefore, females come into the program more scared and concerned yet less knowledgeable than males. These results could occur as a result of social vulnerability differences in men and women, as research suggests that because females are considered a socially vulnerable population, they, in turn, feel more vulnerable and scared of hazards and disasters than males (Ashraf & Azad, 2015; Cutter, 2017; Moreno & Shaw, 2018). Thus, stronger feelings of vulnerability can lead to heightened pre-risk perceptions, particularly in females.

Overall, the completion of the curriculum resulted in increased risk perceptions, as evidenced by the percent difference in risk perceptions models (Table C.20), where greater changes in overall total curriculum scores resulted in a greater change in overall risk perceptions. Post-risk perception scores increased for the entire population in both courses (Table B.18), and demographics and previous experience remained significant factors (Tables B.20, C.13, C.15, C.17, C.19). As expected, direct previous experiences with a hurricane (56% named hurricanes) and flood hazards (60%), coupled with most participants living in a hurricane and flooding-prone region of Texas (74%), were influential factors. In contrast to our expectations, Module 4 post-test scores were a significant positive factor for the hurricane-specific risk perception score models (Harvey, Any Named Hurricane, and Hurricane experience in general) (Table C.19), especially considering the module's content covers multiple hazards and is focused on planning and mitigation.

The statistical analyses also reveal that both multi-hazard hazard fear and general risk perceptions were impacted post-curriculum. Our results suggest that the curriculum may have an impact on specific hazard fears and awareness. Interestingly, fear of tornadoes, earthquakes, and volcanoes increased significantly in the post-tests (Table B.6). Furthermore, those in GEOG 201 were more scared of the tornadoes and volcanoes, while GEOG 305 was more scared of earthquakes (Table 15 and 16). Tornadoes were certainly discussed in length in Module 2, where "Tornado Alley" (a region of frequent tornado occurrences spanning from Texas up through the central part of the U.S.) was explained in detail. Additionally, tornado-related safety guidelines were also discussed in length (e.g., do not shelter under a bridge or underpass). Earthquakes were also explained to occur from time to time in Texas. Therefore, it is understandable for fears of tornadoes and earthquakes to have increased if participants were learning this information for the first time in-detail through the curriculum. However, volcanos were only vaguely mentioned since volcanic activity in Texas is long extinct (Saribudak, 2016). Hurricanes and wildfires, in contrast, saw a decrease in fear rating in the post-tests, though the changes were not significant (Tables B.6 and B.10-11).

The results also indicate that respondents experienced a significant increase in the rating likelihood of direct impact for all hazards in the post-test, though volcano did not see a significant change (Table B.6 and B.10). These results suggest that participants may have become more aware of the variety of hazards they could potentially encounter in Texas, but it does not mean they are necessarily more frightened of them. These findings are similar to Finnis et al. (2010), where they found that hazard education had influenced some of their participants' hazard awareness and risk perceptions for some hazards, such as volcanoes and windstorms (both chosen as more likely by hazard-educated students).

The statistical analyses also demonstrated that gender influences changes in risk perception after completing the online curriculum. Both females and males showed an increase in risk perception scores overall, although females ended the program with higher risk perception scores than males (Tables C.22-24). Both women and men demonstrated increased feelings of being well-informed about natural hazards, which is also supported by the gap in scores closing in the post-tests, but women still reported significantly higher fear or upset when thinking or talking about natural hazards (Tables B.21-22). These findings are supported by other research examining risk perception with factors of gender, where the "risk-as-a feeling hypothesis" is used to partially explain why females have higher risk perceptions than males and why risks or fears may "feel" more intense (Kung & Chen, 2012). The risk-as-a-feeling hypothesis proposed by Loewenstein et al. (2001) states that people react to risk in two ways: cognitively (based on probabilities and outcomes) and emotionally (based on vivid imagery and proximity in time). Pertaining to emotional reactions to risk, Loewenstein et al. (2001) mention various studies where females reported having stronger vivid imagery and experience emotions more intensely compared to males. Kung & Chen (2012) also used this hypothesis to explain that females felt more fearful, worried, and threatened by earthquake risk due to their higher sensitivity and tendency to represent risk more emotionally than males. Considering females in our study scored higher on Module 3 than males in both the pre- and post-tests (Tables B.5 and C.8)., a module that addresses the concept of vulnerability (though not gender differences specifically) and differential disaster impacts, our results could be partially explained by the risk-as-a-feeling hypothesis.

Overall, female participants could have resonated more emotionally with the content of the modules, especially Module 3, thus influencing their risk perception. This finding reflects conclusions from both Cvetković, Öcal, and Ivanov (2019) and Kung and Chen (2012), who reiterate that other factors (not necessarily measured in this study) attribute to females' higher risk perception, such as biology, culture, and social or physical vulnerabilities.

5.3. Vulnerability, Coping, and Planning for Hurricane Impacts

Aside from subject matter proficiency and risk perceptions, the statistical analyses indicate that the curriculum also impacted perceptions of vulnerability, capability, and planning. Similar to the effects on general risk perception, participants' perceived vulnerability increased (Tables B.7 and B.12), meaning participants felt they or their families were more vulnerable to hurricane impacts after finishing the program. However, their perceived ability to cope with hurricane impacts also increased (Tables B.7-8, B.12, and B.14). Adaptive capacity in the context of natural hazards is the ability or capability to adjust, cope with, and recover from disasters, part of which considers the availability of resources capable of supporting those adjustments, as well as cognitive factors such as risk perception or perceived capability (Lopez-Marrero, 2010). Research finds that although certain populations are physically and socially vulnerable to disaster impacts, those populations can and do find various ways to cope within their own communities (Berman et al., 2015; Daramola et al., 2016; Sherman et al., 2015). The presented hazards curriculum not only discusses the concept of adaptive capacity in Module 3, but Module 4 tasked participants with activities that taught them about planning, mitigation, and adaptation and encouraged them to consider their current resources using games ("Stop Disasters" on UNDRR site and "Build a Kit Game" on ready.gov site). These games may influence participants' perception of their own coping capability, as feedback surveys indicated participants enjoyed activities and specifically mentioned the “Stop Disasters” game. Participants also reported in the post-test that they had improved their planning by knowing where to meet their families/loved ones in an emergency or by now having a plan that tells them what to do in emergencies (Table B. 9 and B.16). Our findings suggest that although participants experienced an increase in perceived vulnerability to hurricane impacts, becoming more aware of the vulnerability may have motivated participants to learn more about strategies to cope and adapt.

Overall, our findings demonstrate that the curriculum helped increase natural hazards and disaster knowledge and risk perceptions in young adults. Although some hazards were perceived as more likely to occur than others, specific hazard fears were decreased in general. Our findings also demonstrate how risk perceptions of specific hazards can be increased by a natural hazards education program but can also increase hazard awareness and coping capacity.

5.4. Limitations

One of the original research goals of this study was to compare how the two platforms, eCampus and KidGab, performed to determine whether KidGab was a viable third-party educational platform. However, not enough participants were obtained for KidGab testing, and the KidGab social networking features that would distinguish the two platforms were not used. Participants were given the choice of which platform they wanted to use, and most opted for eCampus, as many were already familiar with using the platform for other courses. In contrast, KidGab required additional user accounts and user guides, which were provided by the researchers, and participants had to learn to navigate a new platform. KidGab's learning module features for an online natural hazards curriculum were also being tested for the first time. For future research, the platforms should be automatically assigned, with KidGab updated to include new features that were missing and identified as necessary for this educational program, including the ability to review previously completed materials and arranging images in order of the modules in a more visually clear manner.

Another issue related to participant numbers is the drop-off experienced throughout testing. Although a total of 120 students originally consented to the research, only 77 completed the program. Participants dropped-out voluntarily at various modules, and some completed the program with low-quality submissions that could not be used in data analysis. Although extra-credit for the course was offered as an incentive for completing the program, credit was rewarded for any legitimate efforts put into the program to comply with Human Research Protection Program requirements. Participants obtained partial credit even if they did not complete the semester-long program, which encouraged some users to purposely submit answers of low quality to obtain credit, thus making their data unusable for analysis. Students who did not answer questions with real seriousness lost points for answers that were obviously not answering module questions. Revising incentives and how they can be delivered and still comply with requirements will need to be taken into consideration in future works.

Naturally, there was some inconsistency with how participants answered repeated questions in the pre and post-test for risk perception. This issue was especially noticed in questions relating to previous hazard experiences. For example, there were questions asking if they had ever experienced a hurricane in their lifetime, and if they could name a major hurricane event they had personally experienced. Some users named a hurricane they experienced, such as Hurricane Harvey, yet answered that they had never experienced a hurricane in their lifetime. Previous experience answers were also seen to have changed in the post-test, such as whether they had experienced flooding in their home or flooding in general. This tendency may be due to participants misremembering their experiences until they reached the post-test or misinterpreting the questions. Questions should be revised and clarified in future research; however, some misinterpretation is expected in human research with surveys.

6. CONCLUSIONS

Through this research, the developed online natural hazards curriculum content and surveys were determined to be effective in improving subject matter proficiency in participants. The increase of total module scores in the post-tests indicates that participants did learn from the content of each module. However, results revealed factors that influenced the participants' base-knowledge going into the program and how well they would perform in the post-tests, such as what course they were in, previous hazard experience, gender, and pre-risk perception. Participants in GEOG 305, which discussed local natural hazards in class, tended to score higher in the pre and post-tests, indicating additional coverage of topics aids subject matter proficiency. Previous hazards education was shown not to be as influential as direct previous experience in determining scores, further supporting the notion in previous literature that direct hazard experiences are more powerful influencers of knowledge than knowledge gained only in the classroom. Although males scored higher overall in the pre-tests, the gender gap in knowledge was observed to close at the end of the curriculum. This result was due to females scoring significantly higher in the module on natural disasters and vulnerability, supporting that females are more sensitive to content relating to disaster impacts and vulnerability than males.

The curriculum also influenced risk perception; those who ended the program with higher module scores were reported by the regression models also to have higher risk perception scores. Influencing risk perception factors found in existing literature (e.g., previous experience, exposure, and gender) were further supported by the results of this research, as these factors were revealed as significant factors in both pre and post-tests. Those who experienced hazards previously, especially hurricane and flooding hazards, showed higher risk perception scores than those who had not, and those who lived in areas more prone to hurricanes and flooding had higher risk perception scores due to higher exposure. Finally, females were more sensitive in their risk perceptions as they started and ended the program with higher risk perception scores and feelings of fear and concern of hazards. Males did experience an increase in fear and concern after the program, but females were observed to have higher scores. However, the entire population generally increased their subject matter proficiency and improved their awareness of natural hazards.

This research contributes to natural hazards and disaster risk perception literature concerning young adults. The methods this project employed also advances knowledge in how to design curriculum and assessments that will improve students' subject matter proficiency and hazard awareness through active and accessible online learning activities, which can be integrated into an interactive online application. The results also examined how local college students were impacted by Hurricane Harvey, and how their risk perceptions and personal experiences with hazards change as they are exposed to a hazards education curriculum. The approach is novel in that integrating an online natural hazards education curriculum into studying risk perception on young adults has not yet been attempted.

This research served as a pilot study for developing a virtual, interactive online curriculum at a high school-level for local community partners that have been affected by Hurricane Harvey in Houston, Texas. It is preferable the deliverables are already developed and tested on college students in a pilot study instead of using the high schools for beta testing as it will be easier to implement the content and ensures the quality of the program. The curriculum can be modified to suit younger reading levels according to the needs and requirements of the collaborator, such as the Houston ISD, and be compatible with any learning management system. If the curriculum is successfully deployed to local schools, benefits include enhancing youth's hazard awareness through easily accessible information provided to them by their schools and publicly online in a safe environment. The content developed will also provide a framework for other studies that examine current risk perceptions and hazards education in children.

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APPENDIX A

PROGRAM DESCRIPTION TABLE AND SCATTERPLOTS

Table A.1 Module Descriptions

Module Name	Description	Learning Outcomes	Activities
Module 1: Hazards	Defines man-made hazards from natural hazards. Introduces physical geography regions of Texas. Discusses physical geography impacts which hazards occur in specific regions and not others.	Define what hazards are. Identify important physical regions and climatic differences in Texas. Describe how physical geography dictates hazards	Short essay discussing a previous hazard experience
Module 2: Natural Hazards of Texas	Weather processes explained and climatological/ meteorological hazards are identified. Earth's structure and physical processes are explained, and geological hazards identified. Discussion on frequency and magnitude of hazards such as tornadoes.	Define weather and explain how it drives specific climatic hazards. Identify common hazards in various regions of Texas. Discuss the frequency and magnitude of hazards	Short essay discussing hazard or hazard impacts in local area
Module 3: Disasters	Defines and discusses risk and disasters with historical examples. Discusses vulnerability (social and physical), resilience, and adaptive capacity.	Define natural disaster. Define and discuss physical/social vulnerability, resilience, and adaptive capacity. Discuss difference between vulnerability and resilience	Short essay on any disaster and discussing vulnerability and resilience
Module 4: Planning and Mitigation	Defines planning and considerations for vulnerable populations. Defines mitigation and structural and non-structural types. Planning, response, and mitigation strategies for multiple hazards and situations. Discussion on disaster impacts, specifically the psychological impacts on both adults and children.	Identify appropriate responses to a variety of natural disasters. Analyze the effectiveness of disaster planning and mitigation strategies in several scenarios Apply knowledge of planning and mitigation strategies in simulated natural disasters and emergencies.	Games and short answers: building an emergency kit and discussing what was needed or not and why and play disaster simulation game and discuss results.
Module 5: Hurricane Harvey: A Case Study	Explains formation and development of Hurricane Harvey. Discusses flooding and extent of the flooding impact. Discusses how locals and government agencies. Discusses planning and mitigation strategy considerations for the Houston area.	Outline events of Hurricane Harvey. Apply knowledge from previous modules to understand extent of disaster impacts. Investigate the mitigation and planning strategies that were implemented by authorities and analyze their effectiveness.	Short essay on maps of Hurricane Harvey impacts and a proposition for a new mitigation or planning strategy for Houston for a future Hurricane Harvey.

