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Article

FireReady Challenge: A 2D Gamified Prototype for Community Fire Safety Preparedness

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A B S T R A C T

Fire protection remains a critical public concern, as fire-related incidents continue to cause substantial property damage, personal injuries, and loss of life. Although public awareness campaigns and routine safety drills are widely implemented, conventional didactic training methods such as posters, presentations, and demonstrations often fail to generate lasting comprehension or meaningful behavioural change. To address this gap, this paper presents the FireReady Challenge, a 2D gamified learning prototype designed to enhance community awareness and preparedness in fire safety. The game adopts the ADDIE instructional model to systematically translate key learning objectives into interactive digital experiences focused on hazard identification, safe evacuation procedures, emergency communication readiness, and proper fire extinguisher use. Gamification elements, including points, badges, real-time feedback, and time-bound missions, are embedded to strengthen motivation and user engagement. This concept design demonstrates an innovative approach to ICT-based fire safety education for community dissemination. Future research will involve pilot-scale deployment and empirical validation to evaluate learning outcomes, usability, and user acceptance.

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I. INTRODUCTION

Fire safety represents a vital component of community resilience, as fire incidents continue to cause significant human and economic losses worldwide. In Malaysia, the Fire and Rescue Department (Bomba) reported nearly 34,000 fire-related distress calls in 2023, with estimated property losses exceeding RM2.6 billion [1]. Despite ongoing campaigns and awareness programs, studies indicate that fire safety knowledge often fails to translate into effective action during real emergencies [2]. Conventional training approaches such as public talks, posters, and annual evacuation drills remain largely passive and provide limited long-term behavioural impact [3]. To address these gaps, innovative digital learning approaches that promote active participation and repeated practice are required. In response, this paper introduces FireReady Challenge, a two-dimensional (2D) gamified prototype that integrates core fire safety education within an interactive environment to improve community awareness, preparedness, and decision-making during fire emergencies. Table 1 shows a summary of localized Malaysia fire statistics.

Table 1. Malaysia Fire Statistics

Statistic	Detail
Number of fire incidents in 2023	Nearly 34,389 distress calls recorded by the Fire and Rescue Department (Bomba), involving estimated losses of around RM 2.6 billion.
Major causes of house fires	About 60% of house fires are caused by electrical issues (unsafe wiring, overloading appliances, etc.)
Fire & rescue incident distribution by state	Incident Report for Mid-2023: • Selangor: 5,136 incidents • Federal Territory of Kuala Lumpur: 1,554 incidents • Johor: 1,507 incidents • Sabah: 1,419 incidents • Perak: 1,263 incidents
Nature of structural/building fires	Approximately 96.47% of reported structural or building fires in a recent year were due to accidents rather than intentional causes.

II. LITERATURES REVIEW

Gamification has proven to be a significant pedagogical method that increases engagement, motivation and knowledge retention in various learning environments [4]. It integrates game elements such as points, rewards, challenges and feedback within instruction design to encourage active involvement and continued attention [5]. Prior studies have shown that gamification environments can effectively enhance learner motivation and thereby improve academic achievement [6], [7]. The idea of serious games takes this concept further, as entertainment delivery is fused with didactic (explicit) goals [8]. Serious games have successfully been employed in areas such as road safety education, occupational health and safety training and disaster preparedness [9], [10]. They offer a form of experiential learning in which knowledge is transferred into practical scenarios that replicate real-life difficulties, consequently developing decision-making processes and situational awareness [11], [12]. Despite the positive results reported in applied serious games and gamified learning across a variety of fields, their use in fire safety education for communities is rare [13], [14]. Although there are already some studies that were conducted during the epidemic, most of them are immersive environment systems in virtual reality (VR) and augmented reality (AR), which need costly terminals and high technical support, but scanty to promote universally [15], [16]. In contrast, 2D-Gamification is an inexpensive and accessible solution that can be applied to common digital de- vices like laptops and smartphones [17], [18], [19]. To fill this gap, this paper presents FireReady Challenge, a two-dimensional gamified prototype designed to raise

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awareness and preparedness for fire safety. The implementation converts basic safety skills such as the recognition of dangers, safe evacuation, using emergency communication and employing the correct extinguisher action into interactive learning situations that involve an ongoing practice with reinforcement of knowledge.

