Leveraging Informal Learning Pedagogies to Empower Coastal Communities for Disaster Preparedness

Piyush Pradhananga[1], Amal Elawady[2]* and Mohamed ElZomor[3]*

[1]Department of Civil and Environmental Engineering, Florida International University, Miami, FL, United States, [2]Moss School of Construction, Infrastructure, and Sustainability, Florida International University, Miami, FL, United States, [3]Extreme Events Institute of International Hurricane Research Center, Department of Civil and Environmental Engineering, Florida International University, Miami, FL, United States

With the increasing frequency and intensity of hurricanes, people and communities within hurricane-prone zones are often overwhelmed and lack effective preparedness in terms of social connectivity critical for making proactive decisions to survive anticipated disasters. Disaster management agencies traditionally share preparedness guidelines through formal educational and other public media channels (such as academic institutions, articles, and the Federal Emergency Management Agency, etc.) only. However, such formal modalities seldom consider the socio-economic status, cultural background, diversity, and education level of communities. Consequently, vulnerable communities are challenged by poor inclusive accessibility, lack of receptiveness, and responsiveness. An *Informal Learning Pedagogy (ILP)* for hurricane preparedness can be a practical solution to disseminate knowledge on preparedness and hurricane impacts at the community level through nurturing enthusiasm to learn from one another within the community setting, which causes ripple effects that are more profound within a diverse community. This approach would effectively support educating more people about hurricane preparedness. The main objectives of this study are: 1) to assess the hurricane preparedness awareness of people living in a hurricane-prone coastal community in South Florida, United States; 2) to investigate the applicability of adopting novel ILP mechanisms for a disaster-prone community and; 3) analyze and plan for the development of online community-centered hurricane preparedness training with a primary focus on preparedness, warning, evacuation, and early recovery. Developing training modules focused on disaster preparedness through informal learning environments depends on incorporating actual community requirements, which reflect audience-centered needs as part of enhancing the resilience capacity of coastal communities. As such, in this study, an online questionnaire survey focusing on the validation of the research hypothesis was designed and conducted among South Florida residents. The survey data results indicated that participation in disaster-preparedness training through informal modalities highly depends on the length of an individual's stay in a disaster-prone zone, anticipated benefits of disaster education, and the availability of online training. This research study contributes to the disaster preparedness and response bodies of knowledge by identifying

informal ways of communicating hazard preparedness knowledge to advance the resilience capacities in disaster-prone communities.

Keywords: community-centered learning, natural disasters, informal learning pedagogy, disaster preparedness, education modules

1 INTRODUCTION

With the increasing frequency and severity of natural disasters worldwide, disaster education is one of the most effective approaches to preparing disaster-prone communities and their people (Preston, 2012). For instance, before a hurricane, residents who feel unsafe in their homes tend to evacuate, while those who feel safe tend to stay (Sadri et al., 2014). It is clear that due to a lack of efficiency in disaster education and practices, people are unable to accurately decide on their rational and required resources, especially when making evacuation decisions (Huang et al., 2016). It also explains why some people feel safe while others are unsafe despite living in the same community and sharing similar demographics (Thiede and Brown, 2013). Another major problem during a disaster is that required disaster supplies become out of stock due to the sudden increase in demands (Wolshon et al., 2005). Consequently, people with limited supplies generally suffer the most before, during, and aftermath. Similarly, there have been shortcomings in providing supplies and support to nursing homes. Such shortcomings were observed in 13 nursing homes during hurricane Katrina when 70 home residents died (Ursano et al., 2007). Some communities lack the readiness to make educated decisions prior to a disaster; therefore, educating the community with fundamental disaster knowledge is deemed necessary, especially in disaster-prone areas (Richard Eiser et al., 2012).

Disaster education is conveyed to the community through traditional channels like public notices, federal/governmental websites, while modern technology platforms such as social media, radio, and news are used to communicate instructions. Authorities deem it vital to provide information about the anticipated risk of pre-disasters, highway traffic, ways to prepare for imminent disasters, etc. (Jhon and Sims, 1983). In many recent disasters, information about one's condition and location, as well as learning about a disaster-affected individual have been possible through the use of social media platforms such as Facebook and Twitter (Houston et al., 2015). These informal education platforms are also advantageous in providing rapid instructions, including disaster preparedness information, disaster warning, response, recovery, and rebuilding, as well as mental and behavioral support (Cecile and Radisch, 2013). Additionally, the use of social media platforms to document the severity of disasters while learning about their impacts and implementing traditional crisis communication activities increased tremendously (Velev and Zlateva, 2015). Thus, social media platforms provide an opportunity to integrate informal learning pedagogies for disaster preparedness, thus increasing the number of people receiving preparedness knowledge and required training.

Informal education is one of the engaging ways of offering creative educational materials with the potential to reach a wider population (Bernhardsdottir et al., 2016). Such learning pedagogy

may leverage the expansion of social media to integrate the use of brochures, posters, documentaries, short videos as well as could be disseminated through cultural and performing arts, after school clubs, and disaster drills in addition to community organizations (e.g., places of worship including churches, mosques, temples, etc.), and non-governmental organization (Petal and Izadkhah, 2008). Nielsen and Lidstone, (1998) found that such a form of training is effective for the public, especially for increasing social awareness. To this end, disaster preparedness is conceptualized as a critical strategy enforced by the government to educate the public on the prevention and reduction of disaster impacts and make them able to take a proactive decisions when facing natural hazards (Cole et al., 2021). The available institutional guidelines are also seldom effective for the public due to a lack of receptiveness and responsiveness from vulnerable communities to follow through the robust technical guidelines (Levac et al., 2012). Additionally, since some vulnerable and underrepresented communities have restricted opportunities, limited access to education, and poverty, formal educational modalities challenge such underrepresented populations (Orencio and Fujii, 2013). To this end, it is critical to investigate innovative means to capture the general public awareness and educate them about disaster preparedness, warning, evacuation, and early recovery.

During the last decade, coastline cities in the United States have not only continued to experience population growth but also have been exposed to costly and damaging natural disasters, including hurricanes (Preston, 2012). According to US. Census Bureau's 2016 population, the population of coastal counties increased by more than 10 million from 2000 to 2016, thereby indicating that established strategies need to be updated to prevent the impact of future disasters on such growing populations (Neumann et al., 2015). 2020 was an abnormally active hurricane season with 30 named storms, among which 12 were major hurricanes (Beven, 2021). Cegan et al. (2022) highlighted that across the country, communities of color and low-income communities who reside in these vulnerable areas did not have the financial resources or access to credit to make their home safer before the disaster (e.g., by raising a home on pilings to avoid floodwaters). Additionally, they could not afford things like flood insurance coverage, which would give them more financial capacity to rebuild after a flood (Brown et al., 2021; Zinda et al., 2021). The devastating hurricanes that hit the United States revealed that people and communities lack effective preparedness in terms of social connectivity and making proactive decisions to survive such disasters (Dow and Cutter, 2002). Although hurricanes are considered predictable and trackable with early warnings, there remains increased anxiety levels among the community in terms of allocating critical supplies for survival (Stark and Taylor, 2014). Sadri et al. (2017) highlighted that the household, neighborhood, and community-related factors significantly impact the rebuilding process

and enhancement of resilience from disasters based on a study of a rural community in Indiana, the United States, that was hit by a deadly tornado. Similarly, due to the lack of community preparedness and resilience during previous hurricanes such as Floyd, Katrina, Sandy, and Irma, there were chaotic as well as shadow evacuations that resulted in congestion and traffic problems which in turn threatened people's safety during hurricanes (Lindell et al., 2005). Learning to deal with such challenges before, during, and after a hurricane is vital regardless of whether people stay or evacuate. Yet, society lacks an innovative community education module that improves the thinking capacity and bolsters effective decision-making during disasters (Shreve and Kelman, 2014). Therefore, this study investigates the applicability of adopting novel learning modalities (*informal learning pedagogy*) for a disaster-prone community and identifies community readiness and communication gaps in preparedness knowledge so that informal learning channels can be prepared based on actual community requirements gathered through survey respondents' feedback.