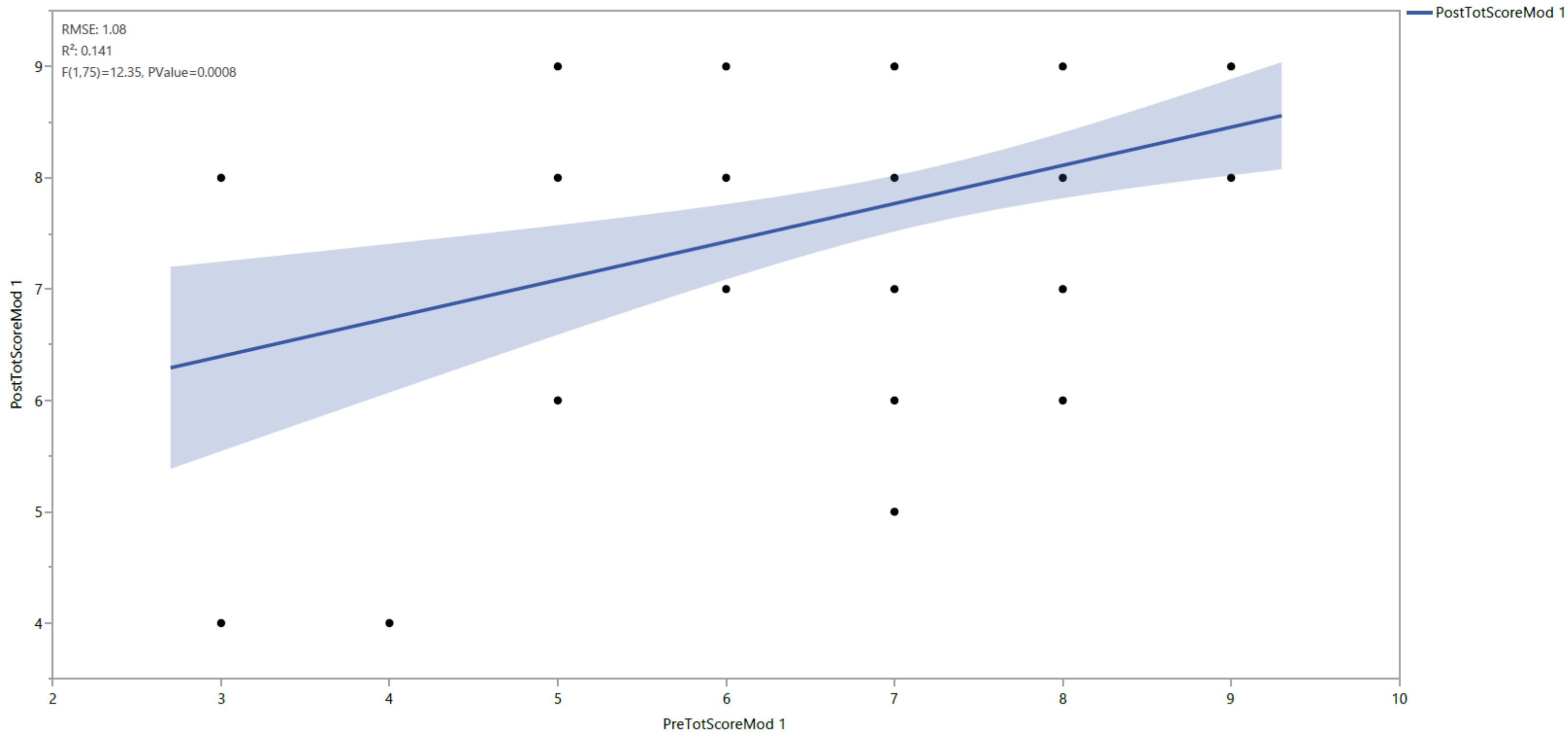

Figure A.1 Scatterplot: Module 1 Scores

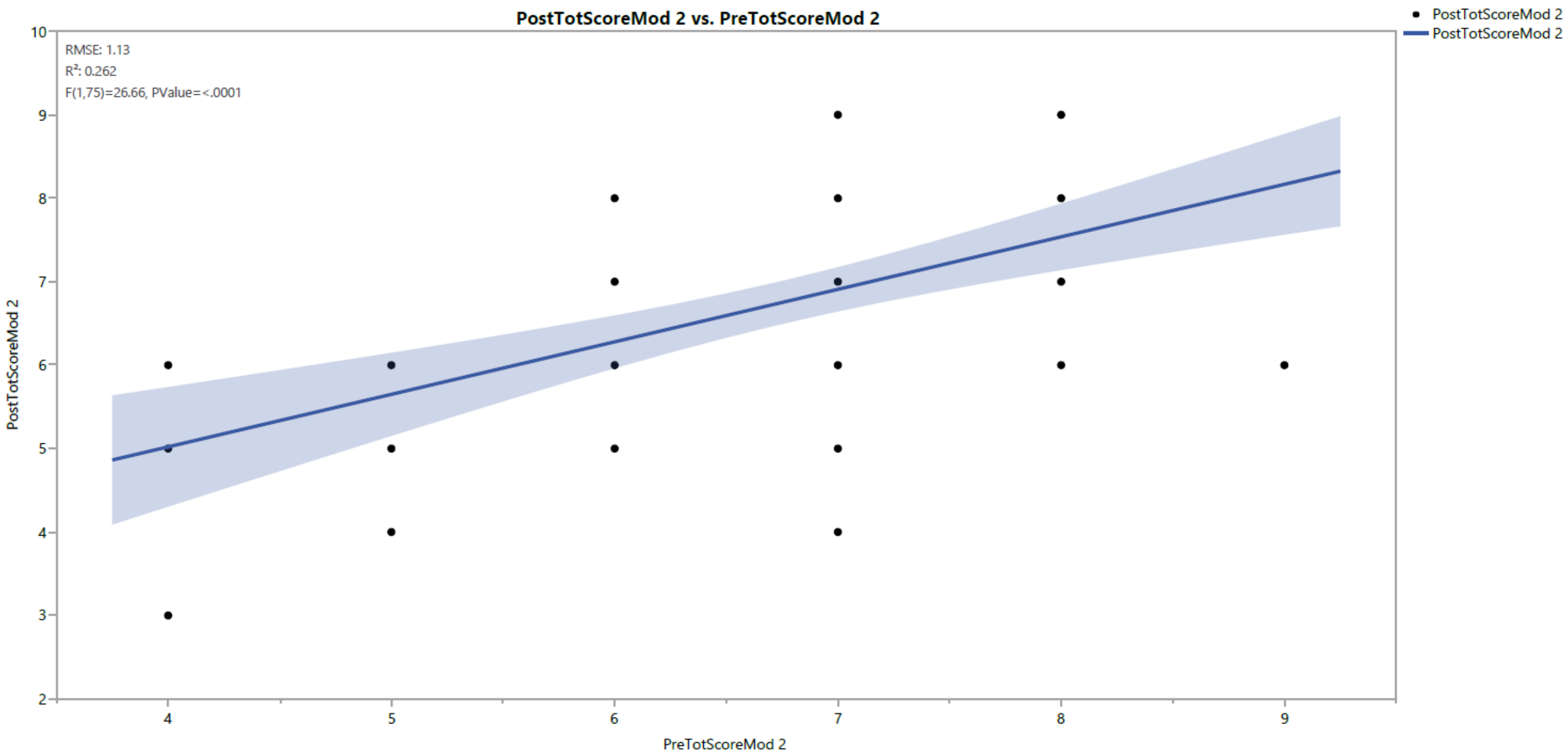

Figure A.2 Scatterplot: Module 2 Scores

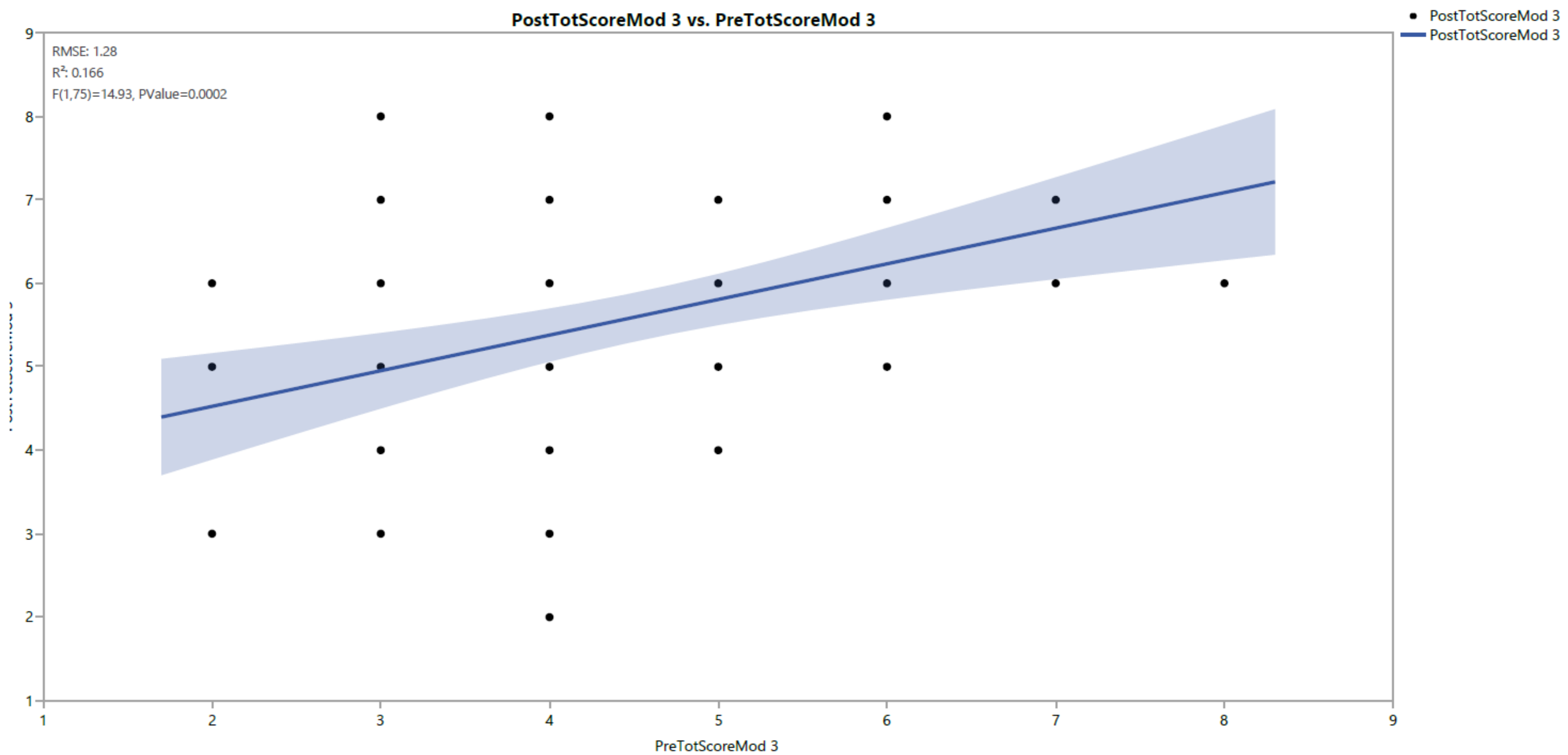

Figure A.3 Scatterplot: Module 3 Scores

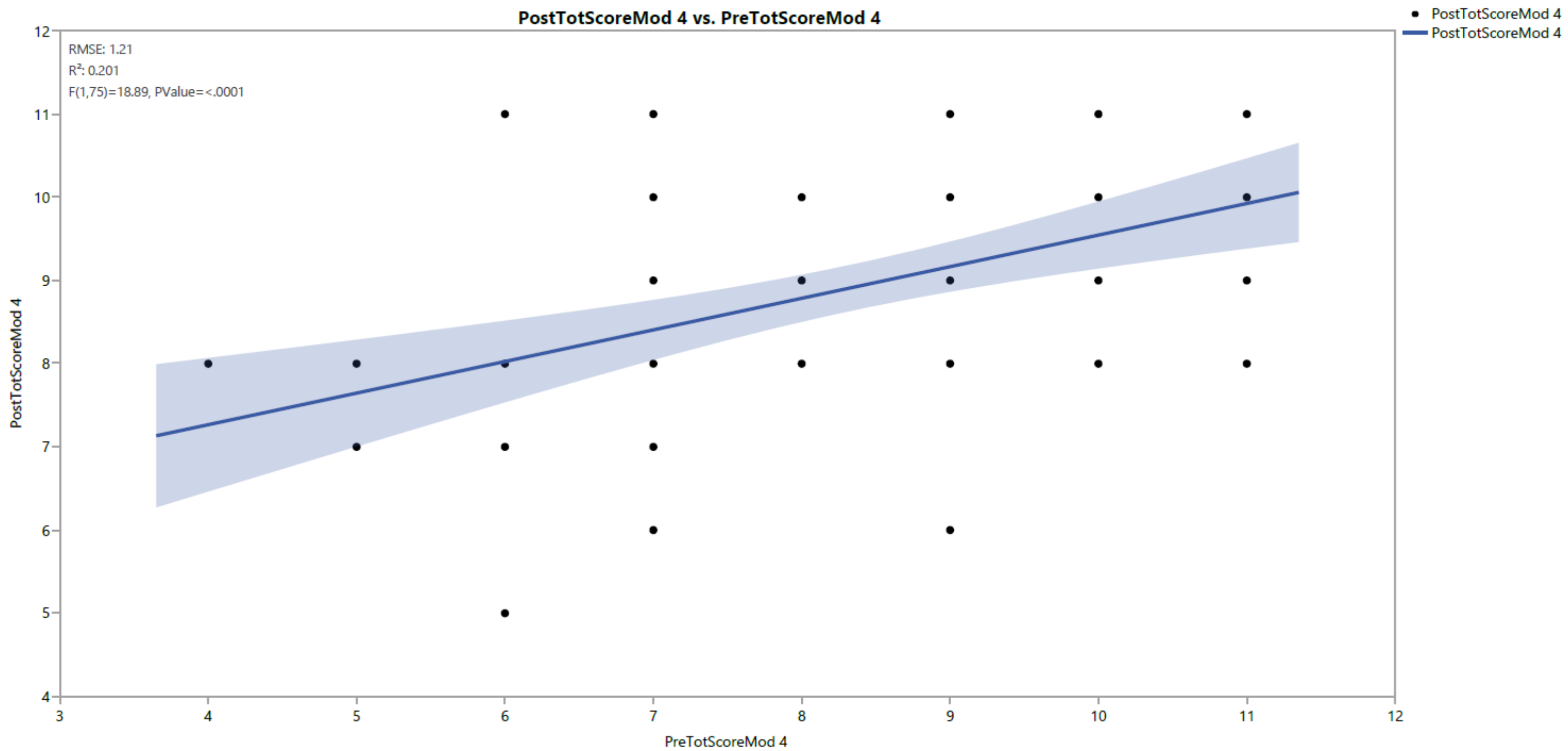

Figure A.4 Scatterplot: Module 4 Scores

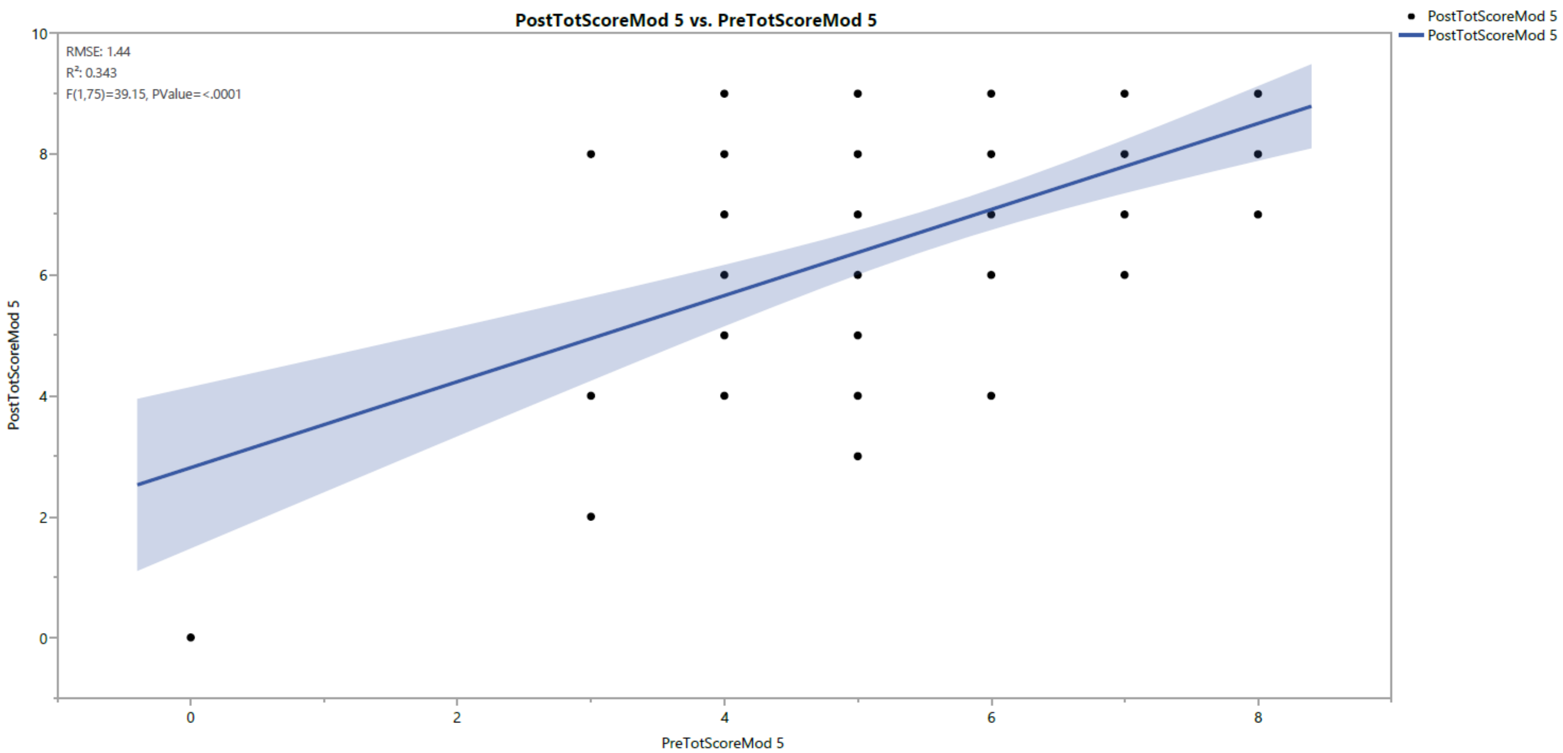

Figure A.5 Scatterplot: Module 5 Scores

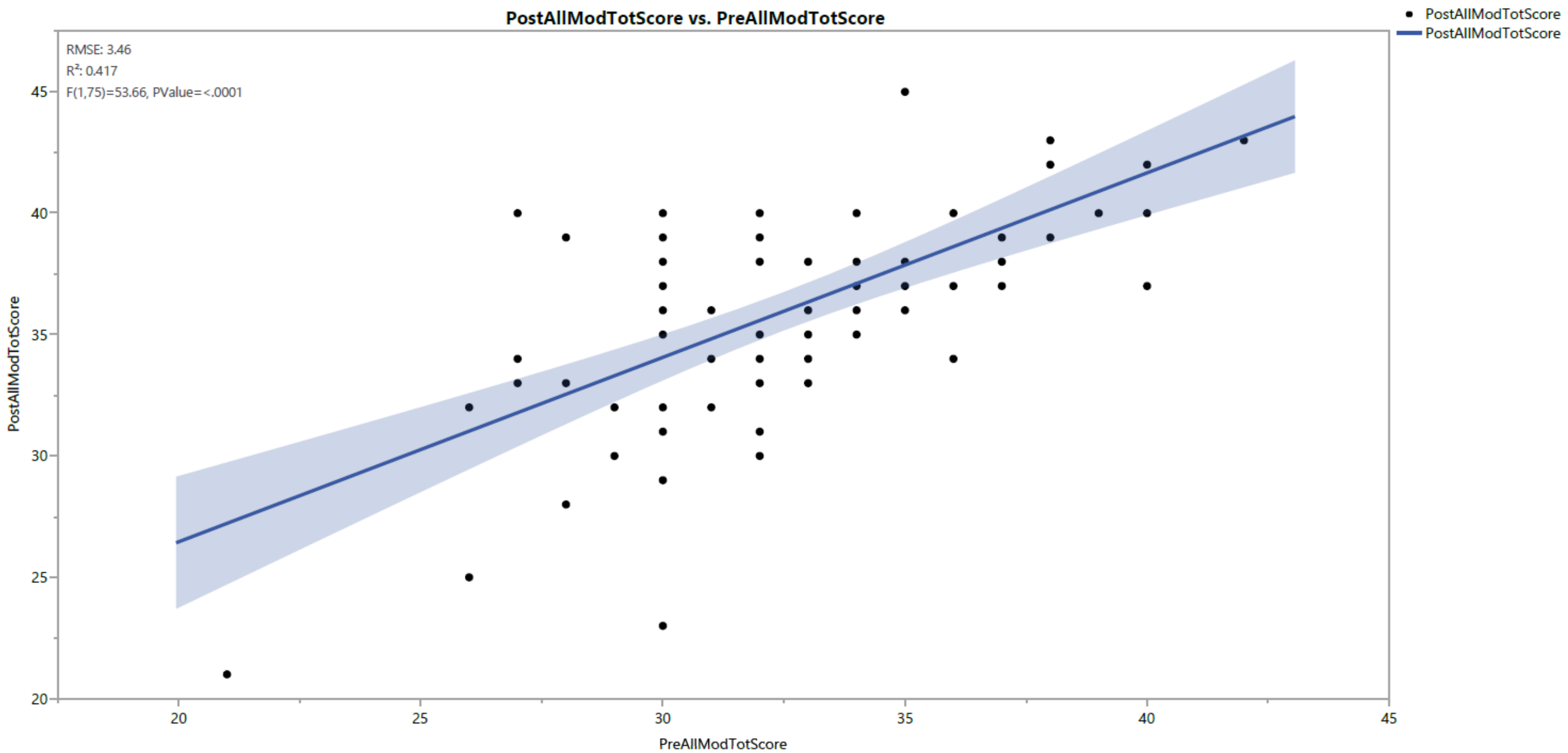

Figure A.6 Scatterplot: All Total Module Scores

APPENDIX B

T-TEST TABLES

Table B.1 T-test: Individual and Total Module Score

		All			GEOG 201			GEOG 305		
Modules		pre	post	p-value	pre	post	p-value	pre	post	p-value
M1	mean	7.182	7.831		6.565	7.739		7.444	7.870	
	std	1.624	1.353	***0.000***	1.621	1.838	***0.000***	1.421	1.172	***0.012***
M2	mean	6.753	6.753		6.478	5.957		6.870	7.093	
	std	1.136	1.715	0.500	1.352	1.680	***0.035***	1.021	1.369	0.067
M3	mean	4.571	5.623		4.261	5.391		4.704	5.722	
	std	1.774	1.948	***0.000***	1.656	3.158	***0.002***	1.797	1.450	***0.000***
M4	mean	8.325	8.909		7.957	8.652		8.481	9.019	
	std	2.538	1.821	***0.001***	2.771	1.692	***0.029***	2.405	1.868	***0.006***
M5	mean	5.701	6.870		5.000	6.348		6.000	7.093	
	std	2.107	3.114	***0.000***	2.545	4.874	***0.000***	1.660	2.274	***0.000***
Total	mean	32.532	35.987		30.261	34.087		33.500	36.796	
	std	14.621	20.250	***0.000***	9.929	31.538	***0.000***	13.651	13.712	***0.000***

Table B.2 T-test: Individual Module Questions

		Module 1			Module 2			Module 3			Module 4			Module 5		
Questions		pre	post	p-value	pre	post	p-value	pre	post	p-value	pre	post	p-value	pre	post	p-value
Q1	mean	0.935	0.961		0.714	0.883		0.896	0.922		0.961	0.987		0.818	0.857	
	std	0.062	0.038	0.160	0.207	0.105	***0.000***	0.094	0.073	0.160	0.038	0.013	0.160	0.151	0.124	0.185
