Changing the Game:

Adapting Capture the Flag To Underrepresented Groups

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ABSTRACT

Capture the Flag (CTF) contests have become popular in the cybersecurity community to display and cultivate skills related to cybersecurity. Professionals within the cybersecurity community participate in them to claim "bragging" rights, conferences use them as a hands-on workshop activity, and universities sponsor them to build interest in cybersecurity. Skill in navigating a CTF contest is a source of prestige, and infers cybersecurity skills. The traditional cybersecurity CTF game uses a competitive context rather than cooperative. Competitors is may work alone or form teams. Games and other technology design are noted for reflecting the creators. Since the majority of cybersecurity professionals and academics are non-diverse, the games they create reflect their cultural bias. One of the ways to reach underrepresented groups, such as women and minorities, is provide learning options that reduce cultural bias. If the major learning option in cybersecurity is CTF games that reflect a traditional cultural bias, underrepresented groups are at a disadvantage.

With this in mind, this research developed a game framework designed for the participants to build an original Capture the Flag. The game framework removes the need for designers to build game functionality, while still retaining full control over the content. Consequently, the Capture the Flag challenges can reflect the interests and cultural background of any group of designers. In addition to the game play and the opportunity to tailor content, the framework also tracks how effective the challenges from the various design teams are based on the interaction of the participants with those challenges.

INTRODUCTION

Gamification can improve user experience and engagement [1]. The game of choice within the cybersecurity community is an electronic versions of Capture the Flag (CTF). These contests generally have themes that shape the content of the game. Like the rest of cybersecurity, CTF contests typically attract fewer underrepresented minorities [2].

Women and underrepresented minorities have not been attracted to cybersecurity programs and computer science in general, resulting in a lack of diversity in the potential workforce [3]. One of the ways to reach underrepresented groups, such as women and minorities, is provide learning options that reduce cultural bias [4]. Cybersecurity education researchers Codish and Ravid advocated for adaptive game framework that allows a game to be tailored to users of the game [5]. A tailored game has greater potential for greater enjoyment and engagement, which is key both in cybersecurity education and recruitment [6]. However, games in general reflect the gendered bias of the designers in the portrayal of characters, and in the style of activities [7]. Allowing underrepresented minorities to design results in content more inclusive for all [8].

BACKGROUND FOR GAMIFICATION AND GENDER/CULTURAL BIAS

The research of gamification in many disciplines including STEM recognizes the need for adaptive gaming to achieve the greatest efficacy [9]. While games cannot be one size fits all [1], there are design principles to improve engagement [10]. Furthermore though the popularity of gamification is growing, resources to support the game delivery are scarce, and open source is a key option to support such sharing [1]. Even outside the academic setting, user evaluation shows game-based learning models have a high level of acceptance if enjoyment is adopted as a design principle. [11].

At an early age the appropriateness of toys for a particular gender is signaled by color [12]. A traditionally masculine toy in pink gave girls "permission" to explore outside cultural boundaries. Previous video game experience has been shown to give a group of participants, typically male, an advantage in in computer-based game play [13]. Though some CTF contests such as Pink Elephant Unicorn (PEU) are designed to teach cybersecurity to an inexperienced as well as experienced audience, there has not been an effort to match the game to the interests of the target group [2]. Having the word "pink" and "unicorn" in the name of the PEU competition signals a more whimsical approach than traditional CTF.

Indie game design has attempted to challenge traditional gender-based biases with limited success [14]. Imposing a requirement to appeal to all comers triggers the motivation to stick with what has previously succeeded. An analysis of app store reviews show cultural factors significantly influence app feedback, but developers have not been sensitive to cultural bias [15]. By providing a framework easy to tailor with minimal overhead, this research reduces the risk of not following convention.

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RESEARCH PROBLEM

Providing a framework easy to tailor with minimal overhead, this research reduces the risk of not following convention. This research addresses the following research questions.

1. Will an adaptive game framework allow diverse teams to successfully create CTF challenges?
2. Will the adaptive CTF challenges engage the users of the target community?

If the diverse game designers are well supported in the game creation step, they apply their creativity to making challenges relevant to the diverse audience. Such challenges adapted to the audience should show a positive level of user acceptance. Therefore the study has the following hypotheses

H0. The adaptive game framework will not result is successful creation of challenges
H1. Diverse design teams will successfully create CTF challenges that reflect their design aesthetic
H2. The diverse design teams will successfully complete game play of the CTF challenges other than their own
H3. The users in the target community will complete a majority of the adaptive CTF challenges
H4. The challenges will receive an acceptable user rating on post-game survey.

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