Improving Disaster Preparedness Education Through Video Games

Alex Alsheimer

Advised by Dr. Sarah Schoemann

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Introduction

Education through video games is not a novel idea. In recent years research has explored the applications of video games as a teaching tool, both in the classroom and outside of it. With this technology being integrated more and more into both formal and informal education, it is worth exploring how it could be used to present vital information in an engaging format.

One area of education that has begun to be explored in the context of video games is that of disaster preparedness education. A handful of games have been developed specifically for the purpose of educating players about disasters and how to prepare for them, while other games not explicitly created for educational purposes have been used to convey similar information. With several different approaches to the topic existing, and multiple researchers putting together surveys of existing games and research, the field of research itself is still in a state of development.

Here, a new disaster preparedness game is proposed and developed that contrasts with many existing alternatives in order to approach disaster preparedness education from a unique angle and offer another perspective on the subject. This game emphasizes the importance of preparedness by confronting the player with the aftermath of a tornado in the form of a storm survey in a familiar location. By emphasizing the aftermath of a storm in contrast to the vast majority of games that focus on the before, players will be able to experience a "worst-case scenario" and be compelled to protect themselves in the face of a natural disaster such as a tornado.

The game developed for this project can be found here: https://amalsheimer.itch.io/surveyor

Previous Work

Using video games as a tool for educating about disaster preparedness is a relatively new implementation with the majority of research on the subject happening within the past ten years. Because of the novelty of the field, there is a lot of room for exploration and experimentation, with different researchers taking varied approaches to the potential application of games in this way.

Serious disaster preparedness games, designed specifically to educate the player regarding disaster preparedness often fall into one of two categories: games that provide an overview of multiple types of disasters and games that focus on one specific type of disaster, typically disasters widely experienced in the geographic region where the research is completed. Some of the specific disasters covered by these games include flooding (Zaini, N. A., Noor, S. F., & Zailani, S. Z., 2020, earthquakes (Winarni, E. W., Purwandari, E. P., & Hervianti, Y., 2018), and volcanic activity (Mani, L., Cole, P. D., & Stewart, I. 2016).

Game structure within both categories of games is varied, with some games using more of a city building and management approach such as *Stop Disasters!* (Playerthree, 2018), and others opting for a more cause-and effect narrative and openly educational approach such as *Disaster Master* (Ready.gov) or *Rules of Disaster* (Catedrilla, G. M., Lerios, J. L., Sapin, S. B., Lanuang, M. C., & Buama, C. A., 2021).

Several researchers have done in-depth analyses comparing existing serious disaster preparedness games, as well as other non-serious games that include or can represent disasters through gameplay such as *SimCity, Fallout 3,* and *Minecraft*. (Gampell, A. V., & Gaillard, J. C. , 2016, Gampell, A., Gaillard, J. C., Parsons, M., & De, L. L., 2020, Le Dé, L., Gaillard, J. C., Gampell, A., Loodin, N., & Hinchliffe, G., 2021). Several of these games fall into the category

of city building and management and are able to achieve similar goals though gameplay as serious games in the same style, as disasters are often innately included in city management games as additional game mechanics. (Gampell, A. V., & Gaillard, J. C., 2016).

In a comprehensive review of available disaster preparedness games, not one was found that focuses specifically on tornadoes. (Solinska-Nowak, A., Magnuszewski, P., Curl, M., French, A., Keating, A., Mochizuki, J., Liu, W., Mechler, R., Kulakowska, M., & Jarzabek, L., 2018). While those that cover multiple disasters, such as the previously mentioned *Disaster Master* (Ready.gov) may include sections or levels devoted to tornadoes, none of the disaster-specific games emphasized tornadoes.