Q2	mean	0.701	0.212		0.675	0.779		0.494	0.766		0.974	0.948		0.377	0.519	
	std	0.883	0.105	***0.000***	0.222	0.174	***0.037***	0.253	0.181	***0.000***	0.026	0.050	0.209	0.238	0.253	***0.008***
Q3	mean	0.948	0.050		0.974	0.922		0.377	0.519		0.805	0.883		0.597	0.870	
	std	0.922	0.073	0.209	0.026	0.073	0.051	0.238	0.253	***0.005***	0.159	0.105	0.079	0.244	0.114	***0.000***
Q4	mean	0.987	0.013		0.987	0.987		0.805	0.922		0.987	0.974		0.935	0.935	
	std	0.987	0.013	0.500	0.013	0.013	N/A	0.159	0.073	***0.010***	0.013	0.026	0.284	0.062	0.062	0.500
Q5	mean	0.818	0.151		0.545	0.455		0.403	0.429		0.883	0.857		0.792	0.883	
	std	0.987	0.013	***0.000***	0.251	0.251	***0.045***	0.244	0.248	0.310	0.105	0.124	0.242	0.167	0.105	***0.045***
Q6	mean	0.922	0.073		0.922	0.831		0.961	0.961		0.610	0.662		0.974	0.974	
	std	0.987	0.013	***0.012***	0.073	0.142	***0.026***	0.038	0.038	0.500	0.241	0.227	0.144	0.026	0.026	0.500
Q7	mean	0.455	0.251		0.403	0.325		0.104	0.312		0.571	0.675		0.260	0.519	
	std	0.714	0.207	***0.000***	0.244	0.222	0.121	0.094	0.217	***0.000***	0.248	0.222	0.059	0.195	0.253	***0.000***
Q8	mean	0.623	0.238		0.597	0.610		0.091	0.091		0.805	0.896		0.078	0.377	
	std	0.844	0.133	***0.000***	0.244	0.241	0.405	0.084	0.084	0.500	0.159	0.094	***0.026***	0.073	0.238	***0.000***
Q9	mean	0.792	0.167		0.935	0.961		0.442	0.701		0.584	0.662		0.870	0.935	
	std	0.545	0.251	***0.000***	0.062	0.038	0.160	0.250	0.212	***0.000***	0.246	0.227	0.101	0.114	0.062	0.066
Q10	mean										0.519	0.584				
	std	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.253	0.246	0.150	n/a	n/a	n/a
Q11	mean										0.623	0.779				
	std	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.238	0.174	***0.001***	n/a	n/a	n/a