2 BACKGROUND AND RELEVANT WORK

South Florida consists of a diverse population that is multilingual and multicultural. For example, according to US. Census Bureau (Census, 2020), the largest ethnic or racial group in Miami-Dade County is Hispanic or Latino with 68.7% of the total population, Black or African American with 14% of the total population, White population with 13.4%, and 3.9% other racial or ethnic groups. On the other hand, Broward County has a White population as the largest ethnic or racial group with 33.1% of the total population, a Hispanic population as the second largest with 31.3%, Black or African American with 26.6% of the total population, and 9% other ethnic or racial groups. Both Miami-Dade and Broward County are within a few miles distance, but the composition of ethnic or racial groups vary significantly from one another. Hence, the broad field of community-centered education in South Florida faces challenges and opportunities to adapt to an increasingly globalized and diverse environment, instructional technology, and new pedagogical approaches.

Community resilience is a collective term that describes the resources and capabilities of a community to survive a disaster (Adhikari et al., 2016). It is highly dependent on household emergency preparedness which incorporates various topics such as understanding the risks of disaster, knowledge of developing and implementing an emergency plan, and having the critical emergency supplies for 72 h, among others (Wartman et al., 2020). Although all vulnerable communities are expected to be properly aware of these topics, Murti et al. (2014) highlighted that only 30–40% of residents in the US. are fully prepared with emergency plans and critical supplies. Communities with a strong social network and shared values have stronger community resilience during adversity (Hatzikyriakou and Lin, 2018). ElZomor et al. (2016) conducted a case study in Phoenix to address the challenges of extreme weather conditions by developing a decision support tool, which also bolsters disaster preparedness and community resilience; their results highlighted the importance of preparedness in dealing with the crisis and

emphasized emergency planning in a decentralized approach. However, to date, many disaster-prone communities lack innovative pedagogies that utilize decentralized approaches.

Community learning approaches can be divided into two primary categories, namely formal and informal learning environments (Bernhardsdottir et al., 2016). A primary difference between formal and informal learning is that formal learning is conducted in a structured setting, which leads to certification based on completing the learning program. In contrast, non-formal learning does not lead to any official certification and is conducted in a non-structured setting (Tait and Latchem, 2015). Community-centered learning is one of the appropriate decentralized techniques for delivering disaster education in an informal platform where people learn from one another within their social network and continually attempt to improve (Scolobig et al., 2015). Since such type of learning takes place in a non-structured setting and there is no official certification, the community-centered learning can be referred as an informal learning approach. The exploration of community learning has been beneficial in other disciplines as well for the enhancement of community engagement and participation of people for recreation and facilitating a true sense of community (Whittaker et al., 2015). For example, a community music project in a neighborhood in the United Kingdom, which involved different music-making activities of various sizes and compositions of groups, helped achieve the social goal and positive outcome by creating artistic expression and participatory practices (Rimmer, 2012). An informal community learning can take many forms, such as wider community fairs, community welfare meetings, and open houses, which provide engaging ways to introduce significant knowledge, information, skills, and competencies of disaster risk reduction for people of all ages (Salmon et al., 2011). However, the adoption of an informal learning method for disaster education has not been widely utilized, even though the world of learning has rapidly evolved through technology. Besides, community-level informal learning utilizes existing societal structures or individuals' social networks to aid in understanding disasters, fundamental strategies, and preparedness (Preston, 2012). However, there is a lack of an easy-to-follow disaster preparedness knowledge database or training to educate the general public.

Petal and Izadkhah (2008) highlighted that social learning in the form of social interaction and iteration of feedback between the learners, and their environment is one of the important informal learning approaches which promotes effective community learning practices. Social support within the personal network of the community is critical in times of acute need, especially for fostering the social capital of individuals (Tidball et al., 2010). Social capital provides us with a tool to measure the community's robustness in terms of the degree of trust and strength of ties among the community members; however, people have limited access to it during the disaster, especially due to a lack of social relations (Sadri et al., 2017). For instance, a study that investigated two unequal communities devastated by Hurricane Katrina reported that residents with a low personal network had access to less social capital in terms of resources than those with a more affluent personal network in the community (Elliott et al., 2010). Therefore, to enhance the weak social capital of residents in

the community, it is critical to realize the economic and social realities of residents at risk and encourage community learning as means of support to prepare for disasters.

In the recent decade, social media platforms such as Twitter, Facebook, YouTube, etc., have played a crucial role in disseminating information in times of emergency (Sadri et al., 2018). Such informal platforms also present a potential medium for teaching the community in disaster-prone areas about practical approaches to disaster preparedness before, during, and in the aftermath (Bernhardsdottir et al., 2016). To this end, technological tools are frequently used for informing, preparing, and educating people to deal with threats posed by hurricanes, such as extreme wind conditions, coastal flooding, and inland flooding (Wolshon, 2001). For instance, the National Hurricane Center (NHC) tracks and predicts the likely behavior of tropical depressions, storms, and hurricanes, then disseminates such information through media meteorologists. These media meteorologists then provide weather forecasts, warnings, and protective information to people within hurricane-prone zones (Tierney et al., 2006). However, people tend to ignore the government's preparedness steps suggested in technological media or emergency preparedness brochures. Consequently, they also may struggle to educate themselves, which in turn causes chaos during disasters. Hence, there is a pressing need for a personalized pedagogical approach for disaster education that prepares and fulfils needs of individuals from different socio-economic status, cultural background, diversity, and education level distributed through informal mediums such as social media, employers, churches, among others and such type of pedagogy can be referred to as informal learning pedagogy.

Informal educators who lead informal learning activities in community settings play an essential role in organizing and communicating disaster preparedness knowledge effectively. Feng et al. (2018) highlighted that the informal learning environments organized by community leaders and informal educators support individuals in cultivating a social setting for discussions, learning, conversation, appreciation, and reflection. However, informal education may not be as effective in all communities since some vulnerable communities in disaster-prone areas have a diverse group of people with different demographics, qualifications, and perceptions (Haupt and Knox, 2018). In this regard, leadership in disaster preparedness is crucial for addressing three key issues, which include notifying and guiding people, building a strong social network among community members, and coordinating with other formal institutions. It particularly plays an important role in the informal learning activities within community settings (such as a workplace, religious institutions, and community meetings, Homeowner Associations - HOA, municipalities, etc.). Hence, it is critical to identify community leaders who possess these capabilities such that they can engage more people in preparedness to improve their attitudes and decision-making abilities.