III. METHODS

The development of the FireReady Challenge prototype was guided by the ADDIE instructional design model, which is a systematic framework used in educational technology to ensure structured and iterative learning design. The model consists of five key stages, namely Analysis, Design, Development, Implementation, and Evaluation [20], [21]. This study focuses on the first three stages, while the remaining stages are planned as part of future empirical validation.

The analysis stage aimed to identify the essential learning needs for enhancing community preparedness in fire safety. Drawing upon current safety guidelines and statistical data from the Fire and Rescue Department of Malaysia [22], four critical domains were established as the foundation of the prototype. These include hazard recognition, safe evacuation, emergency communication, and appropriate use of fire extinguishers. These domains were prioritized because they represent practical competencies that are most relevant in real-life emergency situations and directly support the objectives of fire safety education [23].

The design stage focused on translating the learning objectives into interactive educational scenarios. Each module was developed to replicate real environments where fire risks typically occur, including homes, workplaces, and community buildings. Learners are placed in simulated situations that require them to make quick and accurate decisions under time pressure. To sustain motivation and engagement, the design incorporated gamification elements such as points, rewards, feedback, and countdown timers. This approach is consistent with findings that interactive feedback and progressive challenges improve both cognitive learning and behavioral response [6]. Figure 1 explains the ADDIE Framework for FireReady Challenge.

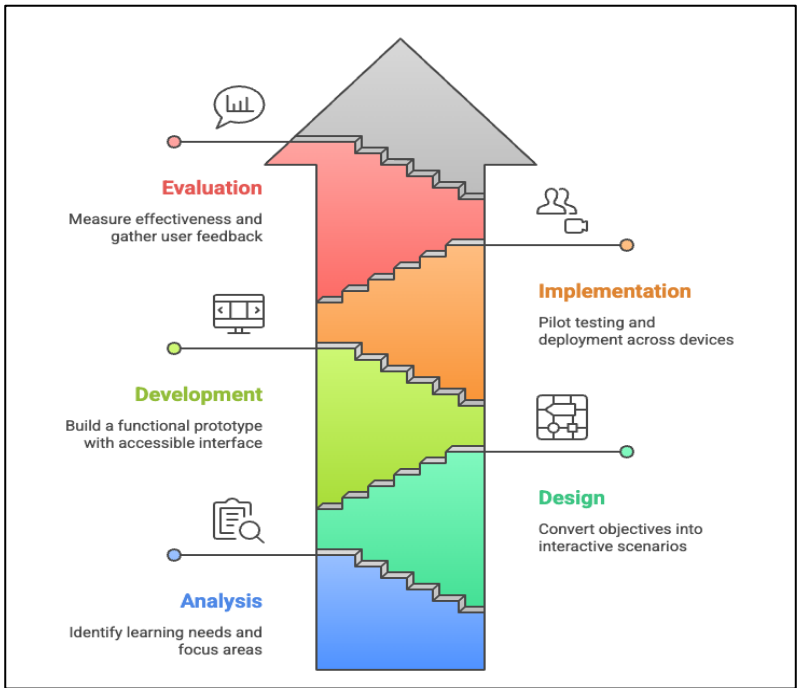

Figure 1. ADDIE Framework for FireReady Challenge

The development phase of the project involved transforming a conceptual design into an active digital prototype. The FireReady Challenge was developed using Replit and Streamlit in Python, enabling the model to be deployed in a browser without requiring special hardware or software.

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This effort allows the game to be played through popular devices including laptops, tablets and smartphones so it can easily reach more people.

The prototype is composed of four integrated modules, which in turn capture different dimensions of the desired competence in fire safety. [The module] Hazard Hunt is about finding those things in familiar places or among people that aren't safe. The Evacuation exercise involves simulated emergencies, prompting the user to make decisions about safe escape paths. With Emergency Communication, players learn to provide critical information when calling for help and Extinguisher Selection teaches them to recognize and employ the right fire extinguisher in various powerful fires.

Immediate feedback and assessment scoring are provided in all modules to reinforce learning and for self-assessment. The simplicity and accessibility of this 2D prototype indicate that it is potentially a viable training tool available for formal education as well as community use, in line with the overall objective to increase literacy about fire safety across varied user groups.