Table B.3 T-test: Comparing GEOG 201 and GEOG 305 Individual and Total Module Scores

201 vs 305 pre-test scores					201 vs 305 post-test scores		
Modules		201	305	p-value	201	305	p-value
M1	mean	6.565	7.444		7.739	7.870	
	std	1.621	1.421	***0.004***	1.838	1.172	0.342
M2	mean	6.478	6.870		5.957	7.093	
	std	1.352	1.021	0.084	1.680	1.369	***0.000***
M3	mean	4.261	4.704		5.391	5.722	
	std	1.656	1.797	0.090	3.158	1.450	0.210
M4	mean	7.957	8.481		8.652	9.019	
	std	2.771	2.405	0.102	1.692	1.868	0.136
M5	mean	5.000	6.000		6.348	7.093	
	std	2.545	1.660	***0.006***	4.874	2.274	0.075
Total	mean	30.261	33.500		34.087	36.796	
	std	9.929	13.651	***0.000***	31.538	13.712	***0.021***

Table B.4 Individual and Total Module Scores for Females and Males

		Females			Males		
Modules		Pre	Post	p-value	Pre	Post	p-value
Mod1	mean	7.313	7.906		7.089	7.778	
	std	1.512	1.830	***0.005***	1.719	1.040	***0.001***
Mod2	mean	6.500	6.594		6.933	6.867	
	std	1.161	1.604	0.310	1.064	1.800	0.365
Mod3	mean	4.625	5.969		4.533	5.378	
	std	2.500	2.289	***0.000***	1.300	1.604	***0.000***
Mod4	mean	8.188	8.844		8.422	8.956	
	std	2.222	2.330	***0.019***	2.795	1.498	***0.009***
Mod5	mean	5.406	6.844		5.911	6.889	
	std	1.539	3.491	***0.000***	2.446	2.919	***0.000***
Total	mean	32.031	36.156		32.889	35.867	
	std	18.547	26.201	***0.000***	11.874	16.482	***0.000***

Table B.5 T-test: Comparing Female and Male Individual and Total Module Score

		Pre-Module Scores			Post-Module Scores		
Modules		Females	Males	p-value	Females	Males	p-value
Mod1	mean	7.313	7.089		7.906	7.778	
	std	1.512	1.719	0.223	1.830	1.040	0.326
Mod2	mean	6.500	6.933		6.594	6.867	
	std	1.161	1.064	***0.041***	1.604	1.800	0.183
Mod3	mean	4.625	4.533		5.969	5.378	
	std	2.500	1.300	0.390	2.289	1.604	***0.038***
Mod4	mean	8.188	8.422		8.844	8.956	
	std	2.222	2.795	0.260	2.330	1.498	0.366
Mod5	mean	5.406	5.911		6.844	6.889	
	std	1.539	2.446	0.060	3.491	2.919	0.457
Total	mean	32.031	32.889		36.156	35.867	
	std	18.547	11.874	0.177	26.201	16.482	0.396

Table B.6 T-test: Risk Perception – Which Hazards are More Likely and Scare the Most

Risk Perception – All							
Do one or more of the following specific hazards scare or upset you more than the others?					How likely is it that you might be directly affected by a ___ in the future?		
Hazard Type		pre	post	p-value	pre	post	p-value
Flood	mean	0.273	0.299		3.519	3.909	
	std	0.201	0.212	0.329	1.016	1.005	***0.001***
Severe Storm	mean	0.156	0.221		3.935	4.442	
	std	0.133	0.174	0.099	0.930	0.487	***0.000***
Hurricane	mean	0.351	0.338		3.442	3.961	
	std	0.231	0.227	0.418	1.276	0.748	***0.000***
Tornado	mean	0.403	0.532		3.013	3.584	
	std	0.244	0.252	***0.034***	0.934	0.746	***0.000***
Wildfire	mean	0.312	0.247		2.416	2.727	
	std	0.217	0.188	0.139	0.746	0.885	***0.002***
Sinkhole	mean	0.169	0.169		2.195	2.519	
	std	0.142	0.142	0.500	0.738	0.858	***0.002***
Earthquake	mean	0.195	0.312		2.312	2.610	
	std	0.159	0.217	***0.019***	0.744	0.899	***0.006***
Volcano	mean	0.156	0.247		1.519	1.636	
	std	0.133	0.188	***0.035***	0.463	0.734	0.114

Table B.7 T-test: Risk Perception, Vulnerability, and Knowledge and Experience

Risk Perception, Vulnerability, and Knowledge and Experience - All				
Questions		pre	post	p-value
Does thinking or talking about any hazards scare or upset you?	mean	2.156	2.234	
	std	1.028	1.024	0.261
How vulnerable do you feel in terms of hurricane impacts directly affecting the accessibility of your home or possible isolation from damage/debris?	mean	3.065	3.532	
	std	1.483	1.226	***0.001***
How vulnerable do you feel in terms of hurricane impacts directly affecting you?	mean	3.221	3.649	
	std	1.359	1.020	***0.002***
How vulnerable do you feel in terms of hurricane impacts directly affecting your family?	mean	3.273	3.636	
	std	1.727	1.103	***0.006***
How vulnerable do you feel in terms of hurricane impacts directly affecting your property and/or possessions?	mean	3.169	3.662	
	std	1.616	1.042	***0.001***
In the past five years, do you feel the risk from hurricanes has:	mean	3.792	3.896	
	std	0.509	0.489	0.125
How concerning are natural hazards to you?	mean	3.857	3.987	
	std	0.729	0.934	0.053
How concerned are you of a natural hazard event occurring in your current location?	mean	3.805	3.922	
	std	0.948	1.152	0.134
Has your home ever been flooded?	mean	1.468	1.506	
	std	0.726	0.806	0.302
How well informed are you about the potential impacts of a natural hazard event (e.g., hurricane, tornado, wildfire, flooding)?	mean	3.688	4.247	
	std	0.612	0.504	***0.000***

Table B.8 T-test: Coping Capability

Questions		pre	post	p-value
How capable do you feel of recovering from damage or loss to material belongings (e.g., home and personal belongings) from a hurricane and its associated hazards (flood and wind damage?	mean	3.584	4.130	
	std	1.404	0.746	***0.000***
How capable do you feel of recovering from injury or loss of life to you or your family from a hurricane and its associated hazards (flood and wind damage)?	mean	3.377	3.792	
	std	1.475	0.956	***0.002***
How capable do you feel of recovering psychologically (e.g., stress and hardship) from a hurricane and its associated hazards (flood and wind damage)?	mean	4.195	4.429	
	std	0.764	0.459	***0.007***

Table B.9 T-Test: Planning

Planning - All				
Questions		pre	post	p-value
Do you or those you live with have a plan of your house showing exits and where to turn off water, electricity, and gas?	mean	1.727	2.104	
	std	0.806	0.936	***0.002***
Have you ever practiced what to do in the event of a natural hazard or disaster (at home, school, or elsewhere)?	mean	2.416	2.610	
	std	0.878	0.609	***0.011***
How motivated are you to learn more about different planning and mitigation practices (e.g., adding storm shutters to your home) that can help you reduce impacts from hazards and disasters?	mean	3.545	3.844	
	std	0.856	0.817	***0.009***
In an emergency, do you know where you would meet your family (or those you live with/are close to)?	mean	2.130	2.364	
	std	0.878	0.787	***0.018***
Do you or those you live with have an emergency plan that tells you what to do to be ready for a natural hazard or disaster?	mean	0.325	0.584	
	std	0.222	0.246	***0.000***

Table B.10 T-test: GEOG 201 and GEOG 305 Risk Perception – Which Hazards are More Likely and Scare the Most

		Risk Perception - GEOG 201						Risk Perception - GEOG 305					
		Do one or more of the following specific hazards scare or upset you more than the others?			How likely is it that you might be directly affected by a ___ in the future?			Do one or more of the following specific hazards scare or upset you more than the others?			How likely is it that you might be directly affected by a ___ in the future?		
Hazard Type		pre	post	p-value	pre	post	p-value	pre	post	p-value	pre	post	p-value
Flood	mean	0.304	0.391		3.522	3.826		0.259	0.259		3.519	3.944	
	std	0.221	0.249	0.213	0.534	1.605	0.136	0.196	0.196	0.500	1.235	0.770	***0.001***
Severe Storm	mean	0.130	0.174		3.739	4.304		0.167	0.241		4.019	4.500	
	std	0.119	0.150	0.332	0.656	0.585	***0.001***	0.142	0.186	0.104	1.037	0.443	***0.001***
Hurricane	mean	0.391	0.261		3.174	3.826		0.333	0.370		3.556	4.019	
	std	0.249	0.202	0.164	1.241	0.968	***0.002***	0.226	0.238	0.299	1.270	0.660	***0.000***
Tornado	mean	0.304	0.739		2.826	3.783		0.444	0.444		3.093	3.500	
	std	0.221	0.202	***0.001***	1.059	0.814	***0.002***	0.252	0.252	0.500	0.878	0.708	***0.001***
Wildfire	mean	0.391	0.348		2.391	2.826		0.278	0.204		2.426	2.685	
	std	0.249	0.237	0.357	1.158	1.150	***0.043***	0.204	0.165	0.145	0.589	0.786	***0.007***
Sinkhole	mean	0.261	0.261		2.174	2.391		0.130	0.130		2.204	2.574	
	std	0.202	0.202	0.500	0.968	1.067	0.198	0.115	0.115	0.500	0.656	0.777	***0.001***
Earthquake	mean	0.304	0.435		2.304	2.870		0.148	0.259		2.315	2.500	
	std	0.221	0.257	0.164	1.221	1.028	***0.022***	0.129	0.196	***0.029***	0.559	0.821	0.066
Volcano	mean	0.304	0.435		1.565	1.652		0.093	0.167		1.500	1.630	
	std	0.221	0.257	0.133	0.530	0.964	0.352	0.086	0.142	0.080	0.443	0.653	0.098

Table B.11 T-test: Comparing GEOG 201 and GEOG 305 Risk Perception – Which Hazards are More Likely and Scare the Most

Risk Perception - GEOG 201 vs GEOG 305 pre								Risk Perception - GEOG 201 vs GEOG 305 post					
Do one or more of the following specific hazards scare or upset you more than the others?					How likely is it that you might be directly affected by a ___ in the future?			Do one or more of the following specific hazards scare or upset you more than the others?			How likely is it that you might be directly affected by a ___ in the future?		
Questions		201	305	p-value	201	305	p-value	201	305	p-value	201	305	p-value
Flood	mean	0.304	0.259		3.522	3.519		0.391	0.259		3.826	3.944	
	std	0.221	0.196	0.349	0.534	1.235	0.494	0.249	0.196	0.140	1.605	0.770	0.343
Severe Storm													
	mean	0.130	0.167		3.739	4.019		0.174	0.241		4.304	4.500	
	std	0.119	0.142	0.342	0.656	1.037	0.103	0.150	0.186	0.253	0.585	0.443	0.147
Hurricane	mean	0.391	0.333		3.174	3.556		0.261	0.370		3.826	4.019	
	std	0.249	0.226	0.319	1.241	1.270	0.089	0.202	0.238	0.172	0.968	0.660	0.207
Tornado	mean	0.304	0.444		2.826	3.093		0.739	0.444		3.783	3.500	
	std	0.221	0.252	0.124	1.059	0.878	0.146	0.202	0.252	***0.007***	0.814	0.708	0.103
Wildfire	mean	0.391	0.278		2.391	2.426		0.348	0.204		2.826	2.685	
	std	0.249	0.204	0.177	1.158	0.589	0.445	0.237	0.165	0.110	1.150	0.786	0.291
Sinkhole	mean	0.261	0.130		2.174	2.204		0.261	0.130		2.391	2.574	
	std	0.202	0.115	0.109	0.968	0.656	0.449	0.202	0.115	0.109	1.067	0.777	0.232
Earthquake	mean	0.304	0.148		2.304	2.315		0.435	0.259		2.870	2.500	
	std	0.221	0.129	0.082	1.221	0.559	0.484	0.257	0.196	0.079	1.028	0.821	0.070
Volcano	mean	0.304	0.093		1.565	1.500		0.435	0.167		1.652	1.630	
	std	0.221	0.086	***0.027***	0.530	0.443	0.357	0.257	0.142	***0.014***	0.964	0.653	0.462

Table B.12 T-test: GEOG 201 and GEOG 305 Risk Perception, Vulnerability, and Knowledge and Experience

