NetGuardians: Lightweight and Interactive Serious Game for Cybersecurity Education

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Abstract*— This paper presents NetGuardians, an interactive narrative-driven serious game designed to support cybersecurity awareness among high school students. As cybersecurity threats continue to increase, particularly affecting young learners, there is a growing need for engaging educational approaches that can introduce essential digital security concepts in an accessible manner. NetGuardians focuses on three fundamental topics: recognizing phishing attacks, promoting strong password practices, and understanding the risks associated with public Wi-Fi usage. The game was developed using the Game Development Life Cycle (GDLC) methodology and integrates storytelling, interactive quizzes, and real-life case scenarios. In addition, a comparative analysis was conducted with existing cybersecurity educational games, including Riskio, CyberHero, and CSRAG, to examine differences in content focus, engagement strategies, and academic design approaches. To explore students' learning experiences, qualitative data were collected through interviews with 25 high school students. The interview questions, based on concepts from serious games and game-based learning literature, focused on perceived learning, engagement, cybersecurity awareness, and digital decision-making. The qualitative findings suggest that participants reported increased cybersecurity awareness, especially regarding phishing and password security, and found the narrative and interactive elements helpful in understanding the material. However, due to the qualitative nature of the study and the lack of empirical learning measurements, the educational impact remains inconclusive. The study concludes that NetGuardians shows potential as a narrative-based tool for cybersecurity education, but further development and quantitative evaluation are needed to confirm its effectiveness.

Keywords—Serious Game, Security Awareness, Cybersecurity, Game Development Life Cycle (GDLC), Interactive

I. INTRODUCTION

The rapid growth of the digital era has greatly benefited education through online learning, easy access to information, and improved learning quality in Indonesia. However, this development has also created serious cybersecurity challenges, such as phishing, data theft, and unauthorized access, which are increasingly challenging to address [1]. High school students are particularly vulnerable due to their limited knowledge of cyberattacks and the lack of security awareness education provided [2]. Studies highlight that teaching security awareness is essential to protect students from cyber risks [3].

To address this, innovative and engaging learning methods are needed, with serious games emerging as a promising approach. Designed not only for entertainment but also for education, serious games have proven effective in enhancing learning engagement and motivation [4]. For example, the Cyber Security-Requirements Awareness Game (CSRAG), tested with 96 students in a classroom setting, demonstrated that simulated cyberattack scenarios and role-switching helped participants understand cybersecurity principles in an accessible and interactive way [5].

In addition, there is research on the design of a board game-based serious game called Riskio, which educates players on defence and attack strategies in the context of cybersecurity within a fictional organization. This game received positive results, as students not only learned the theory but also actively practiced cybersecurity concepts in a fun and engaging way [6]. CyberHero is another adaptive game that tests students' understanding of cybersecurity through various storylines and scenarios. According to research [7], this game helped 80% of participants increase their cybersecurity knowledge. Furthermore, a study by [8], involving five types of serious games developed for 100 students in Thailand, showed that serious games can be an engaging and effective learning tool. Although the study focused on university students, the researchers recommended that this concept should also be applied to elementary school students for optimal results.

The objectives of this research are as follows:

- To develop and evaluate the effectiveness of NetGuardians, a narrative-driven serious game, in enhancing cybersecurity awareness and influencing digital behavior among high school students.
- To present appropriate materials to be included in the serious game so that high school students can easily understand them.
- To conduct a comparison of features, mechanisms, and elements in various cybersecurity-themed games to identify differences in approaches and interactions offered

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The primary objective of this research is to develop NetGuardians, a serious game designed to teach cybersecurity awareness among high school student in a fun way. In addition, the study aims to measure the game's educational impact, focusing on knowledge retention, engagement, and behavior change in relation to cybersecurity topics. In research by [9], to maximize the pedagogical impact of educational games, developers need to synchronize engaging content with specific learning goals. Furthermore, the inclusion of real-time feedback is essential to facilitate the cognitive growth of learners. By comparing NetGuardians with other similar games, this study seeks to determine that narrative-driven games can be an effective tool in teaching cybersecurity concepts to young learners. The research also explores how the game's design elements, such as interactive quizzes and real-life case studies, contribute to the overall learning experience. Through this comprehensive evaluation, the study aims to provide insights into the potential of serious games as an innovative tool for cybersecurity education.