IV. RESULTS

The prototype of FireReady Challenge was implemented as a 2D interactive digital learning platform to change conventional fire safety education into an engaging and experienced learning process. It was designed to offer learners true-to-life situations in which to identify hazards, respond properly to emergency occurrences, and apply prevention through simulated experience.

The prototype starts with an opening screen where the player is introduced to what they will learn and are given some goals for the learning experience. This orientation phase ensures all users know what they are expected to achieve in each module and how their performance is evaluated. The prototype is designed to be accessible and easy-to-use; this means that learners of all ages and digital literacies are potential users of the prototype as well.

FireReady Challenge The central framework of the designed game - FireReady Challenge comprises four learning modules that cover key competencies for fire hazard safety preparedness. Module 1: Hazard Hunt - Teaching learners to identify hazards and potential fire risks around the home, e.g. living room, kitchen, office and bedroom etc. Participants must spot hazardous conditions such as power strips with too many plugs, unattended cooking devices and blocked exits before time runs out. This fosters greater situational awareness and risk mitigation. The Introductory screen of FireReady Challenge can be seen in Figure 2, which gives an insight to the game objectives and to teachers as a preparation for learning about interactive fire safety training.

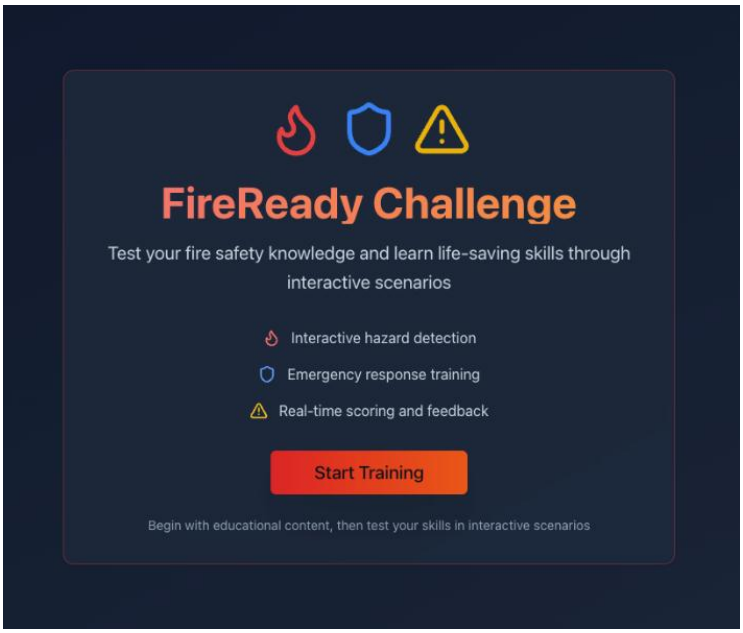

Figure 2. Introductory Screen of FireReady Challenge

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As for the second module, Evacuation Scenario, it deals with how to make decisions in stress. When a simulated alarm appears, players must choose the best safety escape path. It focuses on the need to avoid elevators, how to identify when exits are blocked and what emergency pathways should be used. With a specific count-down timer added, the setting simulates the frenzy of a real crisis, and trains how to act calmly under pressure. Figure 3a: Introductory page for FireReady Challenge This screen serves as the basis for all upcoming modules inside FireReady Challenge, by introducing students to the architecture of the game. Figure 3b generalizes this idea to the kitchen, a high-risk environment that learners are exposed to where they are expected to notice hazards such as grease on the floor, dish towels near stoves, and unsafe ways of using cooking devices

Figure 3c shows that the office and some of the risks presented as both organizational and electrical were presented in it like twisted tapes, heaters sitting near piles of paper to mention only a few as well as blocked emergency exits. The bedrooms themselves (see Fig 3d) add risk that is of direct relevance to personal practices, such as smoking materials and devices charging unattended and candle burning unsupervised. To reinforce the learner's ability to identify hazards, and as seen in Figure 3e, the focus at this point moves from risk identification to various dangers in the dining room (e.g., visible wires, unattended food warmers or candles too close to combustibles). Considering all these scenarios, this represents a logical development from learning how to evacuate towards identifying hazards in context, which makes knowledge of fire safer.