		GEOG 201			GEOG 305		
Questions		pre	post	p-value	pre	post	p-value
Does thinking or talking about any hazards scare or upset you?	mean	2.478	2.217		2.019	2.241	
	std	1.261	0.996	0.133	0.886	1.054	0.058
How vulnerable do you feel in terms of hurricane impacts directly affecting the accessibility of your home or possible isolation from damage/debris?	mean	3.304	3.783		2.963	3.426	
	std	1.676	1.269	0.067	1.395	1.193	***0.005***
How vulnerable do you feel in terms of hurricane impacts directly affecting you?	mean	3.261	3.739		3.204	3.611	
	std	1.292	1.111	0.067	1.411	0.997	***0.006***
How vulnerable do you feel in terms of hurricane impacts directly affecting your family?	mean	3.522	3.739		3.167	3.593	
	std	1.625	1.292	0.164	1.764	1.038	***0.011***
How vulnerable do you feel in terms of hurricane impacts directly affecting your property and/or possessions?	mean	3.348	3.696		3.093	3.648	
	std	1.783	1.130	0.152	1.557	1.025	***0.000***
In the past five years, do you feel the risk from hurricanes has:	mean	3.913	4.043		3.741	3.833	
	std	0.538	0.498	0.272	0.498	0.481	0.161
How concerning are natural hazards to you?	mean	4.130	4.043		3.741	3.963	
	std	0.391	0.862	0.302	0.837	0.980	***0.006***
How concerned are you of a natural hazard event occurring in your current location?	mean	3.739	4.130		3.833	3.833	
	std	1.111	0.937	0.041	0.896	1.236	0.500
Has your home ever been flooded?	mean	1.435	1.522		1.481	1.500	
	std	0.711	0.806	0.288	0.745	0.821	0.415
How well informed are you about the potential impacts of a natural hazard event (e.g., hurricane, tornado, wildfire, flooding)?	mean	3.478	4.130		3.778	4.296	
	std	0.625	0.573	***0.002***	0.591	0.477	***0.000***

Table B.13 T-test: Comparing GEOG 201 and GEOG 305 Risk Perception, Vulnerability, and Knowledge and Experience

201 vs. 305 pre					201 vs. 305 post		
Questions		201	305	p-value	201	305	p-value
Does thinking or talking about any hazards scare or upset you?	mean	2.478	2.019		2.217	2.241	
	std	1.261	0.886	***0.047***	0.996	1.054	0.463
How vulnerable do you feel in terms of hurricane impacts directly affecting the accessibility of your home or possible isolation from damage/debris?	mean	3.304	2.963		3.783	3.426	
	std	1.676	1.395	0.142	1.269	1.193	0.103
How vulnerable do you feel in terms of hurricane impacts directly affecting you?	mean	3.261	3.204		3.739	3.611	
	std	1.292	1.411	0.422	1.111	0.997	0.311
How vulnerable do you feel in terms of hurricane impacts directly affecting your family?	mean	3.522	3.167		3.739	3.593	
	std	1.625	1.764	0.138	1.292	1.038	0.298
How vulnerable do you feel in terms of hurricane impacts directly affecting your property and/or possessions?	mean	3.348	3.093		3.696	3.648	
	std	1.783	1.557	0.219	1.130	1.025	0.428
In the past five years, do you feel the risk from hurricanes has:	mean	3.913	3.741		4.043	3.833	
	std	0.538	0.498	0.173	0.498	0.481	0.118
How concerning are natural hazards to you?	mean	4.130	3.741		4.043	3.963	
	std	0.391	0.837	***0.017***	0.862	0.980	0.367
How concerned are you of a natural hazard event occurring in your current location?	mean	3.739	3.833		4.130	3.833	
	std	1.111	0.896	0.357	0.937	1.236	0.122
Has your home ever been flooded?	mean	1.435	1.481		1.522	1.500	
	std	0.711	0.745	0.413	0.806	0.821	0.462
How well informed are you about the potential impacts of a natural hazard event (e.g., hurricane, tornado, wildfire, flooding)?	mean	3.478	3.778		4.130	4.296	
	std	0.625	0.591	0.066	0.573	0.477	0.186

Table B.14 T-test: GEOG 201 and GEOG 305 Coping Capability

Coping - GEOG 201					Coping - GEOG 305		
Questions		pre	post	p-value	pre	post	p-value
How capable do you feel of recovering from damage or loss to material belongings (e.g., home and personal belongings) from a hurricane and its associated hazards (flood and wind damage?	mean	3.304	4.043		3.704	4.167	
	std	1.130	0.862	***0.001***	1.495	0.708	***0.001***
How capable do you feel of recovering from injury or loss of life to you or your family from a hurricane and its associated hazards (flood and wind damage)?	mean	2.739	3.565		3.648	3.889	
	std	1.565	1.257	***0.004***	1.213	0.818	0.054
How capable do you feel of recovering psychologically (e.g., stress and hardship) from a hurricane and its associated hazards (flood and wind damage)?	mean	3.696	4.174		4.407	4.537	
	std	0.949	0.696	***0.006***	0.548	0.329	0.113

Table B.15 T-test: Comparing GEOG 201 and GEOG 305 Coping Capability

201 vs. 305 pre					201 vs. 305 post		
Questions		201	305	p-value	201	305	p-value
How capable do you feel of recovering from damage or loss to material belongings (e.g., home and personal belongings) from a hurricane and its associated hazards (flood and wind damage?	mean	3.304	3.704		4.043	4.167	
	std	1.130	1.495	0.078	0.862	0.708	0.294
How capable do you feel of recovering from injury or loss of life to you or your family from a hurricane and its associated hazards (flood and wind damage)?	mean	2.739	3.648		3.565	3.889	
	std	1.565	1.213	***0.002***	1.257	0.818	0.114
How capable do you feel of recovering psychologically (e.g., stress and hardship) from a hurricane and its associated hazards (flood and wind damage)?	mean	3.696	4.407		4.174	4.537	
	std	0.949	0.548	***0.002***	0.696	0.329	***0.033***

Table B.16 T-Test: GEOG 201 and GEOG 305 Planning

Planning- GEOG 201					Planning - GEOG 305		
Questions		pre	post	p-value	pre	post	p-value
Do you or those you live with have a plan of your house showing exits and where to turn off water, electricity, and gas?	mean	1.913	2.174		1.648	2.074	
	std	0.901	0.968	0.150	0.761	0.938	***0.003***
Have you ever practiced what to do in the event of a natural hazard or disaster (at home, school, or elsewhere)?	mean	2.130	2.522		2.537	2.648	
	std	1.028	0.715	***0.035***	0.782	0.572	0.080
How motivated are you to learn more about different planning and mitigation practices (e.g., adding storm shutters to your home) that can help you reduce impacts from hazards and disasters?	mean	3.304	3.870		3.648	3.833	
	std	0.767	0.755	***0.004***	0.874	0.858	0.114
In an emergency, do you know where you would meet your family (or those you live with/are close to)?	mean	1.913	2.261		2.222	2.407	
	std	0.992	0.838	***0.036***	0.818	0.774	0.088
Do you or those you live with have an emergency plan that tells you what to do to be ready for a natural hazard or disaster?	mean	0.304	0.609		0.333	0.574	
	std	0.221	0.249	***0.003***	0.226	0.249	***0.003***

Table B.17 T-Test: Comparing GEOG 201 and GEOG 305 Planning

201 vs. 305 pre					201 vs. 305 post		
Questions		201	305	p-value	201	305	p-value
Do you or those you live with have a plan of your house showing exits and where to turn off water, electricity, and gas?	mean	1.913	1.648		2.174	2.074	
	std	0.901	0.761	0.129	0.968	0.938	0.342
Have you ever practiced what to do in the event of a natural hazard or disaster (at home, school, or elsewhere)?	mean	2.130	2.537		2.522	2.648	
	std	1.028	0.782	0.052	0.715	0.572	0.270
How motivated are you to learn more about different planning and mitigation practices (e.g., adding storm shutters to your home) that can help you reduce impacts from hazards and disasters?	mean	3.304	3.648		3.870	3.833	
	std	0.767	0.874	0.065	0.755	0.858	0.435
In an emergency, do you know where you would meet your family (or those you live with/are close to)?	mean	1.913	2.222		2.261	2.407	
	std	0.992	0.818	0.104	0.838	0.774	0.260
Do you or those you live with have an emergency plan that tells you what to do to be ready for a natural hazard or disaster?	mean	0.304	0.333		0.609	0.574	
	std	0.221	0.226	0.403	0.249	0.249	0.391

Table B.18 T-Test: Risk Perception Pre- and Post-Program

Hurricane and Flood Perceived Risk Score				
Population		Pre	Post	p-value
All	mean	29.494	32.468	
	std	46.543	32.121	***0.000***
201	mean	30.652	32.913	
	std	39.601	35.447	***0.044***
305	mean	29.000	32.278	
	std	49.472	31.223	***0.000***

Table B.19 T-Test: Impact of Experience and Proximity on Pre-Risk Perception Score

Hurricane and Flood Pre-Risk Perception Score				
Experience		Yes	No	p-value
Home has been flooded before	mean	32.167	28.678	
	std	32.853	48.463	***0.020***
Experienced Flooding in Lifetime	mean	32.130	25.581	
	std	42.560	27.585	***0.000***
Experienced Hurricane Harvey	mean	31.943	27.452	
	std	43.114	41.132	***0.002***
Experienced Any Named Hurricane besides Harvey	mean	31.870	28.481	
	std	59.573	38.519	***0.035***
Hometown Location Coastal	mean	31.113	25.917	
	std	48.448	24.862	***0.000***

Table B.20 T-Test: Impact of Experience and Proximity on Post-Risk Perception Score

Hurricane and Flood Post-Risk Perception Score				
Experience		Yes	No	p-value
Home has been flooded	mean	31.000	32.982	
	std	24.105	34.375	0.074
Experienced Flooding in Lifetime	mean	33.588	30.269	
	std	28.967	32.125	***0.009***
Experienced Hurricane Harvey	mean	34.029	31.167	
	std	27.323	33.069	***0.013***
Experienced Any Named Hurricane besides Harvey	mean	33.261	32.130	
	std	31.474	32.606	0.213
Hometown Location Coastal	mean	33.547	30.083	
	std	34.637	19.210	***0.003***

Table B.21 T-test: Female and Male General Risk Perception and Knowledge

Female Risk Perception vs Knowledge					Male Risk Perception vs Knowledge		
Questions		pre	post	p-value	pre	post	p-value
Does thinking or talking about any hazards scare or upset you?	mean	2.500	2.594		1.911	1.978	
	std	1.226	0.830	0.334	0.765	1.022	0.318
How well informed are you about the potential impacts of a natural hazard event (e.g., hurricane, tornado, wildfire, flooding)?	mean	3.438	4.063		3.867	4.378	
	std	0.706	0.706	***0.000***	0.482	0.331	***0.000***

Table B.22 T-test: Comparing Female and Male General Risk Perception and Knowledge

Risk Perception vs Knowledge - Pre					Risk Perception vs Knowledge - Post		
Question		female	male	p-value	female	male	p-value
Does thinking or talking about any hazards scare or upset you?	mean	1.226	0.765		2.594	1.978	
	std	32.000	45.000	***0.008***	0.830	1.022	***0.003***
How well informed are you about the potential impacts of a natural hazard event (e.g., hurricane, tornado, wildfire, flooding)?	mean	3.438	3.867		4.063	4.378	
	std	0.706	0.482	***0.011***	0.706	0.331	***0.036***

Table B.23 T-test: Risk Perception Scores by Gender

Perceived Risk Score: Females and Males				
Gender		Pre	Post	p-value
Females	mean	32.156	34.188	
	std	41.749	17.319	***0.020***
Males	mean	27.600	31.244	
	std	42.155	39.598	***0.000***

Table B.24 T-test: Comparing Female and Male Risk Perception Scores

Perceived Risk Score - F vs. M				
Pre or Post		Females	Males	p-value
Pre	mean	32.156	27.600	
	std	41.749	42.155	***0.002***
Post	mean	34.188	31.244	
	std	17.319	39.598	***0.008***

APPENDIX C

REGRESSION MODEL TABLES

Table C.1 Total Module Pre-Test Score Regression Model Group

Total Module Pre-Test Score										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	Coefficient estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Total Module Score - pre)	32.869	***<0.000***	33.233	***<0.000***	31.857	***<0.000***	32.272	***<0.000***	32.758	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	-1.955	0.058	-2.118	***0.035***	-1.943	0.051	-2.026	***0.041***	-2.309	***0.024***
Age (18-20=1)(21-24=2)(25-40=3)	1.139	0.196	1.001	0.251	0.869	0.314	1.215	0.162	0.996	0.264
Gender (1=Female)	-0.760	0.416	-0.925	0.323	-0.541	0.559	-0.792	0.389	-0.799	0.399
Coastal hometown location (1=Coastal)	-1.452	0.148	-1.440	0.150	-1.253	0.201	-1.768	0.081	-1.333	0.193
Pre-Risk Perception Score	-0.015	0.844	-0.010	0.891	-0.027	0.716	-0.011	0.876	0.014	0.862
Previous Hazard Experience	1.289	0.181	0.780	0.152	0.746	***0.046***	1.896	***0.049***	0.149	0.884
Model RSq		0.138		0.141		0.165		0.163		0.116
Model p-value		0.099		0.090		***0.044***		***0.046***		0.183