II. LITERATURE REVIEW

A. Security Awareness

Security Awareness refers to an individual's understanding and consciousness of digital threats such as hacking, phishing, and data theft. According to [10] it encompasses the comprehension of information security, the ability to recognize threats, and the necessary preventive measures to mitigate them. Research has shown that understanding security awareness is crucial to protecting both personal dan operational data in digital world[11]. In today's digital era, high school students are at increased risk of cybercrime because their heavy social media use is often coupled with a lack of awareness or caution [12]. To mitigate these risks, it is vital to cultivate strong security awareness to protect individuals from potential digital threats and foster responsible online behavior.

High school students must prioritize security awareness since their constant presence online increases their exposure to cyber threats. According to [13], many teenagers, like high school students, lack security awareness and understanding of personal data protection, making them vulnerable to get cyberattacks. Also study by [14] shows that many students still don't understand security awareness, which can be improved through a proper education that promotes caution against sharing password or clicking suspicious links. Research done by [15] found that teaching about cyber risks will help students take preventive action for their safe. Teaching about cyberattacks should be introduced at secondary school to cultivate healthy and safe digital behavior[16].

A strategy that can improve high school students' security awareness is a presentation-based approach that blends educational lectures, discussions, and Q&A. For example, research by [17] teaches students about risk using MOD-based apps, while [18] combines multiple methods like video lectures, interactive texts, and group discussions to reinforce learning. Training can also be gamified to boost engagement and retention, as shown in [19].

B. Serious Game

Serious games are digital games that are designed for purposes beyond entertainment such as education, health promotion, and skills training, by combining game elements with learning objectives to boost concentration and learning effectiveness [20], [21]. Various engines can be used to build serious games, such as Unity and Unreal Engine, which are highlighted as accessible choices; each has its own strengths and trade-offs [22]. In education, serious games enhance motivation and improve learning outcomes by supporting interactive, remote instruction and fostering higher order thinking through challenging simulations. However, they require careful planning and development to be effective [23], [24], [25], [26].

C. Visual Novel Based Game

Visual novel games represent a fusion of visual communication design and interactive storytelling, integrating graphic elements such as character design and specific aesthetic styles. These games are distinguished by their narrative depth, serving as effective media for conveying complex historical timelines and cultural insights through story-driven gameplay [27]. Visual novel games integrate storytelling with interactive features, enabling students to actively engage in the learning process instead of merely receiving information passively [28]. Research by [29] explores the potential of visual novels as a novel gamification approach in education, showing that this format enhances student motivation while also combining pedagogy, information security, and digital ethics into one interactive framework. The development of a visual novel encompasses technical, educational, and cyber hygiene elements, from software design to safeguarding user data. According to [30], visual novel game is a tool to boost curiosity and interest in education, such as in learning mathematics, helping students to fell immersed, overcome their negative perceptions, and enhance their understanding of mathematics.

D. Game Development Life Cycle (GDLC)

The Game Development Life Cycle (GDLC) is a structured framework that game developers use to guide creation of a game from concept to completion [31]. There are some sequential stages, such as initiation, Pre-Production, Production, Testing, and Release. Each stage has different objectives and deliverables to ensure an organized development process. The First phase is the Initiation phase that involves conceptualizing the educational game, identifying goals, analyzing user needs, and generating ideas[32]. The Pre-Production phase focuses on prototyping and designing game elements such as characters, narrative, audio, and visuals [33], [34]. Production implements content and game logic by integrating assets, mechanics, and code commonly using Unity[35]. After Production, followed by Testing which performs iterative checks, debugging, and validation against standards before Release. Any bugs and errors discovered during testing will be fixed immediately before the release, which delivers final builds of the game and is distributed along with documentation and user guidance. The game development process followed the GDLC methodology, which allowed the developer to design, test, and release the game in a structured and systematic manner[36].

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III. METHODOLOGY

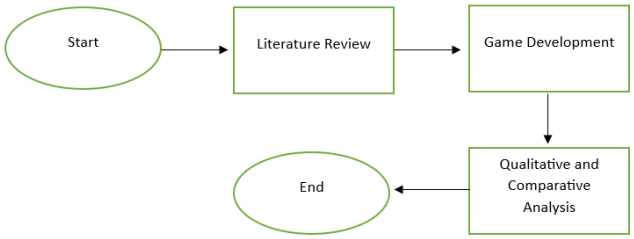

Fig. 1. Research Flow

The research flow begins with identifying the problem or topic, followed by conducting a Literature Review. In this phase, existing studies and frameworks related to security awareness and serious games are examined to gather insights that will inform the game development. After the literature review, the next step is Game Development, where the serious game is designed and developed based on the findings from the review. This game aims to be both engaging and educational for high school students. Once the game is created, a Comparative analysis is conducted, comparing different serious games focused on security awareness to evaluate their features, mechanics, and educational elements.