Additionally, a majority of disaster education games focused on the process of preparing for a disaster before experiencing the intended disaster. There is less focus on the aftermath of a disaster that one may have been unprepared for, and less emphasis on consequences. Gameplay elements fall into categories of "Prevention, Mitigation, and Preparedness" (Gampell, A. V., & Gaillard, J. C., 2016, p. 300). Players are presented with positive outcomes, or the chance to try again if an outcome is less than favorable- sometimes requiring this repetition to proceed forward in the game. (Winarni, E. W., Purwandari, E. P., & Hervianti, Y, 2018).

Method

The format of this disaster preparedness game was designed to mimic a storm survey after a tornado, where damage to structures is analyzed and the intensity of a storm is calculated. The player is given the task of completing the storm survey for a small area, finding and recording specific types of damage for different structures, such as houses, trees, and a gas station. The categories of damage the player analyzes are similar to a simplified version of the

categories used in the Enhanced Fujita Scale - the scale used by the National Weather Service in storm surveys to determine the intensity of tornadoes (McDonald, J. R., & Mehta, K. C., 2006).

The storm survey design was chosen for multiple reasons. Firstly, the novelty of the format. Using a new format that does not share many aspects with existing games allows for the ability to analyze and develop a novel and specific approach. Most importantly, the storm survey design approaches the concept of a disaster from a different perspective. While existing games typically focus on preparation for a storm, this format shows the aftermath of a disaster and the real danger associated with storms.

One of the most important parts about this framework is the tone of the game. The setting of a storm survey is more somber than some of the existing serious games, allowing for a greater emphasis on the severity of a disaster. Many existing serious games, especially those designed for children and adolescents, emphasize playfulness in both content and style in an effort to be age-appropriate. While it is important to consider the age of the player, it is also important not to over-simplify or trivialize the content, especially in the context of something that can be life-and-death such as disaster preparedness. Making the content of the game too lighthearted or humorous "might draw attention to and increase the liking of a campaign, but runs the risk that people do not take the message seriously." (Midtbust, L. G., Dyregrov, A., & Djup, H. W. , 2018, p. 4). However, care was also taken to balance the serious nature of the game, avoiding hyper realistic depictions of damage and loss as to not invoke fear or make the game unsettling.

Additionally, unlike other serious disaster games that are blatantly educational, this game takes a more subtle approach to disaster preparedness education. A problem observed with many existing educational games, both disaster preparedness focused and general educational games is that players do not engage with the material in the same way they would with an

entertainment-focused game, and instead get bored or frustrated with the amount of distracting educational content (Gampell, A., Gaillard, J. C., Parsons, M., & De, L. L., 2020, p. 49). Instead, more effective educational games encourage “stealth learning”, wherein the player learns the concepts in the course of gameplay and applies them in order to succeed in the game itself instead of being overly aware they are being presented with educational information. (Tsai, M.-H., Wen, M.-C., Chang, Y.-L., & Kang, S.-C. (2014,).

Another consideration for this game was the point of view and the role of the player, as this would determine how the educational information would be presented. The player is set as a storm surveyor because it gives the player agency over the situation. Although, unlike other games used for disaster preparedness education, the player is unable to prevent or prepare for the disaster, so it is a different type of agency. Here the player is in charge of observing damaged structures and denoting the specific damage that has occurred due to a tornado. The player is left to observe the “worst case scenario”, but still has some autonomy in the scene. As the player inspects and denotes the damages, the player is made aware of the different levels of damage that can occur to familiar structures, and how those damages correspond to the severity of a tornado.

The locations and types of structures shown in the levels are designed to be familiar to the player. Some of the first levels include a residential neighborhood and a shopping area with a restaurant and gas station, places that most players would be familiar with. These familiar places were selected so the player will have the opportunity to “communicate risk by placing information within their own reality.” (Midtbust, L. G., Dyregrov, A., & Djup, H. W. , 2018, p. 7). If a player can imagine damage like this happening to places they are familiar with, then the experience may be more impactful and cause the information to be more readily available in their minds in an emergency situation.