Table C.2 Total Module Post-Test Score Regression Model Group

Variables	Total Module Post-Test Score									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Total Module Score - post)	38.146	***<0.000***	38.548	***<0.000***	37.346	***<0.000***	37.704	***<0.000***	38.685	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	-2.612	***0.037***	-2.531	***0.036***	-2.347	0.051	-2.406	***0.044***	-2.555	***0.034***
Age (18-20=1)(21-24=2)(25-40=3)	0.457	0.666	0.419	0.689	0.296	0.775	0.626	0.548	0.313	0.767
Gender (1=Female)	0.477	0.672	0.371	0.741	0.710	0.526	0.481	0.664	0.527	0.638
Coastal hometown location (1=Coastal)	-0.114	0.925	-0.186	0.876	-0.029	0.980	-0.528	0.662	-0.265	0.826
Pre-Risk Perception Score	-0.073	0.422	-0.088	0.320	-0.107	0.231	-0.094	0.277	-0.101	0.285
Previous Hazard Experience	0.307	0.791	0.630	0.334	0.685	0.127	1.848	0.110	1.107	0.362
Model RSq		0.091		0.103		0.120		0.123		0.101
Model p-value		0.330		0.253		0.161		0.149		0.262

Table C.3 Module 1 Pre-Test Score Regression Model Group

Module 1 Pre-Test Score										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score - pre)	6.946	***<0.000***	6.867	***<0.000***	6.659	***<0.000***	6.895	***<0.000***	6.921	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.876	***0.013***	-0.926	***0.007***	-0.771	***0.021***	-0.872	***0.011***	-0.903	***0.009***
Age (18-20=1)(21-24=2)(25-40=3)	0.340	0.254	0.332	0.260	0.284	0.325	0.351	0.238	0.334	0.263
Gender (1=Female)	0.211	0.504	0.222	0.483	0.297	0.339	0.209	0.506	0.207	0.514
Coastal hometown location (1=Coastal)	-0.186	0.581	-0.161	0.633	-0.158	0.627	-0.220	0.522	-0.173	0.612
Pre-Risk Perception Score	0.003	0.909	0.009	0.733	-0.010	0.682	0.002	0.927	0.006	0.826
Previous Hazard Experience	0.084	0.795	-0.094	0.609	0.250	***0.046***	0.180	0.581	-0.023	0.945
Model RSq		0.112		0.114		0.161		0.115		0.111
Model p-value		0.201		0.189		***0.050***		0.186		0.205

Table C.4 Module 3 Pre-Test Score Regression Model Group

Variables	Module 3 Pre-Test Score									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score - pre)	5.130	***<0.000***	5.403	***<0.000***	4.918	***<0.000***	5.013	***<0.000***	5.011	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.842	***0.022***	-0.776	***0.024***	-0.801	***0.024***	-0.820	***0.021***	-0.913	***0.011***
Age (18-20=1)(21-24=2)(25-40=3)	0.285	0.359	0.263	0.378	0.236	0.441	0.315	0.306	0.287	0.356
Gender (1=Female)	0.179	0.587	0.110	0.731	0.234	0.478	0.177	0.589	0.163	0.621
Coastal hometown location (1=Coastal)	-0.086	0.807	-0.139	0.683	-0.055	0.873	-0.173	0.628	-0.038	0.916
Pre-Risk Perception Score	-0.025	0.346	-0.036	0.154	-0.031	0.234	-0.028	0.279	-0.015	0.583
Previous Hazard Experience	0.165	0.626	0.418	***0.026***	0.171	0.196	0.432	0.204	-0.179	0.616
Model RSq		0.112		0.170		0.130		0.129		0.112
Model p-value		0.201		***0.037***		0.124		0.126		0.200

Table C.5 Module 4 Pre-Test Score Regression Model Group

Module 4 Pre-Test Score										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score - pre)	8.100	***<0.000***	8.095	***<0.000***	7.941	***<0.000***	7.953	***<0.000***	7.974	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	0.135	0.755	0.052	0.903	0.085	0.843	0.105	0.803	0.015	0.971
Age (18-20=1)(21-24=2)(25-40=3)	0.179	0.631	0.143	0.700	0.126	0.736	0.192	0.606	0.159	0.671
Gender (1=Female)	-0.224	0.573	-0.246	0.538	-0.201	0.616	-0.233	0.556	-0.244	0.541
Coastal hometown location (1=Coastal)	-1.125	***0.009***	-1.097	***0.012***	-1.079	***0.012***	-1.194	***0.007***	-1.062	***0.015***
Pre-Risk Perception Score	0.022	0.485	0.029	0.359	0.025	0.424	0.024	0.428	0.036	0.283
Previous Hazard Experience	0.349	0.391	0.065	0.777	0.098	0.541	0.444	0.280	-0.141	0.743
Model RSq		0.102		0.094		0.098		0.108		0.094
Model p-value		0.255		0.312		0.286		0.223		0.310

Table C.6 Module 5 Pre-Test Score Regression Model Group

Module 5 Pre-Test Score										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score - pre)	5.110	***<0.000***	5.278	***<0.000***	4.670	***<0.000***	4.858	***<0.000***	5.486	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	0.030	0.940	-0.059	0.878	0.000	0.999	-0.045	0.907	-0.042	0.912
Age (18-20=1)(21-24=2)(25-40=3)	0.243	0.475	0.174	0.607	0.119	0.722	0.256	0.451	0.086	0.798
Gender (1=Female)	-0.581	0.111	-0.661	0.071	-0.494	0.174	-0.599	0.099	-0.555	0.122
Coastal hometown location (1=Coastal)	-0.436	0.261	-0.426	0.272	-0.339	0.373	-0.538	0.174	-0.513	0.184
Pre-Risk Perception Score	0.017	0.552	0.021	0.472	0.015	0.589	0.023	0.413	0.006	0.849
Previous Hazard Experience	0.656	0.080	0.374	0.078	0.311	***0.034***	0.722	0.056	0.896	***0.022***
Model RSq		0.099		0.100		0.118		0.107		0.127
Model p-value		0.274		0.271		0.171		0.227		0.135

Table C.7 Module 2 Post-Test Score Regression Model Group

Variables	Module 2 Post-Test Score									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score - post)	7.149	***<0.000***	7.401	***<0.000***	7.168	***<0.000***	7.145	***<0.000***	7.138	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.872	***0.014***	-0.720	***0.033***	-0.794	***0.023***	-0.772	***0.025***	-0.814	***0.018***
Age (18-20=1)(21-24=2)(25-40=3)	0.428	0.155	0.448	0.128	0.449	0.136	0.472	0.118	0.461	0.127
Gender (1=Female)	-0.158	0.619	-0.195	0.535	-0.144	0.655	-0.148	0.642	-0.154	0.629
Coastal hometown location (1=Coastal)	0.601	0.080	0.522	0.121	0.575	0.093	0.529	0.131	0.589	0.090
Pre-Risk Perception Score	-0.031	0.236	-0.048	0.056	-0.038	0.142	-0.040	0.112	-0.034	0.206
Previous Hazard Experience	-0.242	0.458	0.303	0.099	0.015	0.904	0.187	0.572	-0.089	0.797
Model RSq		0.145		0.171		0.138		0.142		0.139
Model p-value		0.081		***0.036***		0.098		0.088		0.096

Table C.8 Module 3 Post-Test Score Regression Model Group

Variables	Module 3 Post-Test Score									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score - post)	6.782	***<0.000***	6.629	***<0.000***	6.578	***<0.000***	6.601	***<0.000***	6.934	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.631	0.088	-0.765	***0.035***	-0.651	0.073	-0.625	0.078	-0.675	0.061
Age (18-20=1)(21-24=2)(25-40=3)	-0.065	0.837	-0.095	0.763	-0.124	0.693	-0.030	0.924	-0.136	0.667
Gender (1=Female)	0.693	***0.042***	0.703	***0.040***	0.731	***0.033***	0.686	***0.040***	0.702	***0.039***
Coastal hometown location (1=Coastal)	0.165	0.645	0.227	0.527	0.212	0.551	0.050	0.889	0.138	0.701
Pre-Risk Perception Score	-0.048	0.079	-0.034	0.200	-0.048	0.074	-0.050	0.057	-0.052	0.068
Previous Hazard Experience	0.324	0.348	-0.149	0.446	0.142	0.293	0.625	0.071	0.377	0.300
Model RSq		0.162		0.159		0.165		0.191		0.165
Model p-value		***0.047***		0.053		***0.043***		***0.019***		***0.044***

Table C.9 Module 5 Post-Test Score Regression Model Group

Module 5 Post-Test Score										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score - post)	6.744	***<0.000***	7.071	***<0.000***	6.271	***<0.000***	6.519	***<0.000***	7.205	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.801	0.104	-0.730	0.118	-0.661	0.156	-0.725	0.121	-0.743	0.111
Age (18-20=1)(21-24=2)(25-40=3)	-0.065	0.876	-0.094	0.817	-0.164	0.686	0.008	0.984	-0.184	0.653
Gender (1=Female)	-0.216	0.629	-0.301	0.491	-0.083	0.849	-0.217	0.618	-0.173	0.692
Coastal hometown location (1=Coastal)	-0.293	0.539	-0.354	0.446	-0.239	0.603	-0.484	0.310	-0.425	0.366
Pre-Risk Perception Score	0.022	0.536	0.010	0.782	0.004	0.906	0.014	0.675	-0.002	0.961
Previous Hazard Experience	0.226	0.622	0.509	***0.047***	0.398	***0.024***	0.892	0.051	0.937	***0.050***
Model RSq		0.070		0.118		0.132		0.116		0.117
Model p-value		0.518		0.172		0.116		0.180		0.177

Table C.10 Module 3 Score in Percentage Change Regression Model Group

Variables	Module 3 Score Difference %									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score Diff%)	0.355	0.191	0.252	0.344	0.387	0.160	0.349	0.200	0.429	0.122
Race (1=Minority/Hispanic, 0=White or did not answer)	0.114	0.385	0.071	0.567	0.093	0.468	0.112	0.381	0.128	0.310
Age (18-20=1)(21-24=2)(25-40=3)	-0.090	0.426	-0.090	0.410	-0.086	0.446	-0.090	0.428	-0.106	0.342
Gender (1=Female)	0.183	0.130	0.204	0.084	0.171	0.159	0.182	0.131	0.190	0.113
Coastal hometown location (1=Coastal)	0.022	0.864	0.048	0.699	0.022	0.865	0.019	0.882	0.000	0.997
Pre-Risk Perception Score	-0.002	0.819	0.003	0.708	0.000	0.991	-0.002	0.826	-0.006	0.520
Previous Hazard Experience	0.017	0.891	-0.142	***0.038***	-0.031	0.518	0.018	0.885	0.144	0.263
Model RSq		0.053		0.110		0.059		0.053		0.070
Model p-value		0.683		0.211		0.628		0.683		0.515

Table C.11 Module 4 Score Percentage Change Regression Model Group

Variables	Module 4 Score Difference %									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Module Score Diff%)	0.093	0.479	0.100	0.462	0.111	0.412	0.124	0.349	0.115	0.401
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.041	0.519	-0.022	0.727	-0.024	0.710	-0.035	0.577	-0.017	0.781
Age (18-20=1)(21-24=2)(25-40=3)	0.013	0.815	0.020	0.716	0.021	0.701	0.010	0.850	0.018	0.748
Gender (1=Female)	0.014	0.810	0.018	0.765	0.014	0.809	0.016	0.783	0.018	0.762
Coastal hometown location (1=Coastal)	0.119	0.060	0.112	0.078	0.111	0.081	0.133	***0.039***	0.108	0.094
Pre-Risk Perception Score	-0.002	0.714	-0.003	0.472	-0.003	0.496	-0.002	0.628	-0.004	0.388
Previous Hazard Experience	-0.073	0.228	-0.007	0.850	-0.006	0.788	-0.090	0.139	0.021	0.742
Model RSq		0.067		***0.048***		***0.049***		0.077		***0.049***
Model p-value		0.541		0.736		0.731		0.447		0.726

Table C.12 Pre-Risk Perception Score: Demographics

Risk Perception Score (pre)		
Variables	parameter estimate	p-value
Constant (Risk Perception Score - pre)	23.130	***<.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	1.200	0.461
Age (18-20=1)(21-24=2)(25-40=3)	0.933	0.519
Gender (1=Female)	4.347	***0.004***
Coastal hometown location (1=Coastal)	4.313	***0.007***
Model RSq		0.230
Model p-value		***0.001***

Table C.13 Post-Risk Perception Score: Demographics

Risk Perception Score (post)		
Variables	parameter estimate	p-value
Constant (Risk Perception Score - post)	27.939	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	0.788	0.579
Age (18-20=1)(21-24=2)(25-40=3)	0.883	0.485
Gender (1=Female)	2.850	***0.028***
Coastal hometown location (1=Coastal)	2.837	***0.041***
Model RSq		0.147
Model p-value		***0.021***

Table C.14 Pre-Risk Perception Score: Demographics and Previous Hazard Experience

