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Cyberverse: A Game-Based Learning Application for Cyber Security

Rhonnel S. Paculanan., Rejan L. Tadeo., Maricar T. Caliliw., Christina P. Atal., Joy N. Sadol

College of Engineering and Technology, Philippines

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Abstract: Games are becoming more frequent in educational settings, and various technologies have been established to meet the needs of designing an education as a game. Aside from education, game-based learning is rising in popularity in various areas, including professional development and networking sites. By incorporating gaming components into the training process, educational platforms that use games will increase student engagement, motivation, and productivity. One of the most defining characteristics of game-based learning environments is their ability to produce innovative and engaging learning experiences (Gee, J. P. 2020; Hamari, J., et al 2021). Games-based learning integrates instruction with authentic gaming experiences. Scientific and popular interest in severe goal games has increased tremendously (Huang, W. H.-Y. et al. 2021; Kapp, K. M. 2020; Zhang, Y. et al. 2023). Cybersecurity refers to the practice of protecting systems, networks, and programs from digital attacks, damage, or unauthorized access. With the increasing reliance on technology and the internet, the significance of cybersecurity has grown tremendously. It encompasses various measures, including: Threat Prevention, Incident Response, Data Protection, Awareness and Training and Compliance (Kshetri, N. 2021; Stallings, W., et al 2022; Kaspersky, E. 2020). Cyber security occupies a major part of society today. Cyber security educational games are a popular form of hands-on exercises that use gamification to train information security skills and enhance cyber security awareness. The objectives of the game application are to (1) create awareness of the necessity of the importance and function of cyber security such as password security, phishing awareness, identity theft, encryption, and network security among others. (2) to distinguish between the various topics of cyber security while playing the game application (3) to determine the evaluation tool to use in the assessment of the cognitive abilities of gamers. A quantitative research design was used to determine the process of the application while the Agile model is commonly used in game development due to its iterative and flexible nature. Technical Aspect which is the ISO 25010 and Game Aspect Method was used for the Evaluation with 60 respondents. The study can identify the genders of the respondents as male and female. The mechanics of the game can make the gamers use and test their knowledge about cyber security. Evaluation results of gamer respondents show the average mean of both males and females are interpreted as "Strongly Agree". This means that they strongly agree that cognitive abilities are used when playing the application. Meanwhile, evaluation results of technical respondents' average mean for both males and females are interpreted as also "Strongly Agree". This means that they strongly agree on all the technical aspects of the application. Overall, evaluation results of all respondents whether gamer or technical are interpreted as "Strongly Agree".

Keywords: Game-Based Learning, Cyber security, educational games, learning

I. Introduction

Games are becoming more frequent in educational settings, and various technologies have been established to meet the needs of designing an education as a game. Aside from education, game-based learning is rising in popularity in various areas, including professional development and networking sites. By incorporating gaming components into the training process, educational platforms that use games will increase student engagement, motivation, and productivity. One of the most defining characteristics of game-based learning environments is their ability to produce innovative and engaging learning experiences (Gee, J. P. 2020; Hamari, J., et al 2021) . Games-based learning integrates instruction with authentic gaming experiences. Scientific and popular interest in severe goal games has increased tremendously (Huang, W. H.-Y. et al. 2021; Kapp, K. M. 2020; Zhang, Y. et all 2023). Students today are particularly interested in computers.

On the contrary, educators will concentrate most of their class time on more effective teaching. Many educators are currently looking into Game-Based Learning as a technique for motivating pupils to achieve academic success. Gamification can also assist instructors and students prepare for the difficulties of globalization in the classroom. Online interactive games are useful and necessary for improving language instruction quality and increasing digital literacy among the younger generation.

There are several examples of game-based learning but one of the significant ones called the Oregon Trail is one of the first and best with applicable educational standards and subject-specific content giving the player a captivating game experience. Other examples of starter games include Banished, Bridge Constructor, Gone Home, Kerbal Space Program, and Myst. Games often have a fantasy element that engages players. Not only does the integration of learning with gaming make it more fun; but it also motivates students to learn, keeping them engrossed in the materials so they learn more effectively and encourages them to learn from their mistakes.

Games are often played for the sole purpose of fun, for taking up challenges and to outplay other opponents. It can also be used as a medium of relieving stress. Games can be played to boost a player's self-esteem and personal development. Through this method of learning, dialogues are created, and social and cultural boundaries are broken. The game-based learning model is usually chosen

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depending on the learning objective.