Interface and Visual Design

The visual style of the game was designed carefully to create a serious yet not uncomfortably realistic experience. Structures are represented with single layer cell shading and clear outlines. This particular style was chosen out of six proposed styles due to its balance of

Figure 1: Proposed visual styles

simplicity and emphasis on important detail. A lined style was chosen over the lineless style as peer consultations revealed the lineless style invoked more of a feeling of detachment from the scene, while a lined style was more engaging. Cell shading was chosen both because it complemented the lined style, and because the more detailed shading was too time-consuming for the scope of the project. All assets used were created specifically for the game using this visual style during the development period.

The user interface is designed to be consistent and familiar in order to integrate seamlessly with the world of the game and not distract the player from the experience. The visual style used for the assets that create the world of the level was carried over into the user interface, with all menus and icons using the same lineart and shading. The font was chosen specifically to

suggest one's handwriting but still be readable, and the interfaces are represented by familiar physical objects like a journal and blueprints. While this is not entirely accurate to the current process of storm surveying (storm surveyors are not marking on the blueprints of a house for example), using a representation of a familiar concept allows players to absorb new information more accurately.

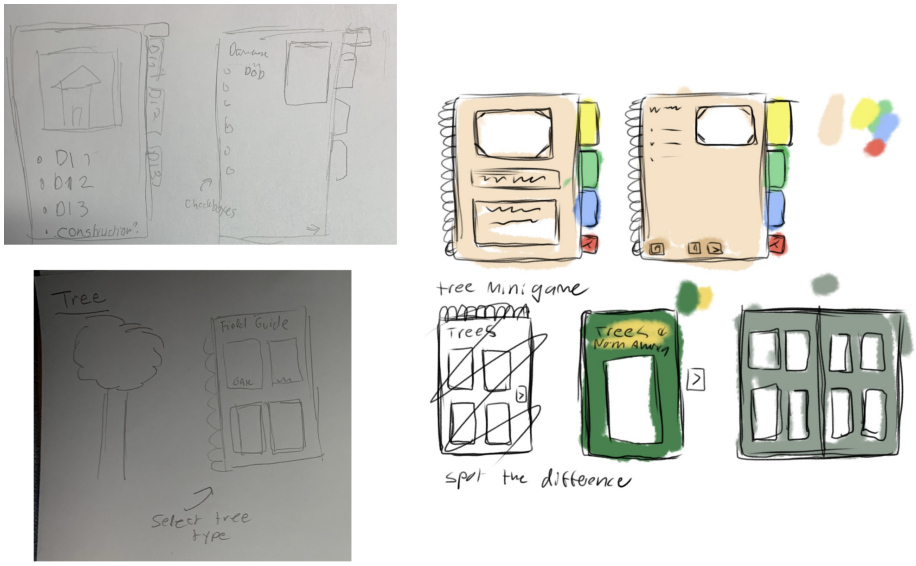

Figure 2: Early user interface prototyping

Additionally, some of the terminology was changed in order to decrease confusion. The Enhanced Fujita Scale refers to structures such as houses and objects such as trees as Damage Indicators (DIs), and the specific types of damage that occur correspond to numerical Degrees of Damage (DoDs) with attached damage descriptions (McDonald, J. R., & Mehta, K. C., 2006). However to avoid confusion with similar naming conventions, and the fact that the game does not use the numerical system that the Enhanced Fujita Scale does, DIs are referred to as "structures" to the player, and DoDs are presented as the corresponding damage descriptions and referred to as "damages". Additionally, the descriptions used for the damages are simplified, and some categories have been modified or excluded for the sake of the player's experience.

The sound of the game was also carefully designed and implemented to enhance the experience. Music chosen for the game was a balance of a light and serious tone, keeping the player engaged and not overbearingly tense, but also converting the severity of the situation. Additionally, to further enhance the familiarity with the concept of the interface as mentioned previously, sounds that mimic paper were added to the journal and the blueprints. These wounds, along with sound effects for selecting options and pressing buttons reinforce actions the player takes with audio cues, assisting the player with memorizing the core concepts of the game, and what order to do them in.