Similarly, the Federal Emergency Management Agency (FEMA) operates various courses and training for pre-disaster preparedness through its different resources like the Center for Domestic Preparedness (CDP), Emergency Management Institute (EMI), and National Training and Education Division (NTED) to have an emergency response community capable of responding to all-hazard events (Wilson and Oyola-Yemaiel, 2001). For instance, one of the courses, "Hazus for Hurricane" in EMI, deals with 1) an overview of the hurricane-related inventory components; 2) defining a hurricane hazard, and 3) adjusting parameters for the identification of economic and social impact from hurricanes which eventually supports emergency management (Federal Emergency Management Agency, 2017). However, these courses and training are technically complex, geared to professionals, and are not prepared to easily educate the general public (Comfort and Wukich, 2013). To fill in this literature gap, the study surveyed a hurricane-prone community to investigate the viability of adopting a novel learning mechanism (*informal learning pedagogy*) through online modalities and advocating for community leaders to circulate fundamental disaster preparedness knowledge, which provisions the development of a more disaster-resilient community. A disaster-resilient community, in turn, would reduce potential adverse impacts on our infrastructure systems, informally educate the general public, and supports the community's health and well-being (Kijewski-Correa et al., 2020).

3 MATERIALS AND ANALYSIS METHODS

This study seeks to identify key information that will facilitate the development of an online community-centered disaster preparedness training with a primary focus on preparedness, warning, evacuation, and early recovery. The authors adopted an exploratory approach focusing on a hurricane-prone region in South Florida and surveyed 126 residents. The succeeding section discusses the survey design and statistical tests in detail.

3.1 Survey Design

The research team surveyed a recurring hurricane-prone vulnerable area during the hurricane season from June to November months. The survey design focused on the following research hypothesis: 1) informal learning pedagogy at the community level maximizes disaster preparedness and leads to a long-term disaster risk reduction; and 2) online platforms play a crucial role in training communities pre- and post-disasters, especially in the acceleration of recovery progress. The survey included open-ended questions, multiple-choice questions, and Likert scale questions, and demographic questions to validate these hypotheses. The open-ended questions focused on recording residents' disaster preparedness awareness to record how they prepare for hurricane season each year. The multiple-choice questions collected data about different preferred features of informal learning pedagogy format such as language, length, platform, training notifications, among others. Besides, the Likert scale questions focused on identifying how residents prepare for pre-disaster, during a disaster, and for post-disaster conditions. While the demographic questions recorded residents' background, type of house where they are currently living, and distance from a large water body. An online surveying tool, Qualtrics, was used to distribute the survey for 3 months. The survey covered two major counties in South Florida: Miami-Dade and Broward. The authors distributed the survey responses using the purposive sampling technique and snowball sampling

technique. Purposive sampling refers to a judgmental sampling method in which individuals are selected to be part of the sample based on the researcher's judgment as to which individuals would be the most useful such that the quality of the collected survey data can be controlled (Kingsford Owusu and Chan, 2019). The research team implemented purposive sampling technique by targeting community gatherings and events such as beach cleanup, church gatherings etc., across South Florida. In these community gatherings, the research team initially explained the objective of research survey and meaning of informal learning pedagogy (i.e., personalized way to learn about disaster education including topics like disaster preparedness and disaster risk reduction such that it would increase capacity of community and resilience against natural disaster). On the other hand, the snowball sampling technique was implemented to increase the survey's reach by requesting the targeted individuals to suggest other individuals with similar expertise (Babbie, 2014). The research team implemented snowball sampling technique by disseminating information related to research and survey questionnaire among community leaders who attended community gatherings and events such that they can share such information in their workplace and social media platforms. Overall, the authors collected 126 responses from residents of different zip codes.

Additionally, different statistical measures were used to assess the consistency, reliability, and adequacy of the data sample size, including the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity (Shrestha, 2021).

3.1.1 Kaiser-Meyer-Olkin Measure of Sampling Adequacy

KMO test is a statistical analysis that measures the adequacy of the sample size for each variable in the model and for the complete model. The KMO measure of sampling adequacy is given by the formula:

$$KMO_j = \frac{\sum_{i \neq j} R_{ij}^2}{\sum_{i \neq j} R_{ij}^2 + \sum_{i \neq j} U_{ij}^2} \qquad (1)$$

Where R_{ij} is the correlation matrix, and U_{ij} is the partial covariance matrix. The KMO value ranges from 0 to 1, and those values between 0.8 and 1 indicate that the sampling is adequate. An average value > 0.6 is acceptable for sample size <100, and an average value between 0.5 and 0.6 is acceptable for sample sizes between 100 and 200.

3.1.2 Bartlett's Test of Sphericity

Bartlett's Test of Sphericity tests the null hypothesis, Ho: The variables are orthogonal (i.e., the original correlation matrix is an identity matrix indicating that the variables are unrelated and therefore unsuitable for structure detection. The alternative hypothesis is H1: The variables are not orthogonal (i.e., they are correlated enough to where the correlation matrix diverges significantly from the identity matrix. Bartlett's test of Sphericity is given by:

$$\chi^2 = -\left(n - 1 - \frac{2p + 5}{6}\right) X \ln|R| \qquad (2)$$

Where p = number of variables, n = total sample size, and R = correlation matrix.

A significant value less than 0.05 shows that the factor analysis is worthwhile for the obtained data set.

3.1.3 Cronbach's Alpha

The Cronbach's Alpha test is conducted to assess the reliability of the questionnaire. It provides a simple way to measure whether the score is reliable, assuming that there are multiple items measuring the same underlying construct. Cronbach's alpha is a measure of internal consistency, and it ranges between 0 and 1. If the value of Cronbach's alpha is greater than 0.7, then it is considered as acceptable. A high level of alpha shows the items in the test are highly correlated. Cronbach's alpha can be expressed as shown in **Eq. 3**.

$$\alpha = \frac{n\,\bar{r}}{1 + \bar{r}\,(n - 1)} \qquad (3)$$

Where n = number of items, $\bar{r}$ = mean correlation between items.