Cybersecurity refers to the practice of protecting systems, networks, and programs from digital attacks, damage, or unauthorized access. With the increasing reliance on technology and the internet, the significance of cybersecurity has grown tremendously. It encompasses various measures, including: Threat Prevention, Incident Response, Data Protection, Awareness and Training and Compliance (Kshetri, N. 2021; Stallings, W., et al 2022; Kaspersky, E. 2020). Cyber security has occupied a major part of society today that's why Cyber security educational games are a popular form of hands-on exercises that use gamification to train information security skills and enhance cyber security awareness.

Cognitive abilities are present in digital games. These abilities are defined as a person's mental capability that involves the ability to reason, plan, solve problems, think abstractly, understand complex ideas, learn quickly, and learn from experience. In a study by Peter Gray in March 2018, as stated in their article Psychological Bulletin, he stated Benoit Bediou and colleagues 2018, analyzed the correlational studies which revealed that the amount of time gaming and high results on tests of perception, attention, spatial cognition, multitasking, and cognitive flexibility (the ability to quickly switch strategies when old ones do not work), have strong positive relationships.

II. Background of the Proposed Project

The Cyber Verse is an innovative game-based learning application designed to enhance understanding and skills in cybersecurity through immersive and interactive experiences. Set in a dynamic digital world, players assume the roles of cybersecurity professionals tasked with defending virtual environments from various cyber threats. By engaging in realistic scenarios, participants learn critical concepts such as threat detection, risk assessment, and incident response. The application not only gamifies the learning process but also fosters teamwork and strategic thinking, making cybersecurity education accessible and engaging for learners of 13 and above and backgrounds. Through its blend of entertainment and education, CyberVerse aims to equip users with the knowledge and tools necessary to navigate the increasingly complex landscape of cybersecurity.

Objectives:

The objectives of game application are to (1) create awareness of the necessity of the importance and function of cyber security such as password security, phishing awareness, identity theft, encryption, and network security among others, (2) to distinguish between the various topics of cyber security while playing the game application, (3) to determine the evaluation tool to use in the assessment of the cognitive abilities of gamers.

Conceptual Framework:

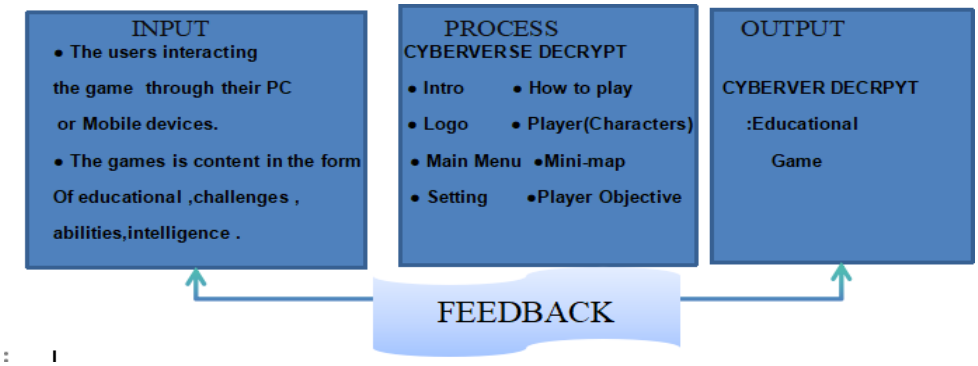

Figure 1. The Conceptual Framework of the Study

Figure 1 states that the input is the game's content in the form of educational, challenges, abilities, and intelligence through their PC or Mobile Devices. During the game, it has an intro with a logo followed by a Main Menu (Setting, How to Play, Player (Characters), Mini-Map, and Player Objective. Players navigate through simulated environments that mimic real-world cybersecurity challenges. It Cover various topics (e.g., phishing, malware, network security with Integrate lessons from actual cybersecurity incidents. Encouraging exploration and self-directed learning through interactive play can provide by the game and the output is analyzing user engagement, retention, and skill acquisition. Ensuring the application is usable for individuals with varying abilities

Scope and Limitation Scope

The function or scope of the game is to stimulate learners' interest with real-life probable scenarios through the friendly interface for interaction and to resolve problem-solving utilizing scalable and flexible methods.

Limitation: the game has 5 levels, and it is a repetitive scenario that becomes less challenging to the player involved. The minimum age of gamer-respondent is set at 13 years.

The study focuses on analyzing different games for creating cyber security awareness and training using technologies that include

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a 3D virtual world or simulation, 2D framework, mobile applications, and web-based application technologies. Most of the games focused on general cyber security awareness, network security, phishing, and end-user PC protection. As the number of studies in cyber security training has been increasing, most of these studies were focused on the public. Very few studies are found to focus on training professionals in the aspects of internal threats. Any study must evaluate the application to identify the suitability and usability of such applications.