Gameplay

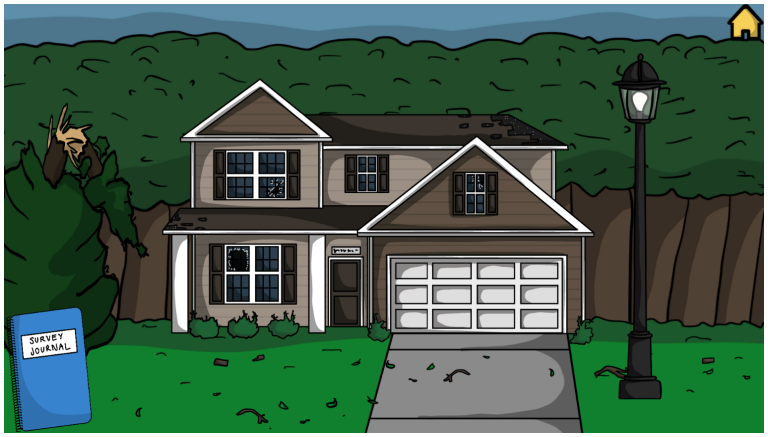

Figure 3: Level layout and user interface

Upon selecting a level to play, the player is brought to a scene containing multiple damaged structures that they are tasked with inspecting for damage. The player is able to move both right and left (using the arrow keys or W and D, standard controls for a game controlled by a keyboard) to see the full extent of the scene, but as to not overwhelm the player with too much information, especially in the earlier levels. The camera view is limited closely to the scene, and the player does not move the view vertically. The level has a slight parallaxing effect, allowing for the illusion of depth in a 2-dimensional space.

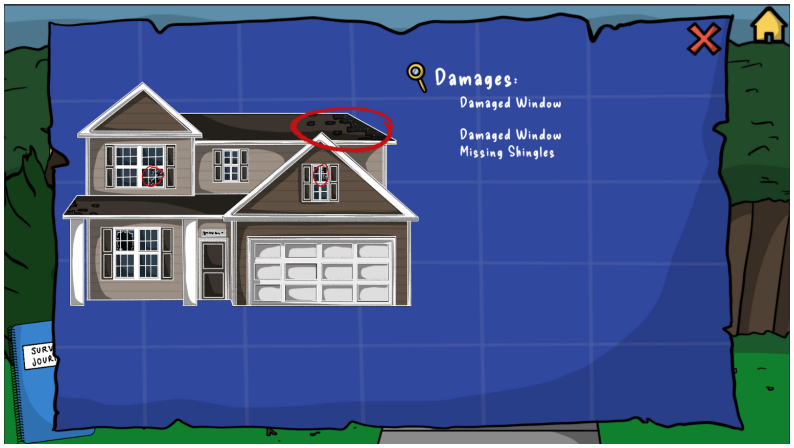

Figure 4: Blueprint view

Players click on each structure in a scene to inspect them. When clicking on a structure, the player is brought to a "blueprint view" where they are able to compare the state of the structure to an overlay of how the structure is supposed to look. When damage is found, the player clicks on the damaged portion, which is denoted with a red circle. The circle appears hand-drawn, implying that the player is notating on the image of the structure itself. A label for each type of damage that is found appears on the screen, the wording of which corresponds exactly to the options in the player's journal. Information specific to certain structures, such as a wood type for a tree is also located on this screen.