A. Game Development

The Game Development Life Cycle (GDLC) methodology, as shown in Figure 2, is utilized in this research. GDLC is chosen to ensure the development of the serious game is more focused and aligns with the standards.

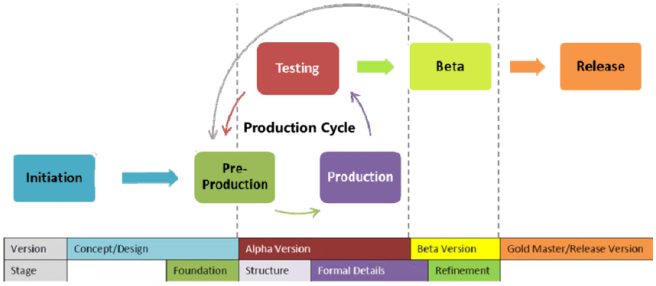

Fig. 2. Game Development Life Cycle (GDLC)

The game Development Life Cycle concists of 5 main phases as follows:

1) *Initiation*

This stage is the initial phase in the development of the serious game, focusing on defining the goals, identifying needs, and conceptualizing the game idea. The goal of the serious game is to educate high school students (ages 15-18) about security awareness engagingly and entertainingly through interactive animations and puzzles. The target audience is students who are familiar with technology but lack an understanding of cybersecurity threats. The game concept combines elements of a visual novel with interactive learning, where players encounter scenarios involving cyber threats like phishing, password security, and public Wi-Fi risks. Through dialogue choices and quizzes, players test and deepen their understanding, with correct answers unlocking more educational content and incorrect ones followed by explanations. This approach provides an enjoyable, interactive, and practical learning experience.

2) *Pre-Production*

In the pre-production stage, the concept of a Serious Game for Security Awareness was designed with a focus on educating high school students about digital safety. The game combines interactive storytelling with quizzes in yes/no and multiple-choice formats, presented through 2D animations and bright visuals. Contextual audio feedback and engaging scenarios, such as phishing and password security, were integrated to enhance learning and player involvement. In the pre-production stage, all required materials and assets are systematically prepared, including educational content, character designs, visual elements, and supporting resources that form the foundation of the game development process.

3) *Production*

In the production stage, the game was developed based on the pre-production design, focusing on visual elements and gameplay implementation. Character assets, including Santi and Pak Bayu, were adapted from copyright-free Itch.io resources and integrated into Ren'Py with 2D animations and dialogues to support the storyline. The development process involved preparing quiz questions in Microsoft Word before implementing them into the game using Ren'Py, with question formats consisting of multiple choice and yes/no types tailored to high school students. A feedback system was also embedded, providing immediate responses praise for correct answers and correct solutions for incorrect ones ensuring interactive learning and evaluation. This serious game will be named NetGuardians.

4) *Testing*

In the testing phase, we verified that animations, features, and quiz elements worked as intended, identified and fixed errors, and gathered player feedback on clarity, interactivity, and gameplay smoothness. We also collected broader input on usability, engagement, content effectiveness, game design, and audio quality to judge overall playability and suitability. Issues found were resolved through iterative revisions in the production phase.

5) *Release*

In the final build stage, NetGuardians will be packaged into an executable (.EXE) file to facilitate distribution and classroom use. All features are optimized to ensure smooth performance without bugs, and a step-by-step installation guide is provided to assist schools in running the game effectively on their computers. This final version is intended to support long-term integration of the game as a learning medium.

B. Qualitative Analysis

This research employs a qualitative analysis approach to evaluate the learning experience and potential educational value of NetGuardians as a narrative-based serious game. Data were collected through semi-structured interviews with 25 high school students, aged between 15 and 18 years. These students were selected based on their familiarity with technology but limited understanding of cybersecurity topics.

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The interviews were conducted after the students played the game, to allow them to reflect on their learning experience. Each interview lasted approximately 15-20 minutes and was designed to explore students' perceptions of the game's impact on their understanding of cybersecurity topics, engagement, and digital decision-making.