This third module, Emergency Communication, instructs the players to report an emergency in an effective way. It takes users through a series of easy-to-follow questions, asking for the address of the building on fire, description of the type of fire and whether anyone is trapped inside. It will aid in the development of optimal communication skills that are essential for enhancing response coordination and reducing panic during actual emergencies. An Evacuation scenario in an office building is demonstrated in Fig. 4a, where players have to select the safest evacuating path rather than unsafe exits like elevators or paths with debris.

The last module, Extinguisher Selection, will teach players the different types of fire extinguishers and how to choose the appropriate one. Learners must select the appropriate extinguisher for a simulated fire, such as electrical fires which would use a carbon dioxide extinguisher or flammable liquid-based fires, which would be extinguished using foam. This activity builds students' understanding around how to work with equipment and respond physically. In Figure 4b we demonstrate an emergency communication situation in which players are led to report a fire and to discuss the need for accurate information sharing.

Gamification elements like scores, feedback messages, and achievement badges are peppered throughout the game play in order to maintain player motivation and engagement. At the end of each, players get a performance summary with their accuracy, reaction time to make decisions and an overall readiness score. This feedback allows students to self reflect as well as reinforcing their learning of safety theory.

The design of FireReady Challenge is an example of how theoretical learning objectives can be transformed into a purposeful digital experience for practice. The prototype integrates instructional design and interactive technology to create an easily replicable, scaled implementation for community fire safety education.

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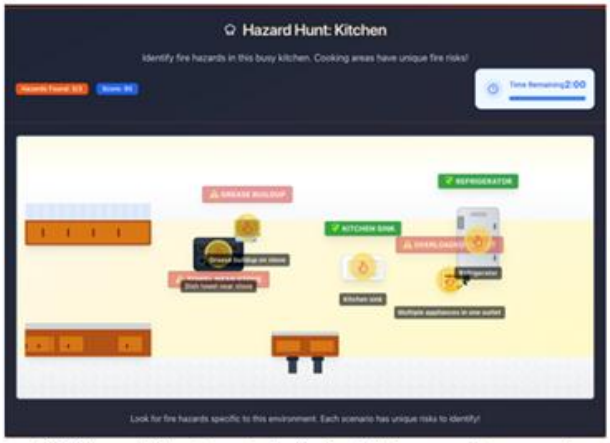
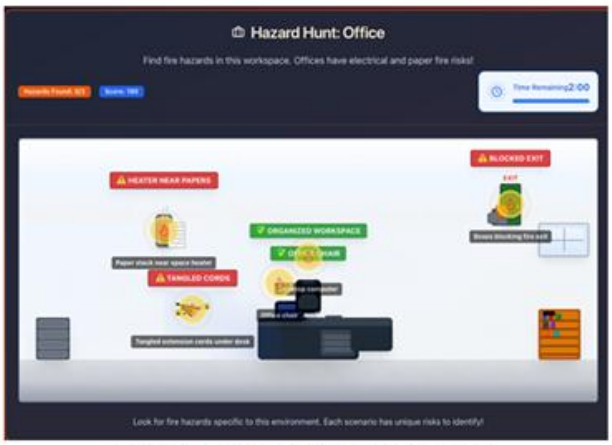
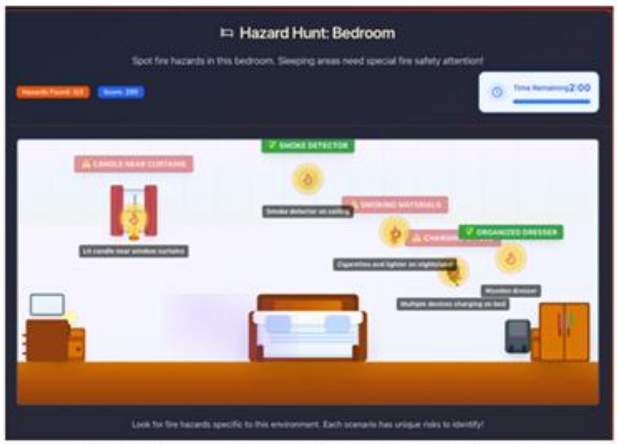
(a) Hazard Hunt module in the living room scenario