Variables	Risk Perception Score (pre)									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Risk Perception Score - pre)	21.254	***<0.000***	22.855	***<0.000***	19.302	***<0.000***	21.537	***<0.000***	22.001	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	2.281	0.154	1.648	0.301	1.880	0.236	1.590	0.327	1.702	0.257
Age (18-20=1)(21-24=2)(25-40=3)	1.245	0.368	0.840	0.550	0.555	0.691	1.189	0.407	0.222	0.868
Gender (1=Female)	4.030	***0.005***	3.733	***0.011***	4.489	***0.002***	4.181	***0.005***	3.899	***0.005***
Coastal hometown location (1=Coastal)	3.379	***0.029***	3.665	***0.020***	4.025	***0.009***	3.455	***0.035***	2.679	0.077
Previous Hazard Experience	4.174	***0.005***	1.977	***0.021***	1.530	***0.009***	2.765	0.078	5.341	***0.000***
Model RSq		0.311		0.284		0.299		0.261		0.360
Model p-value		***<0.000***		***0.000***		***<0.000***		***0.001***		***<0.000***

Table C.15 Post-Risk Perception Score: Demographics and Previous Hazard Experience

Risk Perception Score (post)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (post)		Hurricane (post)		Flood (post)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Risk Perception Score - post)	26.730	***<0.000***	27.863	***<0.000***	22.096	***<0.000***	25.659	***<0.000***	26.135	***<0.000***
Race (1=Minority/Hispanic, 0=White or did not answer)	1.484	0.300	0.913	0.525	1.745	0.190	1.307	0.351	1.309	0.344
Age (18-20=1)(21-24=2)(25-40=3)	1.084	0.382	0.857	0.499	0.533	0.646	0.886	0.471	0.594	0.626
Gender (1=Female)	2.646	***0.037***	2.679	***0.043***	4.135	***0.001***	2.674	***0.034***	3.102	***0.014***
Coastal hometown location (1=Coastal)	2.235	0.105	2.656	0.060	2.485	0.051	1.905	0.174	2.386	0.075
Previous Hazard Experience	2.691	***0.039***	0.552	0.469	1.849	***0.000***	3.563	***0.025***	3.341	***0.011***
Model RSq		0.197		0.153		0.294		0.206		0.222
Model p-value		***0.007***		***0.034***		***0.000***		***0.005***		***0.003***

Table C.16 Pre-Risk Perception Score: Demographics, Previous Hazard Experience, and Total Module Scores

Risk Perception Score (pre)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Risk Perception Score - pre)	22.478	***0.001***	23.743	***0.001***	21.532	***0.002***	22.541	***0.002***	20.956	***0.002***
Race (1=Minority/Hispanic, 0=White or did not answer)	2.206	0.183	1.590	0.337	1.738	0.290	1.526	0.365	1.774	0.259
Age (18-20=1)(21-24=2)(25-40=3)	1.287	0.361	0.867	0.544	0.616	0.663	1.227	0.402	0.190	0.889
Gender (1=Female)	4.000	***0.006***	3.707	***0.013***	4.442	***0.003***	4.155	***0.006***	3.923	***0.005***
Coastal hometown location (1=Coastal)	3.322	***0.036***	3.625	***0.024***	3.928	***0.013***	3.399	***0.045***	2.720	0.078
Total Module Score (pre)	-0.038	0.844	-0.027	0.891	-0.071	0.716	-0.031	0.876	0.032	0.862
Previous Hazard Experience	4.221	***0.005***	1.998	***0.023***	1.580	***0.009***	2.823	0.082	5.334	***0.000***
Model RSq		0.311		0.284		0.301		0.261		0.360
Model p-value		***0.000***		***0.001***		***0.000***		***0.001***		***<0.000***

Table C.17 Post-Risk Perception Score: Demographics, Previous Hazard Experience, and Total Module Scores

Variables	Risk Perception Score (post)									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (post)		Hurricane (post)		Flood (post)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Risk Perception Score - post)	18.950	***0.001***	20.368	***0.001***	16.745	***0.002***	17.673	***0.002***	19.226	***0.001***
Race (1=Minority/Hispanic, 0=White or did not answer)	2.075	0.159	1.462	0.323	2.132	0.121	1.917	0.185	1.820	0.202
Age (18-20=1)(21-24=2)(25-40=3)	1.006	0.413	0.786	0.533	0.490	0.672	0.806	0.507	0.534	0.659
Gender (1=Female)	2.608	***0.038***	2.670	***0.042***	4.059	***0.001***	2.632	***0.035***	3.059	***0.015***
Coastal hometown location (1=Coastal)	2.312	0.091	2.761	***0.050***	2.553	***0.045***	1.973	0.155	2.470	0.064
Total Module Score (post)	0.213	0.129	0.205	0.156	0.152	0.252	0.218	0.119	0.190	0.169
Previous Hazard Experience	2.690	***0.037***	0.459	0.545	1.780	***0.001***	3.600	***0.022***	3.229	***0.013***
Model RSq		0.223		0.177		0.307		0.233		0.243
Model p-value		***0.006***		***0.029***		***0.000***		***0.004***		***0.003***

Table C.18 Pre-Risk Perception Score: Demographics, Previous Hazard Experience, and Individual Module Scores

Risk Perception Score (pre)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Risk Perception Score - pre)	23.034	***0.001***	23.548	***0.001***	22.087	***0.002***	23.112	***0.002***	21.342	***0.002***
Race (1=Minority/Hispanic, 0=White or did not answer)	1.421	0.414	0.819	0.632	0.832	0.628	0.717	0.681	1.188	0.476
Age (18-20=1)(21-24=2)(25-40=3)	1.119	0.427	0.759	0.590	0.635	0.654	1.048	0.471	0.211	0.878
Gender (1=Female)	3.680	***0.014***	3.355	***0.028***	4.242	***0.006***	3.828	***0.013***	3.627	***0.014***
Coastal hometown location (1=Coastal)	4.423	***0.009***	4.649	***0.006***	4.885	***0.004***	4.630	***0.010***	3.725	***0.027***
Mod1 (pre)	0.217	0.707	0.380	0.514	-0.034	0.954	0.220	0.710	0.209	0.710
Mod2 (pre)	-1.220	0.098	-1.211	0.103	-1.004	0.190	-1.325	0.080	-0.866	0.239
Mod3 (pre)	-0.372	0.510	-0.668	0.255	-0.494	0.391	-0.443	0.448	-0.239	0.665
Mod4 (pre)	0.582	0.221	0.676	0.155	0.603	0.210	0.651	0.183	0.643	0.163
Mod5 (pre)	0.336	0.497	0.360	0.468	0.337	0.505	0.447	0.379	0.125	0.801
Previous Hazard Experience	3.552	***0.020***	1.949	***0.031***	1.280	***0.047***	2.231	0.171	4.694	***0.003***
Model RSq		0.358		0.350		0.343		0.322		0.388
Model p-value		***0.001***		***0.001***		***0.001***		***0.003***		***0.000***

Table C.19 Post-Risk Perception Score: Demographics, Previous Hazard Experience, and Individual Module Scores

Variables	Risk Perception Score (post)									
	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (post)		Hurricane (post)		Flood (post)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Risk Perception Score - post)	16.625	***0.005***	18.069	***0.003***	14.777	***0.011***	15.036	***0.013***	17.025	***0.004***
Race (1=Minority/Hispanic, 0=White or did not answer)	1.124	0.453	0.452	0.763	1.279	0.372	0.964	0.511	0.979	0.508
Age (18-20=1)(21-24=2)(25-40=3)	1.161	0.344	1.064	0.399	0.739	0.534	1.001	0.411	0.701	0.571
Gender (1=Female)	3.003	***0.019***	3.048	***0.025***	3.986	***0.002***	2.931	***0.021***	3.349	***0.009***
Coastal hometown location (1=Coastal)	2.987	***0.034***	3.576	***0.013***	3.197	***0.017***	2.760	0.051	3.134	***0.024***
Mod1 (post)	0.258	0.636	0.245	0.663	0.332	0.529	0.434	0.430	0.371	0.499
Mod2 (post)	-0.400	0.454	-0.595	0.277	-0.502	0.325	-0.513	0.329	-0.338	0.532
Mod3 (post)	-0.699	0.168	-0.621	0.246	-0.310	0.535	-0.649	0.197	-0.661	0.192
Mod4 (post)	1.134	***0.023***	1.150	***0.025***	0.919	0.057	1.096	***0.027***	0.923	0.069
Mod5 (post)	0.590	0.117	0.644	0.111	0.294	0.440	0.581	0.121	0.553	0.144
Previous Hazard Experience	2.498	0.052	0.172	0.829	1.559	***0.004***	3.367	***0.032***	2.629	0.051
Model RSq		0.300		0.259		0.347		0.309		0.300
Model p-value		***0.006***		***0.022***		***0.001***		***0.004***		***0.006***

Table C.20 Risk Perception Score Percentage Change: Demographics, Previous Hazard Experience, and Total Module Scores

Risk Perception Score (Total Module Difference %)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (diff %)		Hurricane (diff %)		Flood (diff %)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Risk Perception Score - diff %)	0.186	***0.021***	0.166	***0.028***	0.130	0.089	0.155	***0.042***	0.134	0.081
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.019	0.726	-0.015	0.774	-0.002	0.968	-0.004	0.934	0.000	0.996
Age (18-20=1)(21-24=2)(25-40=3)	0.006	0.905	0.012	0.794	0.015	0.756	0.005	0.912	0.014	0.770
Gender (1=Female)	-0.069	0.165	-0.059	0.234	-0.054	0.282	-0.073	0.139	-0.063	0.202
Coastal hometown location (1=Coastal)	-0.073	0.173	-0.071	0.179	-0.093	0.078	-0.084	0.112	-0.075	0.155
Total Module Score (diff %)	0.445	***0.032***	0.461	***0.023***	0.502	***0.014***	0.471	***0.022***	0.485	***0.017***
Previous Hazard Experience	-0.055	0.275	-0.046	0.106	0.059	0.062	0.055	0.371	0.069	0.160
Model RSq		0.139		0.156		0.167		0.134		0.149
Model p-value		0.096		0.057		***0.044***		0.111		0.072

Table C.21 Risk Perception Score Percentage Change: Demographics, Previous Hazard Experience, and Individual Scores

Risk Perception Score (Individual Module Difference %)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (diff %)		Hurricane (diff %)		Flood (diff %)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Risk Perception Score - diff %)	0.204	***0.017***	0.197	***0.013***	0.152	0.067	0.174	***0.035***	0.151	0.065
Race (1=Minority/Hispanic, 0=White or did not answer)	0.001	0.984	0.004	0.938	0.018	0.757	0.015	0.788	0.025	0.656
Age (18-20=1)(21-24=2)(25-40=3)	-0.005	0.927	-0.002	0.972	0.004	0.936	-0.003	0.949	0.002	0.968
Gender (1=Female)	-0.056	0.273	-0.035	0.487	-0.043	0.404	-0.060	0.237	-0.047	0.354
Coastal hometown location (1=Coastal)	-0.086	0.125	-0.076	0.157	-0.100	0.066	-0.094	0.087	-0.081	0.133
Mod1 (diff %)	0.050	0.581	0.068	0.439	0.059	0.515	0.050	0.580	0.055	0.533
Mod2 (diff %)	0.122	0.371	0.179	0.179	0.167	0.222	0.121	0.382	0.174	0.201
Mod3 (diff %)	-0.039	0.465	-0.070	0.190	-0.028	0.598	-0.038	0.482	-0.049	0.351
Mod4 (diff %)	0.165	0.135	0.163	0.124	0.122	0.287	0.159	0.167	0.147	0.179
Mod5 (diff %)	0.108	0.138	0.127	0.073	0.129	0.077	0.125	0.093	0.139	0.057
Previous Hazard Experience	-0.046	0.380	-0.068	***0.026***	0.054	0.123	0.039	0.575	0.088	0.092
Model RSq		0.160		0.212		0.181		0.154		0.186
Model p-value		0.272		0.082		0.184		0.305		0.155

Table C.22 Gender: Pre-Test Model with Total Module Scores

Gender (Pre-Test)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Gender)	0.282	0.622	0.415	0.471	0.229	0.684	0.312	0.585	0.262	0.645
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.107	0.425	-0.089	0.495	-0.117	0.370	-0.100	0.446	-0.109	0.406
Age (18-20=1)(21-24=2)(25-40=3)	-0.145	0.198	-0.139	0.210	-0.135	0.226	-0.140	0.216	-0.136	0.228
Coastal hometown location (1=Coastal)	0.013	0.918	-0.003	0.979	0.011	0.929	0.006	0.967	0.021	0.873
Risk Perception Score (pre)	0.026	***0.006***	0.023	***0.013***	0.028	***0.003***	0.025	***0.006***	0.027	***0.005***
Total Module Score (pre)	-0.012	0.416	-0.015	0.323	-0.009	0.559	-0.013	0.389	-0.013	0.399
Previous Hazard Experience	-0.022	0.860	0.062	0.376	-0.049	0.312	0.017	0.895	-0.062	0.631
Model RSq		0.159		0.168		0.171		0.159		0.162
Model p-value		0.052		***0.039***		***0.036***		0.053		***0.048***

Table C.23 Gender: Post-Test Model with Total Module Scores

Gender (Post-Test)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (post)		Hurricane (post)		Flood (post)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Gender)	-0.063	0.909	0.000	1.000	-0.041	0.936	-0.060	0.914	-0.101	0.853
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.066	0.636	-0.050	0.706	-0.145	0.250	-0.072	0.602	-0.096	0.475
Age (18-20=1)(21-24=2)(25-40=3)	-0.159	0.167	-0.159	0.159	-0.120	0.257	-0.160	0.161	-0.146	0.198
Coastal hometown location (1=Coastal)	0.074	0.567	0.048	0.711	0.055	0.641	0.079	0.551	0.084	0.505
Risk Perception Score (post)	0.023	***0.038***	0.022	***0.042***	0.034	***0.001***	0.023	***0.035***	0.027	***0.015***
Total Module Score (post)	-0.003	0.837	-0.004	0.763	0.000	0.995	-0.003	0.830	-0.003	0.848
Previous Hazard Experience	0.013	0.915	0.090	0.188	-0.157	***0.001***	-0.011	0.944	-0.163	0.189
Model RSq		0.108		0.130		0.242		0.108		0.130
Model p-value		0.223		0.125		***0.003***		0.224		0.125