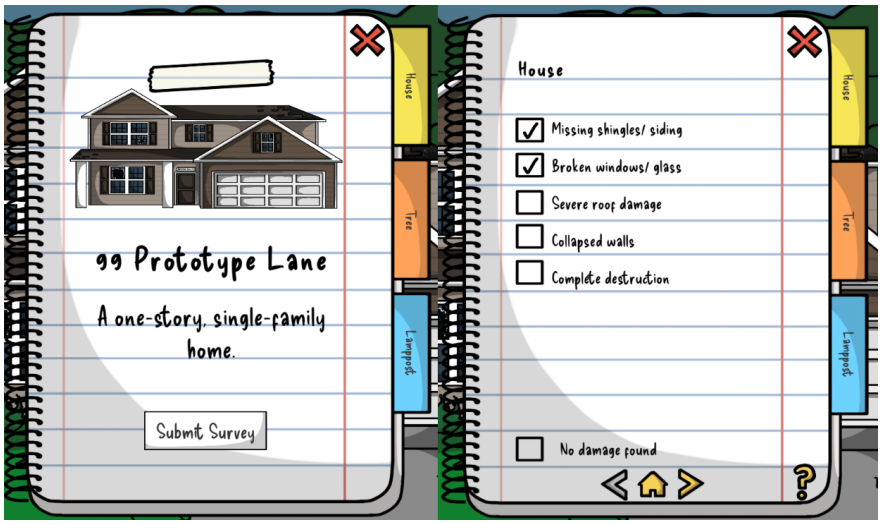

Figure 5a: Survey Journal homepage **Figure 5b: Survey Journal tab**

The “survey journal” (accessed by clicking on the journal icon in the scene, or by pressing E) is where the player accesses information about the level and the structures they are inspecting, as well as where the player enters the information they have discovered in the blueprint view. They are able to navigate through the pages of the journal using the tabs on the side and the icons on the bottom of the structure pages.

The journal homepage is where the player can view the information about the level as well as choose to submit the results of their survey after inspecting everything. The journal also has three tabs, each of which corresponds to a specific type of structure that the player will inspect. If there are multiple instances of the same type of structure, such as multiple trees or poles, the information for all of these instances will be located in a single tab.

The tabs located on the side of the journal correspond to the different structures the player is tasked with inspecting. Each page has a list of possible damages for a type of structure. Here, the player will select the damages observed in the blueprint menu, or select the option stating that they have not found any damages for that structure type.

After recording damages for all of the available structures, the player has the ability to submit their survey. After submission, the survey will be “graded” and the player will receive a score from 0-100. This score is calculated based on how well the player’s selections for damages (both what they selected and what they did not select) match up with the actual damages located in the level. The player will also receive, along with the grade, information about the storm such as a wind speed range calculated based on the Enhanced Fujita Scale.

Difficulty

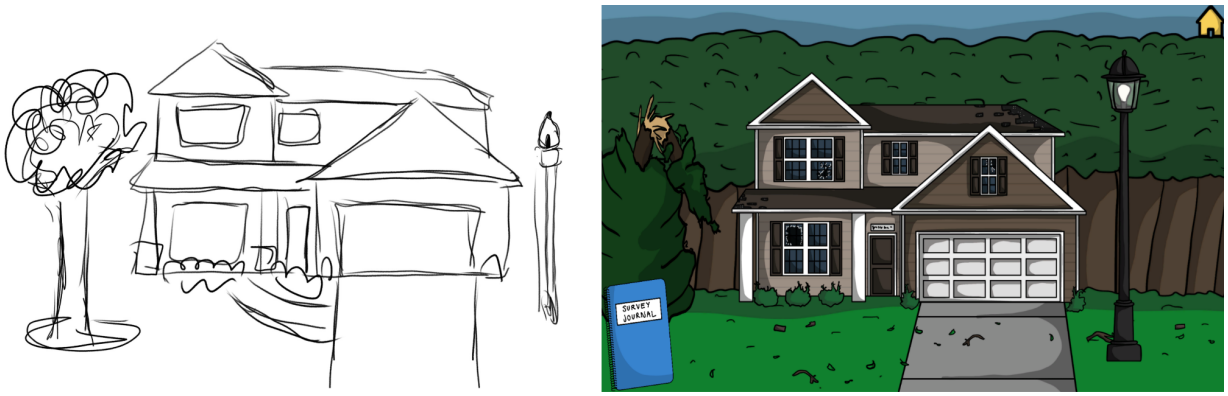

Figure 6: Level 1 design with three indicators (*tree, house, and lamppost*)