3.2 Ordered Probit Regression Model

To determine the preference and need for informal learning pedagogy for people in disaster-prone communities, the study utilized a statistical method, ordered probit regression analysis. It is a suitable analysis for a categorical dependent variable. It is conducted to determine which independent variable has a statistically significant effect on the dependent variable, as well as to determine how well the model predicts it (Xu et al., 2016; Pradhananga et al., 2021). An ordered probit regression analysis is the selected method for the collected data, as this analysis is fit for the generalization of cases of more than two outcomes of an ordinal dependent variable (a variable with potential values such as poor, fair, good, excellent). Therefore, since an ordered logit model estimates the probability of the dependent variable to be only one, the ordered probit regression model was the best fit for this study. The dependent variable was defined as expected need of disaster preparedness training, while the independent variables were the following: a benefit to an individual, a benefit to the community, interest in understanding the risk associated with natural disasters, interest in learning about knowing the area, interest in learning about emergency resource checklist, interest in learning about reliable sources of weather and traffic information, interest in learning about preparing evacuation plan, interest in learning about common practices for protecting personal belongings, interest in learning about property risk assessment, interest in learning about preparing communication plan with friends/family, interest in learning about accommodation for people with special needs, interest in learning about communicating with first responders during an emergency, interest in learning about post-disaster health and safety, interest in learning about post-disaster logistics, interest in learning about neighborhood voluntary activities, preference to training modalities, languages and conducting leaders, respondents' personal demographics including length of stay in the disaster-prone zone ownership of properties, household members, location, academic background, etc. The ordinal probit regression model utilizes these parameters through the following equation:
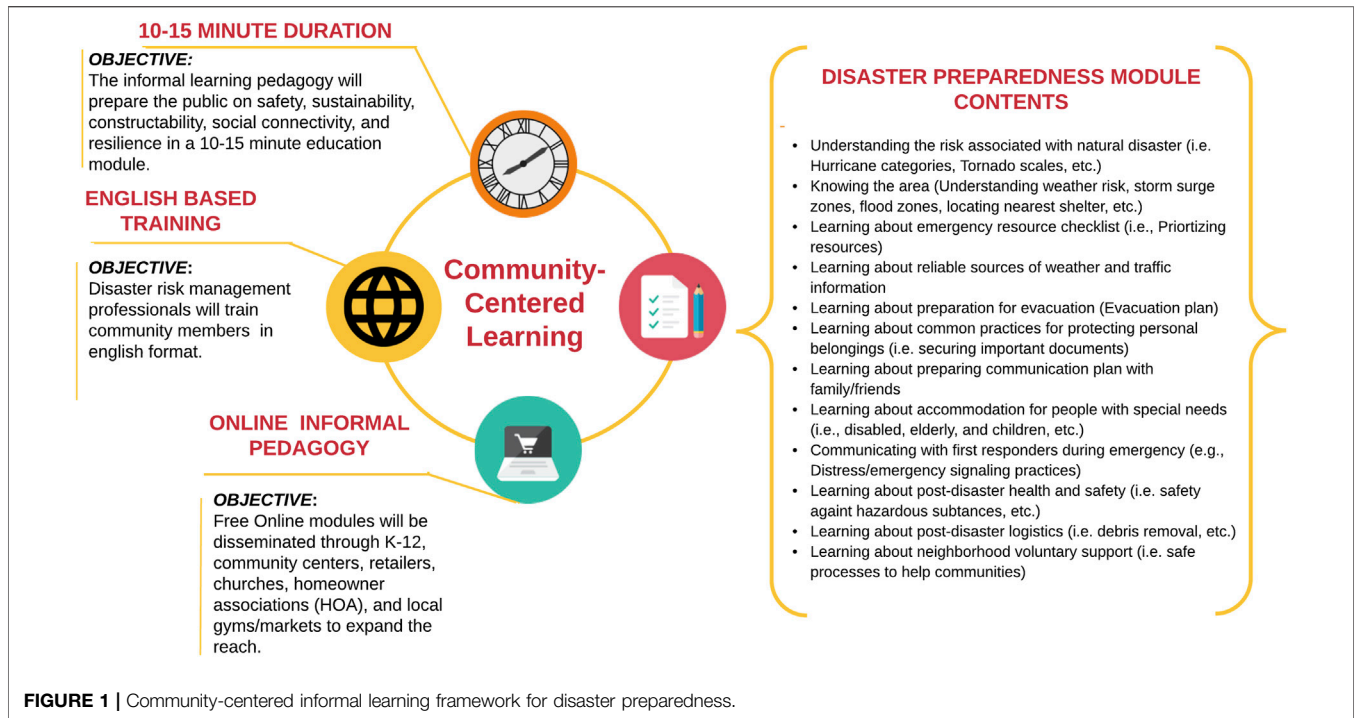
FIGURE 1 | Community-centered informal learning framework for disaster preparedness.

$$y_i^* = X_i\beta + \varepsilon \qquad (4)$$

Where y_i^* is a latent variable measuring the need for disaster preparedness training for the ith participant; X_i is a (k x 1) vector of observed nonrandom explanatory variables; β is a (k x 1) vector of unknown parameters, and error factor (ε) captures the reality that the need for disaster preparedness training is not perfectly predicted by the regression equation. Therefore, the need for disaster preparedness training, y_i is determined from the model as follows:

$$y_i = \begin{cases} 1 \; if -\infty \le y_i^* \le \mu_1 \; (Not\, at\, all\, necessary) \\ 2 \; if\, \mu_1 \le y_i^* \le \mu_2 \; (Probably\, not\, necessary) \\ 3 \; if\, \mu_2 \le y_i^* \le \mu_3 \; (Possibly\, necessary) \\ 4 \; if\, \mu_3 \le y_i^* \le \mu_4 \; (Probably\, necessary) \\ 5 \; if\, \mu_4 \le y_i^* \le \mu_5 \; (Definately\, necessary) \end{cases} \qquad (5)$$

In **Equation 4**, the partial change in y^* with respect to X_i is β_i units. This implies that for a unit change in X_i, y^* is expected to change by β_i units, holding all variables constant. Furthermore, the significance test uses the t-score to describe how the mean of the data sample with a certain number of observations is expected to behave. On the other hand, the p-value indicates the confidence level, in terms of correlation, of each variable to the dependent variable. The confidence interval in the analysis is assumed to be 90%; thus, the area under the curve (z) is obtained as 1.645.

4 RESULTS

This section analyzes results pertaining to peoples' disaster preparedness awareness in hurricane-prone communities to develop a simple, interactive, and free online education module. This module demonstrates the required and identified disaster preparedness topics as well as respondents' logistical preferences, as shown in **Figure 1**. The descriptive analysis results from the obtained data related to the module showed following conclusion.

a. An effective way to educate people pertaining to disaster preparedness is through video modules distributed through community leaders such as employers, government/non-government organizations, Homeowners Association (HOA), and community organizations (i.e., churches, gyms, etc.), among others. Among these community leaders, more than 50% of the participants preferred to be notified and guided by employers. Thus, employers can conduct online meetings, utilize emails or social media platform to distribute the informal learning pedagogy.

b. Based on the respondents' feedback, it can be inferred that these educational video modules could be 10–15 min in length and dictated by professionals. This approach would help residents take proactive decisions in responding to an imminent disaster, thus requiring less time and effort to make preparations, as well as recover in the aftermath fully. Hence, the development of an informal community-centered training module embraces active engagement through the problem-based learning (PBL) approach, which promises to improve the individual's critical thinking ability during natural hazards (ElZomor et al., 2018). To this end, such PBL pedagogical modules/training expose individuals to real-world issues, which develops self-learning techniques allowing residents to make proactive decisions when responding to approaching natural disasters.
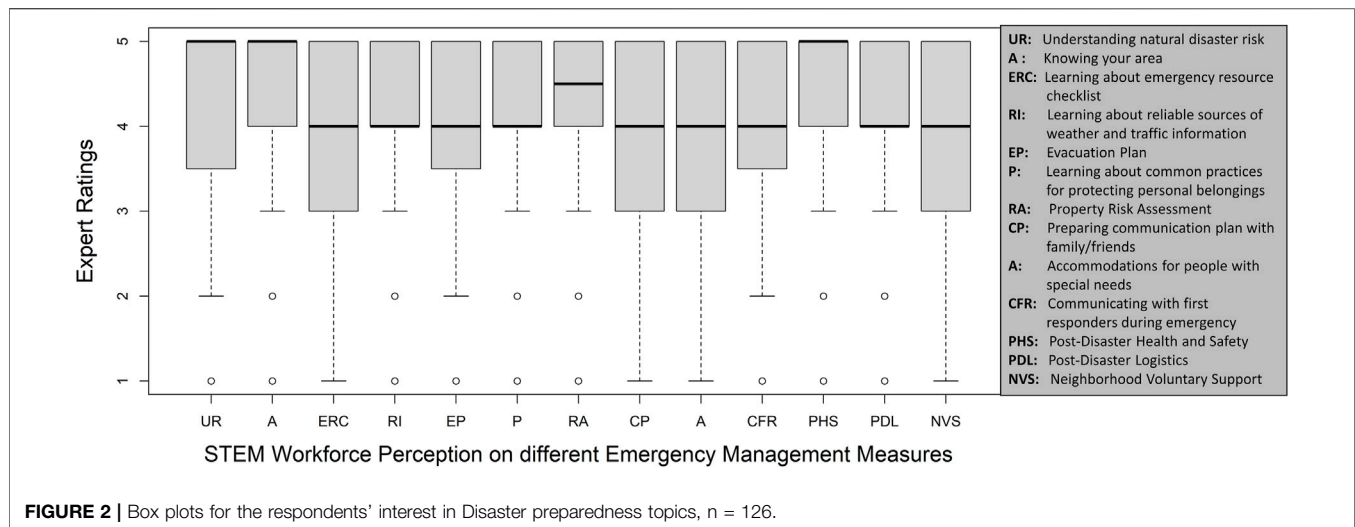
FIGURE 2 | Box plots for the respondents' interest in Disaster preparedness topics, n = 126.