III. Related Review Literature and Studies

A review of these studies has indicated that the cyber security awareness approach through gaming is relatively quite new and needs extensive research studies and evaluation approaches for analyzing various security issues and related gaming techniques.

In this review, taxonomy for cyber range systems and analysis of existing literature that focuses on architecture and scenarios, but also capacities, functions, resources, etc. In this paper, the IoT-based smart grid's risks and future approaches are analyzed and focuses on forms of cyber threats and include an in-depth understanding of the smart grid's cyber-security environment. This concentrates on addressing and analyzing vulnerabilities in the network, challenging countermeasures, and requiring protection. We strive to provide a deep understanding of cyber-security vulnerabilities and solutions and provide a road map to future cyber-security research directions in smart grid applications.

A Cyber Security Control V&V process model is built in this study to solve the problem, based on the principle of adaptive focusing testing. Additionally, a quantitative approach is built to define and prioritize fault-prone information security controls. It has been verified that the model built may provide an additional and more reliable framework for expert subjective judgment.

Statistics for game hardware and software revenue and the volume of players indicate a major social and entertainment culture (though the actual size of the mainstream stream-videogame industry at present is open to interpretation). Industry commentators and digital game researchers often quote game statistics about other media. For example, Sony's Playstation2 console launched in Japan in February 2000, selling 980,000 units in its first weekend and thus becoming the biggest launch of any electronic consumer device in history (Wired Staff 2000). Console quickly became a groundbreaking success, selling nearly 1 million units in its first weekend in Japan, setting a record for consumer electronics. Nutt discusses the PS2's innovative features, such as DVD playback capabilities, which broadened its appeal beyond gaming. (Nutt, C. 2020). Announcing Xbox Cloud Gaming (Beta) with Xbox Game Pass Ultimate." Xbox Wire. This official announcement details the launch of Xbox Cloud Gaming, its features, and how it integrates with Xbox Game Pass Ultimate. Microsoft. (2020).

"What Is Xbox Cloud Gaming?" PCMag. This article explains the capabilities of Xbox Cloud Gaming, how it works, and its impact on the gaming experience. Cohen, A. (2021).

The games-based learning method has several advantages. The obvious advantage is that games-based learning methods provide an interactive approach to trainers educating the users about a specific program. It enables the players to acquire skills and enable thought processes in a fun and interactive way. The adaptability and flexibility of game approaches enable to design of the game to suit almost every training subject possible.

Research Design

A quantitative research design, characterized as a descriptive-developmental approach that involves quantifying, analyzing, and interpreting statistical results to provide a descriptive understanding of the features and mechanics of the game was used. The method understands how players interact with the game, their levels of engagement, and the difficulty of the challenges they face.

Data Collection

The researchers used various data collection methods to analyze the game to collect the necessary information for this study. Evaluation questionnaires and data tabulation are used as methods. This study focuses on quantitative data collection, employing a questionnaire designed specifically for the evaluation of the game. An A4-point Likert scale is used to technically evaluate the game application. The Likert scale ranges from "1" indicating "Strongly Disagree" to "4" indicating "Strongly Agree."

Game Development Life Cycle (GDLC)

Game creation involves extensive research. Research the type of game to be developed and create a game design document (GDD), even if it is a simple game. The GDD is a brief for the entire project and outlines all the major details like game mechanics, genre, world-building, story, and marketing strategy. The GDD should answer any question a potential audience might have about the game, from high-level concepts down to the minutiae of aesthetic choices in visual and audio design.

IV. Gdlc Agile Method

The Agile model is commonly used in game development due to its iterative and flexible nature. It promotes iterative development, adaptability to changing requirements, and cross-functional collaboration. Agile allows for rapid prototyping, continuous improvement, and early player feedback. Its emphasis on flexibility and collaboration makes it well-suited for game development, where creativity, player engagement, and responsiveness to market demands are important.

The choice of a GDLC model depends on various factors, but Agile's advantages in game development include its iterative

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approach, adaptability, and focus on collaboration and player feedback.