(b) Hazard Hunt module in the kitchen environment



(c) Hazard Hunt in the office scenario



(d) Hazard Hunt in the bedroom environment

(e) Hazard Hunt in the dining room scenario

Figure 3. Hazard Hunt Module

A countdown timer is incorporated into the scenarios to simulate urgency, further motivating players to act quickly and decisively, as they would in real-life emergencies. Figure 4c shows the Fire extinguisher selection module, where learners choose the appropriate extinguisher for an electrical fire in a server room, reinforcing practical equipment knowledge. At the conclusion of the game, a results screen summarizes the learner's performance and provides targeted safety reminders. Players receive feedback on their accuracy, speed, and decision-making, accompanied by a knowledge reinforcement segment that highlights key fire safety rules. Figure 4d shows the

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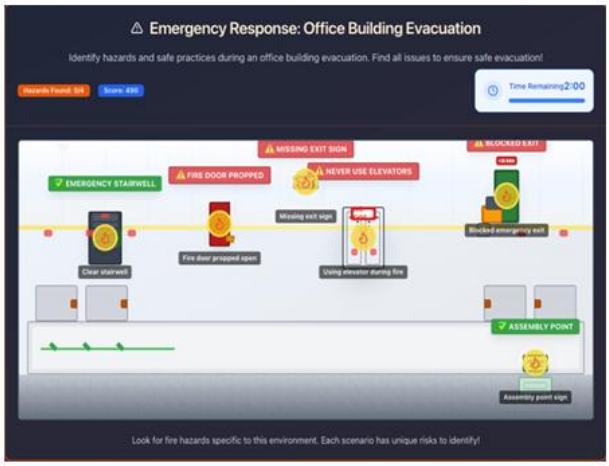
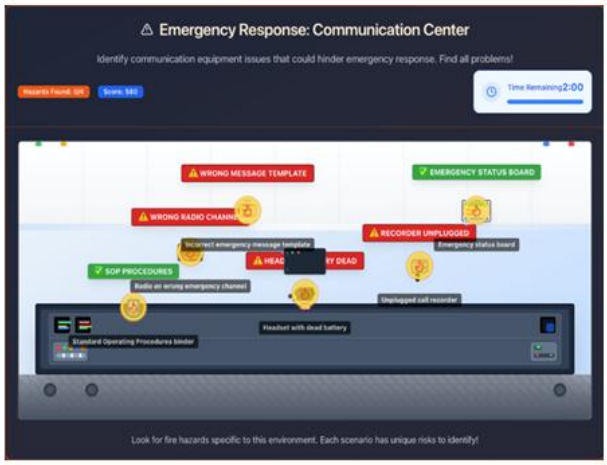
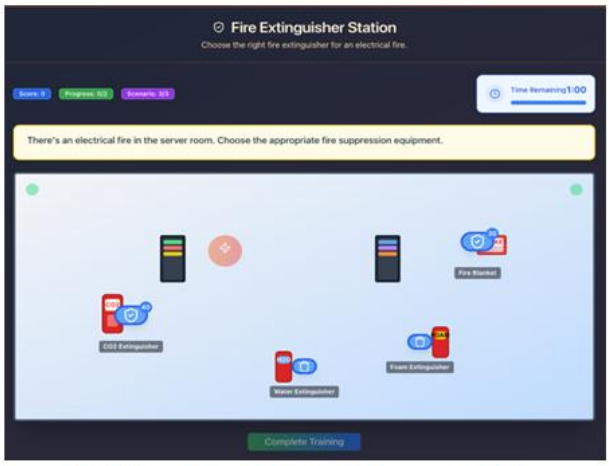
Results and feedback screen summarizing learner performance, awarding badges such as Fire Hero, Fire Aware, or Fire Risk, and presenting key safety reminders.