4.1 Peoples' Interest in Disaster Education

To understand the level of interest as well as disaster preparedness knowledge in a disaster-prone community, responders were questioned about preference and priority in disaster preparedness topics that would serve their actual needs and be of interest in an online training activity. The result was graphically represented using box plots where the expert ratings are represented by a five-point scale with 1 indicating not at all interested and 5 indicating very interested, as shown in **Figure 2**. The obtained results show that the understanding of natural disaster risk, knowing your area, and post-disaster health and safety have the highest Likert scale rating of 5. Whereas property risk assessment has a Likert scale rating of 4.5, and the rest of the topics have a rating of 4. These higher ratings indicate that many people are inclined to learn more about these topics, which may be because their level of awareness of such a topic is inadequate.

4.2 Socio-Demographic Background Information

The survey collected socio-demographic information, housing information, and location information, including annual income, marital status, educational background, house members, home type, and homeownership as given below.

a. Annual income is one of the significant socio-demographic characteristics which influence disaster preparedness (Phillips et al., 2005). In this study, seven respondents had an annual income of $10,000 or less, ten had $20,001-$30,000, 17 had $30,001-$50,000, 18 had $50,001-$80,000, 15 had over $80,000 and 27 preferred not to answer. The obtained results indicate that a high proportion of individuals have low income, and some are facing poverty. That said, it can be inferred that such economic status may set those people to be more vulnerable and may not be adequately prepared or knowledgeable about preparedness, warning, evacuation, and early recovery.

b. Moreover, the marital status of the respondents was also recorded, and a significant number of respondents, 93, were single, ten married, one divorced, one widowed, four living in cohabitation, and two preferred not to answer. It is evident from the results that many respondents are single, and few are married. Since previous studies have indicated that those who are married or have a household are more likely to be prepared for disaster, it is critical to improve single individuals' attitudes and decision-making abilities in different stages of disaster preparedness through the informal learning approach (Horney et al., 2014).

c. Also, among the recorded responses, 28 have completed high school, 62 Undergraduate, 20 graduate, and two others. Previous research has considered the educational background to be a critical factor in determining the residents' decision-making ability for disaster preparedness (Laditka et al., 2008).

d. Based on the obtained results, more than 50% of the respondents have an undergraduate degree highlighting that many participants may not consider preparedness training as an essential education and require an innovative pedagogy that increases their interest in disaster preparedness.

e. Based on the survey results, there were a higher number of Hispanic white participants, i.e., 72 in the survey, while there were 14 non-Hispanic Asian and African American participants, as shown in **Figure 3**. Out of 127 participants, 59 Hispanic and 21 Non-Hispanic survey participants indicated that they had not received any disaster preparedness training. Thus, understanding the needs of people from different languages, cultures, and diversity at all levels of education would help to maximize disaster preparedness and community resilience.