Table C.24 Gender: Pre-Test Model with Individual Module Scores

Gender (Pre-Test)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (pre)		Hurricane (pre)		Flood (pre)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Gender)	0.344	0.562	0.424	0.474	0.295	0.612	0.357	0.546	0.334	0.571
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.039	0.778	-0.026	0.846	-0.057	0.670	-0.036	0.790	-0.044	0.747
Age (18-20=1)(21-24=2)(25-40=3)	-0.150	0.183	-0.146	0.187	-0.142	0.199	-0.146	0.195	-0.146	0.193
Coastal hometown location (1=Coastal)	0.039	0.778	0.023	0.865	0.052	0.701	0.032	0.826	0.047	0.742
Mod1 (Pre)	0.037	0.426	0.041	0.372	0.050	0.288	0.036	0.429	0.037	0.425
Mod2 (Pre)	-0.078	0.190	-0.074	0.213	-0.092	0.123	-0.077	0.193	-0.080	0.183
Mod3 (Pre)	0.040	0.372	0.029	0.537	0.047	0.294	0.039	0.388	0.040	0.379
Mod4 (Pre)	-0.003	0.937	-0.004	0.924	0.002	0.959	-0.004	0.919	-0.003	0.937
Mod5 (Pre)	-0.061	0.124	-0.067	0.087	-0.047	0.231	-0.062	0.115	-0.058	0.153
Risk Perception Score (pre)	0.024	***0.014***	0.021	***0.028***	0.026	***0.006***	0.023	***0.013***	0.025	***0.014***
Previous Hazard Experience	-0.002	0.990	0.065	0.374	-0.065	0.200	0.024	0.850	-0.033	0.811
Model RSq		0.217		0.227		0.237		0.218		0.218
Model p-value		0.072		0.056		***0.042***		0.071		0.071

Table C.25 Gender: Post-Test Model with Individual Module Scores

Gender (Post-Test)										
Variables	Harvey		Any Named Hurricane (excluding Harvey)		All Hazards (post)		Hurricane (post)		Flood (post)	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Gender)	-0.052	0.929	-0.025	0.965	0.049	0.929	-0.051	0.931	-0.054	0.925
Race (1=Minority/Hispanic, 0=White or did not answer)	-0.051	0.717	-0.019	0.887	-0.120	0.364	-0.047	0.738	-0.080	0.562
Age (18-20=1)(21-24=2)(25-40=3)	-0.128	0.270	-0.119	0.288	-0.095	0.385	-0.127	0.274	-0.104	0.365
Coastal hometown location (1=Coastal)	0.060	0.657	0.013	0.918	0.050	0.692	0.058	0.671	0.073	0.582
Mod1 (post)	0.027	***0.019***	0.024	***0.025***	0.034	***0.002***	0.027	***0.021***	0.029	***0.009***
Mod2 (post)	0.009	0.854	0.018	0.715	-0.002	0.962	0.009	0.860	0.000	0.996
Mod3 (post)	-0.041	0.414	-0.051	0.294	-0.036	0.441	-0.040	0.423	-0.052	0.301
Mod4 (post)	0.098	***0.040***	0.113	***0.016***	0.063	0.167	0.097	***0.041***	0.098	***0.037***
Mod5 (post)	-0.040	0.398	-0.036	0.433	-0.027	0.544	-0.040	0.402	-0.029	0.545
Risk Perception Score (post)	-0.035	0.332	-0.054	0.134	-0.005	0.883	-0.035	0.328	-0.029	0.409
Previous Hazard Experience	-0.021	0.862	0.142	***0.042***	-0.138	***0.006***	-0.009	0.955	-0.163	0.198
Model RSq		0.184		0.234		0.273		0.184		0.204
Model p-value		0.164		***0.046***		***0.014***		0.165		0.101

Table C.26 Likert-scale Knowledge Question Simple Regression with Gender

How well informed are you about the potential impacts of a natural hazard event (e.g., hurricane, tornado, wildfire, flooding)?								
Variables	pre		post		diff#		diff%	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Question)	3.867	***<0.000***	4.378	***<0.000***	0.511	***0.000***	0.170	***0.001***
Gender	-0.429	***0.017***	-0.315	0.054	0.114	0.573	0.080	0.297
Model RSq		0.074		***0.049***		***0.004***		***0.014***
Model p-value		***0.017***		0.054		0.573		0.297

Table C.27 Likert-scale Fear Question Simple Regression with Gender

Does thinking or talking about any hazards scare or upset you?								
Variables	pre		post		diff#		diff%	
	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value	parameter estimate	p-value
Constant (Question)	1.911	***<0.000***	1.978	***<0.000***	0.067	0.677	0.152	0.094
Gender	0.589	***0.011***	0.616	***0.008***	0.027	0.913	0.049	0.727
Model RSq		0.083		0.091		***0.000***		***0.002***
Model p-value		***0.011***		***0.008***		0.913		0.727

APPENDIX D

SURVEY QUESTIONS

Table D.1 Module 1 Questions

Module 1								
Which of the following changes day to day?	At least one natural hazard exists locally at any point and time. (t/f)	Define what a natural hazard is in your own words.	The land features and climate patterns of a place determine which natural hazards can occur in a given location. (t/f)	What are the four common regions of Texas?	What region of Texas would be most likely to experience a Hurricane? Why?	What type of climate exists around Texas A&M University in College Station, TX?	Which of the following are natural hazards? (Select all that apply)	Which of the following are types of natural hazards? (Select all that apply)

Table D.2 Module 2 Questions

Module 2								
Cold fronts bring more severe storms. (t/f)	If an air mass comes north from the Gulf of Mexico it will be: (t/f)	List the natural hazards that can occur in College Station, TX	Texas does not experience drought. (t/f)	What man-made factors make floods worse? Choose all that apply.	What three states would have the most earthquakes?	Which of the following are very common natural hazard events that can occur in Texas? Choose all that apply	Which of the following natural hazards could be related to severe storms? Select all that apply.	Why is extreme heat dangerous?

Table D.3 Module 3 Questions

Module 3								
______ describes the likelihood (or chance) that the natural hazard event will occur. (t/f)	An event can be classified as a disaster if (select all that apply):	An event is only a disaster if it affects people in some way. (t/f)	Define in your own words vulnerability in the context of natural hazards and disasters.	Is cost (in terms of economic losses) an accurate measure of the severity of a disaster? Justify your answer.	Resiliency can be increased by taking adaptive action. (t/f)	Social vulnerability refers to factors such as (select all that apply):	Vulnerability is the chance that a natural hazard event can affect you. (t/f)	What are the three components that vulnerability is made of?

Table D.4 Module 4 Questions

Module 4										
What should you NOT do if you have a pet during a disaster?	After a disaster occurs, it's important that children have a routine. (t/f)	An action is considered mitigation if it takes place before a disaster.	Give reasons why people may evacuate and reasons why people might not evacuate.	If you are driving on the road and a tornado is spotted nearby, what would you do? Why?	What does a Watch mean in weather alerts?	What is an example of non-structural mitigation? Choose all that apply.	When making a household emergency plan, how many hours' worth of supplies should you plan on having?	When stuck outside during a thunderstorm, lie flat on the ground spread-eagle on your stomach so the electricity can go from you to the ground quicker. (t/f)	Which of the following are safe places to be during a tornado? (choose all that apply)	Why should you avoid flood waters, both while evacuating or sheltering-in-place, as much as possible?

Table D.5 Module 5 Questions

Module 5								
Explain why overbuilding a city in a floodplain, with concrete paving over green spaces, may exacerbate flooding issues.	Hurricane Harvey was destructive because of the category 4 winds. (t/f)	Hurricane Harvey's origins were off the coast of Africa. (t/f)	In Harris County, flood levels during Harvey exceeded the 500-year levels. (t/f)	In terms of fatalities, what was the most common cause of deaths directly related to Hurricane Harvey?	Recovery from Harvey is still ongoing. (t/f)	Where does Harvey rank in terms of damage cost compared to other hurricanes as of 2018?	Which of the following factors does the Saffir-Simpson scale take into consideration when categorizing hurricanes? (Select all that apply)	Why would a hurricane moving slow or stalling over land be potentially destructive?

Table D.6 Multi-Hazard Risk Perception Questions

Multi-Hazard Risk Perception Questions			
• Do one or more of the following specific hazards scare or upset you more than the others? • How likely is it that you might be directly affected by a ___ in the future?			
Hazard Type	Codes	Hazard Type	Codes
Flood	0 – No 1 - Yes	Wildfire	0 – No 1 - Yes
Severe Storm	0 – No 1 - Yes	Sinkhole	0 – No 1 - Yes
Hurricane	0 – No 1 - Yes	Earthquake	0 – No 1 - Yes
Tornado	0 – No 1 - Yes	Volcano	0 – No 1 - Yes

Table D.7 Risk Perception, Vulnerability, and Knowledge and Experience Questions

Risk Perception, Vulnerability, and Knowledge and Experience Questions			
Questions	Codes	Questions	Codes
Does thinking or talking about any hazards scare or upset you?	1 - Strongly Disagree 2- Disagree 3 - Undecided 4 - Agree 5 - Strongly Agree	In the past five years, do you feel the risk from hurricanes has:	1 - Very much decreased 2 - Decreased 3 - Neither increased or decreased 4 - Increased 5 - Very much increased
How vulnerable do you feel in terms of hurricane impacts directly affecting the accessibility of your home or possible isolation from damage/debris?	1 - Not at all vulnerable 2 - Mostly not vulnerable 3 - Undecided 4 - Somewhat vulnerable 5 - Very vulnerable	How concerning are natural hazards to you?	1 - Not at all 2 - Not really 3 - Undecided 4 - Somewhat 5 - Very
How vulnerable do you feel in terms of hurricane impacts directly affecting you?	1 - Not at all vulnerable 2 - Mostly not vulnerable 3 - Undecided 4 - Somewhat vulnerable 5 - Very vulnerable	How concerned are you of a natural hazard event occurring in your current location?	1 - Not at all 2 - Not really 3 - Undecided 4 - Somewhat 5 - Very
How vulnerable do you feel in terms of hurricane impacts directly affecting your family?	1 - Not at all vulnerable 2 - Mostly not vulnerable 3 - Undecided 4 - Somewhat vulnerable 5 - Very vulnerable	Has your home ever been flooded?	0 - No 1 - Yes
How well informed are you about the potential impacts of a natural hazard event (e.g., hurricane, tornado, wildfire, flooding)?	1 - Uninformed 2 - Not well-informed 3 - Neither informed or uninformed 4 - Well-informed 5 - Very well-informed		
How vulnerable do you feel in terms of hurricane impacts directly affecting your property and/or possessions?	1 - Not at all vulnerable 2 - Mostly not vulnerable 3 - Undecided 4 - Somewhat vulnerable 5 - Very vulnerable		

Table D.8 Coping Capability and Planning Questions

Coping Capability and Planning Questions			
Questions	Codes	Questions	Codes
How capable do you feel of recovering from damage or loss to material belongings (e.g., home and personal belongings) from a hurricane and its associated hazards (flood and wind damage?	1 - Very incapable 2 - Somewhat incapable 3 - Neither capable or incapable 4 - Somewhat capable 5 - Very capable	Have you ever practiced what to do in the event of a natural hazard or disaster (at home, school, or elsewhere)?	1 - No 2 - Unsure 3 - Yes
How capable do you feel of recovering from injury or loss of life to you or your family from a hurricane and its associated hazards (flood and wind damage)?	1 - Very incapable 2 - Somewhat incapable 3 - Neither capable or incapable 4 - Somewhat capable 5 - Very capable	How motivated are you to learn more about different planning and mitigation practices (e.g., adding storm shutters to your home) that can help you reduce impacts from hazards and disasters?	1 - Not at all motivated 2 - Somewhat unmotivated 3 - Neither motivated or unmotivated 4 - Motivated 5 - Extremely motivated
How capable do you feel of recovering psychologically (e.g., stress and hardship) from a hurricane and its associated hazards (flood and wind damage)?	1 - Very incapable 2 - Somewhat incapable 3 - Neither capable or incapable 4 - Somewhat capable 5 - Very capable	In an emergency, do you know where you would meet your family (or those you live with/are close to)?	1 - No 2 - Unsure 3 - Yes
Do you or those you live with have a plan of your house showing exits and where to turn off water, electricity, and gas?	1 - No 2 - Unsure 3 - Yes	Do you or those you live with have an emergency plan that tells you what to do to be ready for a natural hazard or disaster?	1 - No 2 - Unsure 3 - Yes

Table D.9 Demographic Questions

Demographic Questions	
Questions	Codes
Minority/Hispanic? (0 White or did not answer)	0 - White/No answer 1 - Minority/Hispanic
What is your age?	18-20=1, 21-24=2, 25-40=3
What is your gender?	0 - Male 1 - Female
Coastal hometown location? (regional)	0 - Non-coastal 1 - Coastal