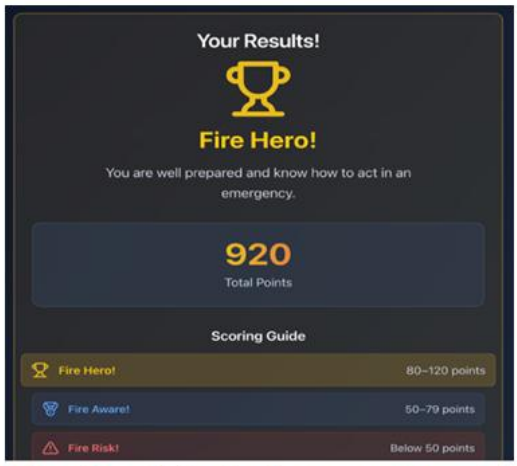
(a) Evacuation scenario in an office building



(b) Emergency communication scenario



(c) Fire extinguisher selection module



(d) Results and feedback screen summarizing learner performance

Figure 4. Simulation Modules and Outcomes

V. DISCUSSION

The development of FireReady Challenge highlights the significant potential of gamification as an innovative approach to community fire safety education. This prototype demonstrates how interactive digital tools can transform traditional awareness programs into engaging and outcome-based learning experiences. Its modular design provides flexibility for use in schools, workplaces, and community training settings, encouraging repeated learning and active participation.

The prototype can be applied in diverse educational contexts. In schools, it can complement fire safety drills and classroom lessons by allowing students to engage with practical scenarios through active simulation. In community centers, it can serve as a low-cost platform for residents to build awareness and preparedness skills. In workplaces, particularly in small and medium enterprises, the prototype can support ongoing safety training without disrupting daily operations. This aligns with previous studies that suggest interactive learning enhances engagement and promotes behavioral change in safety education [6], [23].

The two-dimensional format of the game provides accessibility advantages compared with high-immersion technologies such as virtual reality or augmented reality. It can be deployed using standard digital devices such as laptops, tablets, or smartphones, eliminating the need for expensive

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equipment or specialized technical support. This design ensures greater scalability and inclusivity, especially in resource-limited environments. The simplicity of the platform allows users to replay scenarios multiple times, strengthening retention and skill mastery through continuous feedback. This finding supports evidence that repetition within gamified learning environments enhances long-term learning outcomes [24], [25].

Although the prototype has substantial conceptual merit, it is a work in progress and empirical validation is needed. Further research will pilot test to determine gains in knowledge, decision quality and user involvement. Although 2D-AR enhances the elements of accessibility, The two-dimensional environment provides lower experiential immersion than VR/AR environments (and they can reduce emotional engagement as well) [16]. Another issue is the different level of literacy that may exist among digital content users, especially elderly people or those living in rural areas.

To mitigate these limitations, future improvements should involve adaptive learning capabilities that dynamically modify game difficulty in accordance to the user's performance, multilingual interfaces for broader users coverage and inclusive design factors underpinned with the UDL framework. These refinements will guarantee FireReady Challenge is a fair and effective learning platform for all communities.

VI. CONCLUSION

The FireReady Challenge Prototype is novel in using a play based gamification approach together with information and communication technology for fire safety education. It demonstrates how traditional awareness offerings can be enhanced through interactive education that initiates learner immersion, motivation, and behavioral change. The ADDIE instructional design framework has been used to model the prototype which translates basic fire safety competencies including hazard recognition, safe evacuation practices, effective emergency communication and proper use of fire extinguisher into meaningful learning experiences in digital format.

The 2-Dimensional format promotes ease of use for diverse audiences and is an economical tool that can be used by schools, businesses, communities, etc.. Scenarios are re-cyclable to be practiced numerous times, helping increase knowledge retention and users' confidence in actual emergencies. This is an example of the game-based learning can enhance community preparedness and safety in places people live.

The next steps will focus on the pilot testing of the prototype at schools, institute of works and community centres. The evaluation will assess the effectiveness of learning through pre-post-testing knowledge, accuracy, and response time and early indicators such as engagement level, ability for tasking completion and overall performance.

User acceptance will be examined based on theoretical constructs derived from the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT) as well as Protection Motivation Theory (PMT). The modality of the evaluation will be in functions of the perceived usefulness, performance expectancy, effort expectancy, behavioral intention, perceived vulnerability and response efficacy. This will validate FireReady Challenge as a successful educational resource, and offer new directions for digital safety training and community-based learning.

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