f. Additionally, the survey collected data regarding the respondents' housing information. Based on the results, 83 respondents live in single-family homes, while 16 live in apartments, 10 in condominiums, three in duplexes, and one in a mobile home, as shown in **Figure 4**. Since most of the resiliency efforts to build houses that can withstand natural disasters focus on isolated single-family houses, it is evident
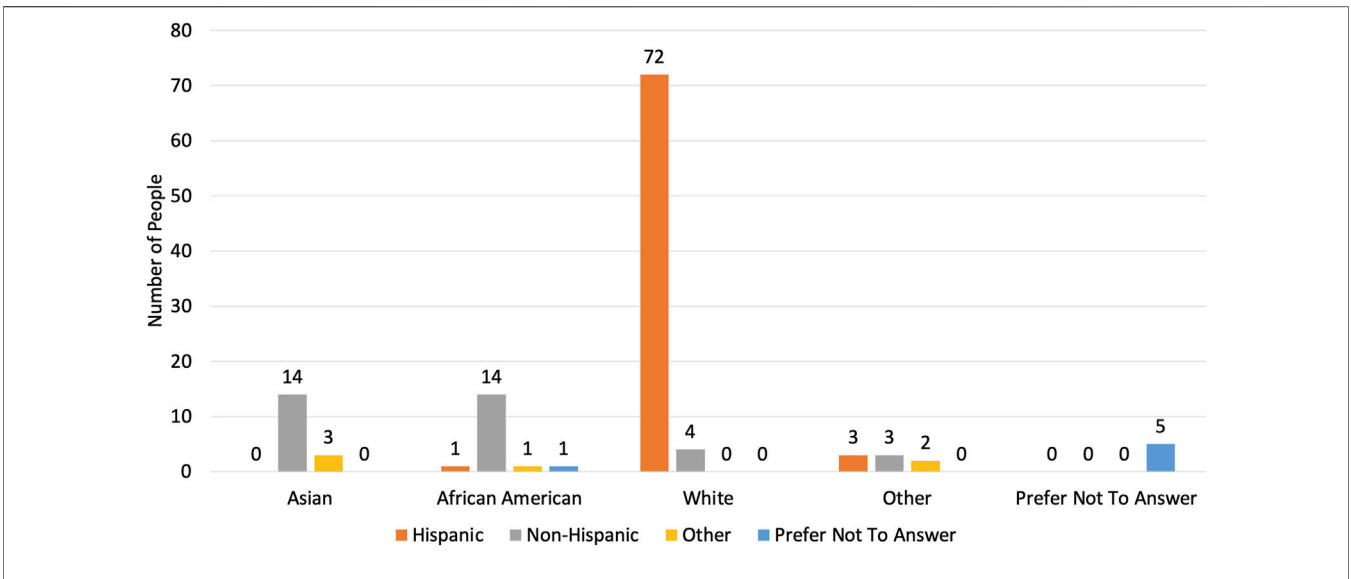
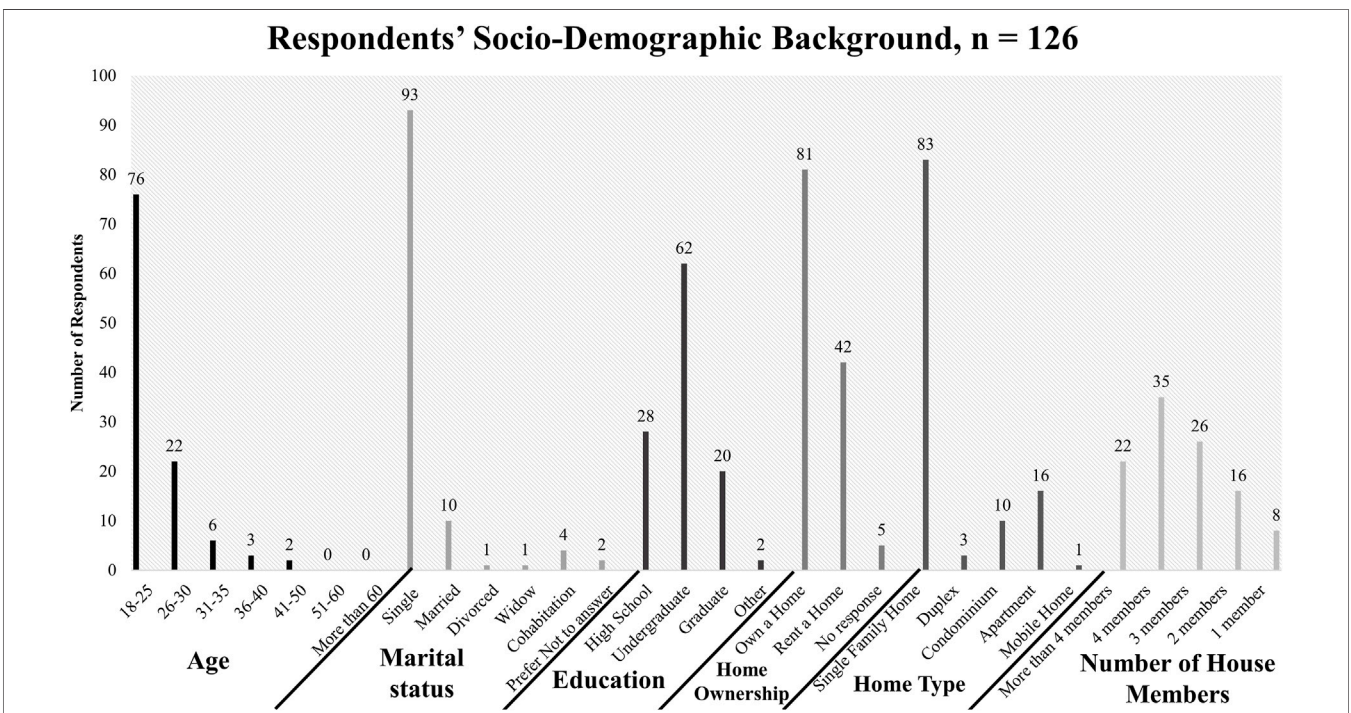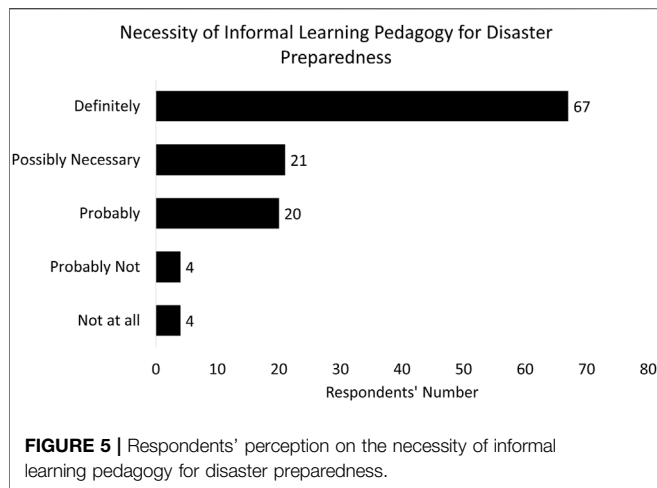**FIGURE 3 |** Survey participants' ethnicity and race.

FIGURE 4 | Respondents' Socio-Demographic and Background Data, n = 126.

that larger multifamily dwellings may be more vulnerable to disaster risks and slower recovery post-disasters. Based on the survey results, even though a higher number of respondents live in single-family homes, such homes may or may not be resilient to disasters.

g. Moreover, respondents specified their homeownership status, where 81 stated they owned their home, 42 stated they rented, and 15 did not respond. Since more than half of the

respondents own a home, such vulnerable populations must receive the necessary training on property risk assessment, protecting personal belongings, providing voluntary support to the community, and post-disaster health and safety capacity such that post-disaster recovery is faster.

h. Finally, respondents were also surveyed on the number of house members, where 22 indicated that their home had more

FIGURE 5 | Respondents' perception on the necessity of informal learning pedagogy for disaster preparedness.

than four members, 35 respondents had four members, 26 respondents had three members, 16 respondents had two members, and eight respondents lived alone, as shown in **Figure 4**. Previous studies have highlighted that a household with children and multiple family members are more likely to be evacuated during disasters such as a hurricane.

4.3 Necessity of Informal Learning Pedagogy

Informal learning creates an environment where an individual can remotely access information anytime, which in turn not only increases the reach but also adds value to communities by providing personalized, comprehensive, and timely disaster preparedness information for households in disaster-prone communities. Clark et al. (2018) highlighted that remote leaning modality such as social media (e.g., LinkedIn, Instagram, Facebook) and video conferencing service (e.g., google meet, zoom) increases social connectivity through features such as instant messaging, private/public community groups, share videos, images, and external links, among others to many individuals easily. Thus, based on the findings of this study remote training modality is possible medium for increasing reach and accessibility to informal learning pedagogy. To understand the desirability of such an innovative pedagogical method for disaster preparedness, respondents were asked to rate the necessity of informal learning pedagogy in their coastal community, as shown in **Figure 5**. The higher rating for "definitely," "possibly necessary," and "probably" indicates that many respondents prefer community leaders to conduct a remote training modality to educate and prepare them for disasters. Since many people struggle to follow through with the profound and lengthy institutional text guidelines (e.g., FEMA guidelines), not to mention some are not even aware of the accessibility of these preparedness guidelines, there remains high desirability of easily accessible and summarized informal learning modules for disaster preparedness in vulnerable coastal communities. Hence, the

survey feedback indicates that the informal learning approach would not only address the issues in institutional guidelines but also align with the needs and modalities suggested by the people intending to learn about disaster preparedness strategies. Therefore, this feedback provides an opportunity to improve and accelerate disaster education in vulnerable communities.

4.4 Statistical Analysis

To analyze the consistency, reliability, and adequacy of the data sample size, statistical tools such as Cronbach's alpha, Bartlett's Test, Kaiser-Meyer-Olkin Measure of Sampling Adequacy test were conducted in SPSS. The Cronbach's alpha value was found to be 0.969. The obtained value of Cronbach's alpha is greater than 0.7, which indicates that the sample size is reliable. Similarly, **Table 1** illustrates the value of Kaiser-Meyer-Olkin statistics which is equal to 0.923 > 0.6, indicating that the sample size is adequate. Bartlett's test of Sphericity is utilized to test the adequacy of correlation between the data variables. As shown in **Table 1**, the test value is 1,637.738, and an associated degree of significance is less than 0.0001. The results indicate that the variables are not orthogonal, and the null hypothesis can be rejected.