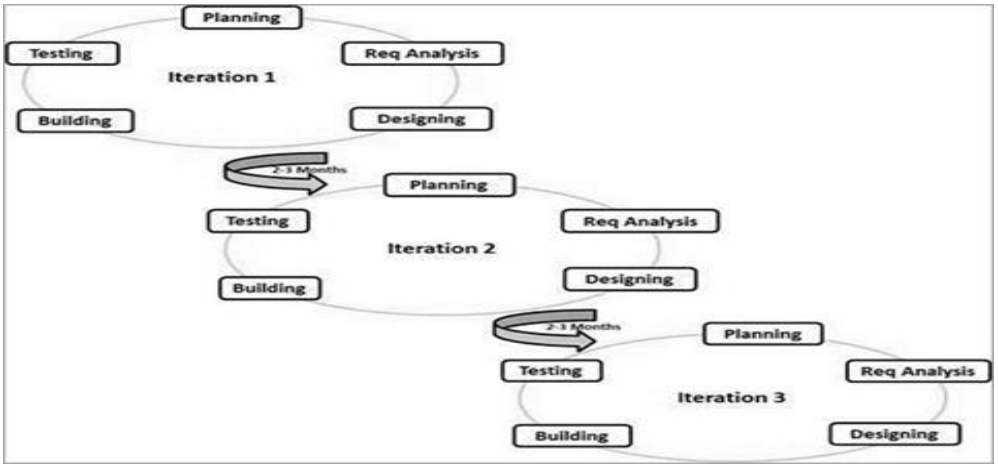

Figure 2: GDLC Agile Model

Figure 2 states that Game Development Life Cycle has a structured process that outlines the various stages involved in creating a video game. It typically includes the following phases: Plan - The project scope, objectives, and requirements are defined by the developer. Design - The design phase involves creating detailed specifications and designs for the game. Develop - The development phase is where the actual coding and implementation of the game occur. Test - Testing is an integral part of the Agile SDLC model. In the testing phase, the game is thoroughly tested to ensure that it functions as intended and meets the specified requirements. Deploy - The deployment phase involves making the game available for use by players. Review - refers to the sprint review or iteration review. After completing as print or iteration, the development team presents the completed work to stakeholders for feedback and validation and lastly to launch or release the game to the public or target audience.

Use Case Diagram

Through associations or connections, the diagram visually depicts the relationships between players and use cases. The associations indicate who initiates or participates in the interaction in each use case. This aids in identifying the system's functionalities and the roles of the players in utilizing those functionalities.

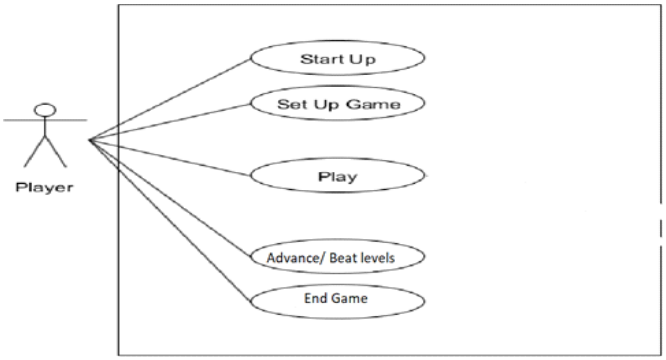

Figure 3: Use Case Diagram

Evaluation Process

The application is assessed by two groups of respondents, namely, the gamer group and the technical group. The respondents of the gamer group are selected based on their experiences in playing games. They evaluated the application based on acceptability and ease of playing the game. The respondents of the technical group are selected based on their backgrounds in information technology; have experience as systems administrators; or have exposures in developing systems and game applications.

Method for Evaluation (Technical Aspect)

1) ISO/IEC 25010 is an international standard that defines a quality model for software product evaluation. It provides a framework for assessing the quality of software products based on eight characteristics:

Functionality–The game provides the functions that meet the stated and implied needs of the user.

Usability–The game's ability to be understood, learned, used, and attractive to the user.

Efficiency–This is the game's ability to optimize desired outcomes.

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Reliability – The game's ability to perform its intended functions under stated conditions for a stated period.

Portability–The game's ability to be easily played.

2) Method for Evaluation (Game Aspect) - The PASS Theory of Intelligence, proposes that intelligence consists of four interconnected cognitive processes:

Planning - a cognitive process requiring the individual to determine, select, and use a strategy to solve a problem

Attention - a cognitive process requiring the individual to selectively attend to a particular stimulus and inhibit attending to competing stimuli.

Simultaneous - a cognitive process involving integrating separate stimuli into a single whole or group

Successive - a cognitive process requiring the sequential ordering of things.