The game itself is not designed to be highly difficult as it is designed to educate. A key component to the success of an educational game is ease of use and accessibility for people who may not have prior experience playing video games (Winarni, E. W., Purwandari, E. P., & Hervianti, Y., 2018, p.2617, Gampell, A., Gaillard, J. C., Parsons, M., & De, L. L. 2020, p.47). However, the levels are intended to increase in difficulty as the player progresses in order to keep them engaged in a state of flow. The first level acts as a tutorial level, where the player is walked through the process step by step, being shown what each part of the interface does and how to use it, as well as introduced to the concept of a storm survey for those unfamiliar with the concept. This first level includes all of the foundational concepts the player will be using and expanding on in the later levels.

Following the tutorial level, the player is left to problem-solve on their own. The levels become larger, asking the player to move more to the sides in order to see all of the structures they are to inspect. Additionally, players are given multiple instances of the same type of structure to inspect with varying levels of damage. The severity of the damage changes as the player proceeds, as well as the types of structures the player is inspecting, encouraging the player to look for different types of damage.

Figure 7a: Blueprint view with hints inactive **Figure 7b: Blueprint view with hints active**

To make sure this game is accessible to many different types of players, the game also features the ability to enable and disable "hints". These hints display the total number of damages a player is required to find per item on the blueprint page, which can be helpful not only for structures with many damages, but also for structures with no damages present. This feature is disabled by default and can be enabled in the main menu.

Future Research

This project has a lot of possible avenues for future research and development, both with the game itself and the application of the game as a teaching tool. Due to the nature of the project, a very limited amount of time had to be split between development, asset creation, and research, leaving areas for improvement in all aspects.

The vast majority of this project was focused on the development process and creation of assets. Ideally a comparative user study would be conducted, comparing this newly created type of disaster education game to pre-existing games in order to have a complete understanding of this game as a teaching tool. Previous research that was consulted for this project cross examined existing games in a similar fashion. This user study would allow for a true measure of the effectiveness of this particular format, as well as an opportunity to see what aspects of the game can be improved.

Additionally, there are still improvements that can be made to the game itself. The game, as it currently stands, only has three levels. The three levels are able to portray the intention of the game and showcase the mechanics, but do not allow for a lot of time in gameplay. While more levels are designed, the levels have yet to be implemented due to time constraints.

The game was also originally intended to include more of a narrative detailing the human experience with a storm. Non-Player Characters (NPCs) were planned to be included that spoke to the player about their experiences with the tornado that destroyed the structures, creating more of an emotional response in the player that may make the experience more memorable. This would also allow for more emphasis on preparedness directly, with characters mentioning what they did or did not do to prepare for the tornado and how that affected them. The tutorial was also originally planned to be given by an NPC instead of a series of text prompts, again to create more of a personal connection to the situation.

This framework also has potential applications beyond tornadoes. Expansion to similar survey methods regarding other types of disasters could potentially be implemented in the future for further education on disaster preparedness. The narrative of the game could also be altered for a more entertainment-focused approach, perhaps scouting for the perfect hideout in a post-apocalyptic world or with a focus on rebuilding a damaged structure. Perhaps this approach could be more engaging and make players uninterested in educational content more likely to engage.

Conclusion

Using a unique approach for this disaster preparedness game that focuses on the aftermath of the storm allows for exploration of preparedness in a new light. By designing a game that puts the player face to face with a “worst-case scenario” we can create a motivating

force to actually apply learned preparedness strategies. Using a system that presents educational material subtly and in a serious yet not overwhelming tone will hopefully allow for increased player engagement and information retention from other disaster preparedness education strategies.

This project could lead to a promising new category of disaster preparedness education through games. This game could be implemented as part of a comprehensive disaster education program alongside other materials and games, or as a stand-alone experience

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