To address the two research hypotheses, the study developed an ordered probit regression model that analyzed the relationship between the expected need for disaster preparedness training and the independent variables associated with respondents' preferences and perspectives. The descriptive statistics of explanatory variables in an ordered probit regression model are as shown in **Table 2**, which includes minimum, maximum, mean, standard deviation, and variance.

Table 3 presents the results of ordered probit regression analysis conducted in Stata, where the regression coefficient values, standard error, Z value, and p-value are tabulated. Factors such as interest in understanding the risk associated with natural disasters, interest in knowing your area, learning about emergency resource checklist, learning to establish proper communication plans with family/friends, and academic background do not have significant p-value, while all other variables have p-value less than 0.1 indicating that data is statistically significant. In **Table 3**, μ_1, μ_2, μ_3, and μ_4 are the coefficients of the ordered probit model with the values −11.281, −9.179, 7.517, and 27.5, respectively. These values are the thresholds that reflect the predicted cumulative probabilities at covariate values of zero.

TABLE 1 | Kaiser-Meyer-Olkin and Bartlett's test of sphericity.

Kaiser-meyer-olkin measure of sampling adequacy		**0.923**
Bartlett's test of sphericity	**Approx. Chi-square**	**1,637.738**
	Df	78
	Sig	0.000

TABLE 2 | Descriptive statistics of explanatory variables.

S.N.	Explanatory variables	Min	Max	Mean	Std. Dev	Variance
1	Benefit to individual (1 if beneficial to individual, 0 otherwise)	1	5	4.27	1.03	1.06
2	Benefit to community (1 if beneficial to community, 0 otherwise)	1	5	4.38	0.93	0.87
3	Interest in understanding the risk associated with natural disasters (1 if interested, 0 otherwise)	1	5	4.16	1.06	1.12
4	Interest in learning about knowing the area (1 if interested, 0 otherwise)	1	5	4.30	0.9	0.81
5	Interest in learning about emergency resource checklist (1 if interested, 0 otherwise)	1	5	4.11	0.98	0.96
6	Interest in learning about reliable sources of weather and traffic information (1 if interested, 0 otherwise)	1	5	4.20	0.92	0.85
7	Interest in learning about preparing evacuation plan (1 if interested, 0 otherwise)	1	5	4.16	0.92	0.86
8	Interest in learning about common practices for protecting personal belongings (1 if interested, 0 otherwise)	1	5	4.19	0.91	0.83
9	Interest in learning about property risk assessment (1 if interested, 0 otherwise)	1	5	4.21	0.94	0.89
10	Interest in learning about preparing communication plan with friends/family (1 if interested, 0 otherwise)	1	5	4.16	0.95	0.91
11	Interest in learning about accommodation for people with special needs (1 if interested, 0 otherwise)	1	5	4.04	1.05	1.09
12	Interest in learning about communicating with first responders during an emergency (1 if interested, 0 otherwise)	1	5	4.15	0.93	0.87
13	Interest in learning about post-disaster health and safety (1 if interested, 0 otherwise)	1	5	4.23	0.94	0.89
14	Interest in learning about post-disaster logistics	1	5	4.16	0.91	0.83
15	Interest in learning about neighborhood voluntary (1 if interested, 0 otherwise)	1	5	4.1	1.05	1.11
16	Training preference of respondent (1 if interested in training, 0 otherwise)	1	5	4.22	1.08	1.16
17	Respondents' length of stay in disaster-prone zone (1 if smaller duration of stay, 0 otherwise)	4	8	7.42	1.18	1.4
18	Respondents' academic background (1 if higher degree, 0 otherwise)	1	9	2.05	1.14	1.3

TABLE 3 | Coefficients and p-value from ordered probit analysis for expected need of disaster preparedness training.

Variable description	Coeff (β)	Std. Error	Z	p-value
Benefit to individual (1 if beneficial to individual, 0 otherwise)	10.005	4.38	2.28	0.022
Benefit to community (1 if beneficial to community, 0 otherwise)	−7.648	3.98	−1.92	0.055
Interest in understanding the risk associated with natural disasters (1 if interested, 0 otherwise)	0.811	2.21	0.37	0.714
Interest in learning about knowing the area (1 if interested, 0 otherwise)	−2.073	1.54	−1.35	0.179
Interest in learning about emergency resource checklist (1 if interested, 0 otherwise)	12.753	48.04	0.27	0.791
Interest in learning about reliable sources of weather and traffic information (1 if interested, 0 otherwise)	−5.267	3.05	−1.73	0.084
Interest in learning about preparing evacuation plan (1 if interested, 0 otherwise)	5.603	2.66	2.11	0.035
Interest in learning about common practices for protecting personal belongings (1 if interested, 0 otherwise)	3.214	1.81	1.77	0.076
Interest in learning about property risk assessment (1 if interested, 0 otherwise)	−8.790	4.15	−2.12	0.034
Interest in learning about preparing communication plan with friends/family (1 if interested, 0 otherwise)	−5.485	3.69	−1.48	0.138
Interest in learning about accommodation for people with special needs (1 if interested, 0 otherwise)	14.408	7.05	2.04	0.041
Interest in learning about communicating with first responders during an emergency (1 if interested, 0 otherwise)	4.683	2.54	1.85	0.065
Interest in learning about post-disaster health and safety (1 if interested, 0 otherwise)	5.747	2.78	2.07	0.039
Interest in learning about post-disaster logistics	8.941	4.47	2.00	0.046
Interest in learning about neighborhood voluntary (1 if interested, 0 otherwise)	12.804	5.43	2.36	0.018
Training preference of respondent (1 if face to face, 0 otherwise)	−10.202	4.85	−2.1	0.036
Respondents' length of stay in disaster-prone zone (1 if smaller duration of stay, 0 otherwise)	3.977	1.88	2.12	0.034
Respondents' academic background (1 if higher degree, 0 otherwise)	1.001	0.94	1.06	0.29
μ_1	−11.281	7.82		
μ_2	−9.179	7.18		
μ_3	7.517	3.51		
μ_4	27.500	48.89		
Number of observations				109
Pseudo R-Squared				0.89

5 DISCUSSION

Disaster preparedness is highly influenced by peoples' receptiveness and responsiveness and inclusive accessibility to the guidelines. One of the effective solutions to maximize these factors in emergencies is the integration of community-centered informal learning pedagogy. This approach can significantly increase the local participation of people from different cultures, languages, and backgrounds. Additionally, it would also increase their interest in learning and sharing preparedness knowledge among the community members, which is validated by the survey analysis results.

a. Based on the results of **Table 3**, a positive regression coefficient (5.603) for evacuation preparation infers that people are more likely to participate in informal disaster preparedness training to learn how to develop an evacuation plan. This may be because people have struggled to prepare timely during the most recent hurricanes, which has led to an increase in chaos and a

lack of accessibility to resources. An informal disaster preparedness training can potentially educate the vulnerable community on proper plans for evacuation in such a way that the enthusiasm to learn from one another within the community setting would cause a ripple effect, which in turn supports educating more people in disaster preparedness promptly.