Respondents of the Study

There are two groups of respondents: (a) the gamer group, and (b) the technical group. There are 30 respondents composed of male and female in the gamer group. They evaluated the game based on their experiences as gamers on acceptability and ease of play. The minimum age of a gamer is set at 13 years old. Likewise, there are 30 respondents composed of male and female in the technical group. All technical respondents are presumed to be of mature age. They evaluated the game based on their technical backgrounds and knowledge of the development of the game application with a total of 60 respondents. Weighted Average, Percentage, and the Likert Scale were used to measure the evaluation of both Technical and Game Aspects.

V. Results and Discussion

Project Description

"Cyber Verse Decrypt" is a 3D platform educational game application. The objective is to enable a gamer to unwittingly use cognitive abilities such as sustained attention, speed of information processing, cognitive flexibility and control, working memory, and pattern recognition when playing the application. A Random Algorithm is applied to challenges to deter the anticipation of its appearances.

Summary of Evaluation of Technical-Respondents

Table 1: Summary of Evaluations of Technical-Respondents

Criteria (ISO25010)	Respondents (30)			
	Male (13)		Female (17)	
	WM	VI	WM	VI
1.Functionality	3.4	SA	3.7	SA
2.Reliability	3.4	SA	3.7	SA
3.Efficiency	3.3	SA	3.5	SA
4.Usability	3.3	SA	3.6	SA
5.Portability	3.4	SA	3.7	SA
Overall Average Mean (gender)	3.3	SA	3.6	SA

Table 1 displays the summary of evaluation of Technical-Respondents based on the criteria of ISO25010. Technical male genders have an overall average mean of 3.3 understood as “Strongly Agree” while technical female genders have an overall average mean of 3.6 interpreted as “Strongly Agree”. Regarding the application's acceptability and usability in light of the standards by which the technical features were assessed, all technical respondents are in strong agreement.

Project Evaluation Results

Two sets of respondents are used to evaluate the gaming application: (a) the gamer respondents and (b) the technical respondents. While the other group, the technical respondents, concentrated on the technical value and performance of the game application from their technical point of view, the gamer group's assessments concentrated on the acceptability and simplicity of use of the game application based on gamers' experiences. For the two examinations, the technical group used the ISO 25010 evaluation form while the gaming group used the PASS Theory of Intelligence evaluation form.

Accompanying percentages show the respondents' demographic profile (gamers and technical), including gender and groupings.

Summary of Evaluation of Gamer-Respondents based on PASS Theory of Intelligence

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Table 2: Summary of Evaluations of Gamer-Respondents

PASS Theory of Intelligence	Respondents (30)			
	Male (23)		Female (7)	
	WM	VI	WM	VI
1.Planning	3.9	SA	3.9	SA
2.Attention	4.0	SA	3.6	SA
3.Simultaneous	4.0	SA	3.6	SA
4.Successive	4.0	SA	3.6	SA
Overall Average Mean (gender)	4.0	SA	3.7	SA

Table 2 displays the summary of evaluation of Gamer-Respondents based on PASS Theory of Intelligence. Gamer male genders have an overall average mean of 4.0 understood as “Strongly Agree”, whereas Gamer female genders have an overall average mean of 3.7 interpreted as “Strongly Agree”. All Gamer responders highly believe that cognitive skills are used when playing the program based on the criteria of PASS Theory of Intelligence.

VI. Summary of Findings

The game application is built to educate people about cyber security and to test people's knowledge about said topic. A group of gamer-respondents are asked to assess the acceptability and ease of playing the game using the PASS Theory of Intelligence evaluation form. Likewise, the ISO 25010 evaluation format is used by the technical respondents in the technical evaluation of the acceptability and usability of the application. This study is significant in determining the level of gamers' understanding of cyber security as well as making them aware that they are unwittingly using their cognitive abilities while playing the game.

VII. Conclusion

The study can create a game application on the basics of cyber security with lots of challenges to solve such as password security, phishing awareness, identity theft, encryption, and network security among others. The issue of the cognitive abilities of gamers is also explored while playing the game application. The study can identify the genders of the respondents as male and female. The mechanics of the game can make the gamers use and test their knowledge about cyber security. Evaluation results of gamer respondents show the average mean of both males and females are interpreted as "Strongly Agree". This means that they strongly agree that cognitive abilities are used when playing the application. Meanwhile, evaluation results of technical respondents' average mean for both males and females are interpreted as also "Strongly Agree". This means that they strongly agree on all the technical aspects of the application. Overall, evaluation results of all respondents whether gamer or technical are interpreted as "Strongly Agree".

Recommendations

The game could have been better overall if given more time, especially in terms of graphics and level of difficulty. It should have also been updated to reduce bugs and in corporate new challenges to keep players on their toes.

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