b. On the other hand, a negative regression coefficient (-8.79) for interest in learning about property risk assessment infers that people are less likely to be inclined to learn property risk assessments because individuals with technical knowledge more effectively conduct the property risk assessments. Additionally, people are more dependent on the suggestions of professionals to protect their property, due to which there is less inclination towards learning those skills.

c. Besides, the need for informal disaster preparedness training is positively influenced by the interest in learning to accommodate people with special needs (14.408). This result infers that since the population with special needs is considered a minority, people are more likely to prioritize their safety. Moreover, as existing organizations have also failed to provide support to minorities' needs during emergencies in past disasters, there is a higher inclination towards learning about their needs.

d. Also, since many people in the disaster-prone area might not be fully aware of ways to contact and communicate with first responders during natural disasters, this relevant topic is directly proportional to the need for disaster preparedness training, as indicated by a positive regression coefficient of 4.683.

e. Results also suggest that interest in learning about post-disaster logistics and health and safety education positively impacts the need for informal disaster preparedness training, as the coefficient value for these factors is 8.941 and 12.804, respectively. It can also be inferred that people are more likely to be inclined towards learning strategies to minimize risks post-disaster. This could be because the most recent hurricanes in South Florida have shown an unpredictability of their paths and caused damages where it was not anticipated.

f. Besides, faster post-disaster recovery is directly influenced by volunteering activities. Thus, results indicate that people in disaster-prone areas are more likely to be inclined towards learning how to safely volunteer in post-disaster activities, as the regression coefficient for this factor is 12.804.

Therefore, these statistically significant explanatory variables support the first hypothesis as there is potential for an increase in efficiency in disaster preparedness through an informal learning approach such that it fosters long-term disaster risk reduction.

Another result in **Table 3** includes a positive regression coefficient (3.214) for interest in learning about protecting personal belongings, which indicates that people are more likely to be inclined towards learning the best strategies for protecting their personal belongings during a disaster. Thus, disaster preparedness training should place special attention on addressing these concerns since many people are unaware

of proper procedures for protecting their belongings, whether they evacuate or not. Besides, the regression coefficient value for the individual benefit of disaster is obtained as 10.005 while that for community benefit is −7.648. It can be inferred from this result that quality training, which highlights the anticipated benefits of disaster education, is more likely to attract participants and amplify positive outcomes from the training. Also, as many individuals have easy access to social media platforms and applications in their smartphones to acquire traffic and weather information, people are less likely to be inclined to learn about sources of traffic and weather information, as indicated by a negative regression coefficient of −5.267 in **Table 3**. People who have spent less than a year in a disaster-prone area have less knowledge of natural disasters' impact. As such, they are also more likely to need informal disaster preparedness training to understand the risk and prepare effectively. Considering a result of a positive regression coefficient of 3.97 for respondents' length of stay in the disaster-prone zone, it can be inferred that people who have spent long periods of time and have potentially more experience with natural disasters do not value the need for such training. Additionally, the results indicated that people are more likely to value the need for informal disaster preparedness training if such training is online, which is indicated by a negative regression coefficient of −10.202. Therefore, a high inclination towards informal online training supports the second hypothesis, and these statistically significant explanatory variables indicate that people efficiently learn about the disaster preparedness's fundamental topics.

6 LIMITATIONS

Some of the limitations of this research include:

1) The survey data was collected randomly from only a limited counties in South Florida, which were viable to the research team. Therefore, the collected sample data may not be an accurate representative sample of the people in all of South Florida; however, the authors reached the targeted demographics to analyze the research hypotheses for informal disaster preparedness training. Moreover, due to the low sample size, the study did not introduce random parameters in the modeling, which captures the heterogeneity that exists among different observations;

2) The assessment of respondents' interest in disaster preparedness topics of the survey questionnaire may be subjective due to personal opinions and self-judgments. However, the authors believe that anchorage of the questions in the survey to relevant findings of research available in various literature supports valid judgments and;

3) The ordered probit regression model was developed based on professional judgment, available variables, data from similar studies in literature, as well as own experiences to choose the control variables. Therefore, the model may not be the only representation of the factors, which influence evacuation during hurricanes.

7 CONCLUSION

There are several challenges in communicating disaster preparedness knowledge throughout the vast majority of disaster-prone communities. The survey results also indicated that approximately 63% of the survey participants had not received any disaster education or training. Therefore, this study is a novel initiative to understand in which areas of preparedness and recovery are people lagging. Through identification of these key areas, decision makers can make appropriate improvement in management and availability of resources. Additionally, the study results also highlighted that many participants preferred 10–15 min video module instead of technical guidelines. Hence, it is compelling to propose innovative means to outreach such vulnerable populations with effective preparedness knowledge such that community resilience in coastal areas can be further improved. Based on the ordered probit regression model estimation results, important conclusions can be drawn to better comprehend the necessity of efficient disaster preparedness training which are listed as follows:

- *People who have spent less than a year in a disaster-prone area have less knowledge of natural disasters' impact and are more likely to benefit from informal disaster preparedness training;*
- *The interest positively influences the need for informal disaster preparedness training in learning to accommodate people with special needs (i.e., elderly, people with disabilities, etc.);*
- *Many people in disaster-prone areas are not fully aware of contacting and communicating with first responders during natural disasters. Thus, this training remains a relevant deliverable directly in line with the needs of disaster prone communities for informal disaster preparedness trainings;*
- *Interest in learning about post-disaster logistics and health and safety positively impact the need for informal disaster preparedness training;*
- *Volunteering activities directly influence faster post-disaster recovery. Thus, results indicate that people in disaster-prone areas are more likely to be inclined towards learning how to volunteer in post-disaster activities safely;*
- *Interest in learning about protecting personal belongings positively impacts the need for disaster preparedness training;*
- *A quality training that highlights the anticipated benefits of disaster education is more likely to attract participants and amplify positive outcomes from the training;*
- *As many individuals rely on social media platforms and applications in their smartphones to acquire traffic and weather information, learning about sources of traffic and weather information in informal learning pedagogy is less likely to be valued by people;*
- *Although evacuation is one of the significant phases in a destructive disaster such as a hurricane, many people do not have adequate knowledge of developing a proper evacuation plan. Thus, people are more likely to be inclined towards participating in informal disaster preparedness training to learn how to develop an evacuation plan;*
- *Property risk assessments are more effectively conducted by individuals with technical knowledge. Thus, results indicate that people are less likely to be inclined towards learning property risk assessments;*
- *Informal disaster preparedness training is more likely to be receptive and valued by disaster-prone communities if such training is online.*

Decision makers can use these measures to improve disaster preparedness plans and make informal learning pedagogy more accessible to all disaster-prone communities. It is also essential to consider diversity, culture, equity, and inclusion during development of pedagogical content and while selecting candidates to deliver informal training. By providing comprehensive procedures related to such interesting preparedness topics online, coastal communities, especially new members of the community, can successfully prepare for all three phases of natural disasters. Therefore, the findings of this study aid in determining the most effective approach to educating communities in disaster-prone zones such that they can respond and recover during future emergencies.

DATA AVAILABILITY STATEMENT

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the IRB Approved by FIU (IRB-19-0208). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

PP is a Phd student at in Civil Engineering - FIU, who is working on a dissertation topic related to Disaster Preparedness under the supervision of AE and ME. The contribution of the research is important vital given that it provides an unorthodox mean to educate communities during disasters about wind engineering (i.e., Hurricanes).

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