The interview questions were developed based on concepts widely discussed in the serious games and game-based learning literature, focusing on perceived learning, engagement, cybersecurity awareness, and reflection on digital decision-making. The interview questions were as follows:

1) After playing NetGuardians, how would you describe your overall experience with the gameplay and story?

2) How did the game influence your interest in learning about the cybersecurity topics presented? Please explain which aspects of the game affected your motivation to continue playing.

3) After playing the game, how would you describe your understanding of the cybersecurity concepts presented in the game?

4) How enjoyable did you find the game overall? Were there moments that you found particularly engaging and interesting

5) How did the feedback provided by the game during gameplay affect your understanding of the cybersecurity topics?

6) Were the game mechanics easy to understand? Did you face any challenges or confusion while playing it?

7) What suggestions do you have to improve the game so that it becomes more effective and enjoyable as a cybersecurity learning tool?

The qualitative data collected from the interviews were analyzed through thematic analysis, where responses were read and coded to identify recurring themes. These included changes in cybersecurity awareness, narrative engagement, and digital decision-making. The study was conducted in two stages to ensure validity and reliability, with initial coding done by one researcher, followed by a second researcher to verify the identified themes. This thematic analysis provided insights into the students' learning experiences and the effectiveness of the game in promoting cybersecurity awareness.

C. *Comparative Analysis*

In this study, a comparative analysis of several similar educational games was conducted by examining aspects such as genre, gameplay, features, user experience, and academic relevance. This analysis aimed to identify the position and advantages of the developed Serious Game for Security Awareness while ensuring its design aligns with the needs and characteristics of high school students as the target users.

IV. RESULT

A. *Material Collecting*

The collection of materials used in NetGuardians was sourced from various scientific journals discussing security awareness and other reliable online references. The content covers several key topics, including phishing, password security, and public Wi-Fi safety, which were structured and simplified to be easily understood by high school students. In terms of assets, characters Santi and Bayu were adapted from Itch.io (Mad Scientists/NSAID), while the game backgrounds were obtained from Itch.io (Lornn), ensuring both relevance and efficiency in the development process.

Fig. 3. Character Assets

Fig. 4. Background Asset

B. *Gameplay Analysis*

In this section, we delve deeper into the gameplay mechanics and how they contribute to educating high school students on the importance of security awareness. The flow of the game was designed to be intuitive, with clear transitions from one stage to another. This structure is crucial in ensuring that players are engaged without feeling overwhelmed. The game begins with a Title Screen that leads to the Main Menu, where players have the option to start the game, adjust settings, or exit, as shown in Figure 5. The flow is simple yet effective in maintaining the focus on the educational objectives.

The game progresses through various Topics, each introducing a new aspect of security awareness, such as phishing, password security, and Wi-Fi safety. After each topic, players engage with Quizzes designed to reinforce their

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understanding of the material. The quizzes are interactive, with both multiple-choice and true/false questions. Players are given immediate feedback on their answers, which allows them to correct misconceptions and improve their knowledge.

C. Game Design and Implementation

The game design and implementation of NetGuardians were carefully designed to create interactive and educational experiences for high school students that about 15-18 years old. Design for NetGuardians intended to be both engaging and easy to navigate. Assets that sourced from itch.io, specially from "MadScientists" and "Lornn", which included character design and background. This choice not only just saved time but also ensured that design of this game appealing and relevant for the audience.

The overall visual style is influenced by visual novel and anime-style, which are popular in high school students. Colour that picked for this game is bright and vibrant, using tones that eye catching that ensuring game feel fresh and exciting to play.

Fig. 5. Main Menu Interface

Fig. 6. In game Interface

To further engage players, NetGuardians incorporate several interactive elements which usually applied in a visual novel. The main form of interaction comes through the dialogue box and the interactive quiz. Figure 7 contains quizzes that ranged from simple yes/no answers to complex multiple choice questions that will test players' understanding of security awareness topics such as phishing, creating secure passwords, and understanding digital threats. After each question, player will receive feedback on whether their answer was correct or not. Feedback contains the explanations for the answers, reinforcing their learning process and helping players to understand more.

Another feature is the case study elements. As shown in Figure 8, where players will be given with a real-life scenarios related to security awareness. For example, they may be asked to determine the best course of action in a given situation. These case studies promote critical thinking and allow players to apply their knowledge in practical contexts.

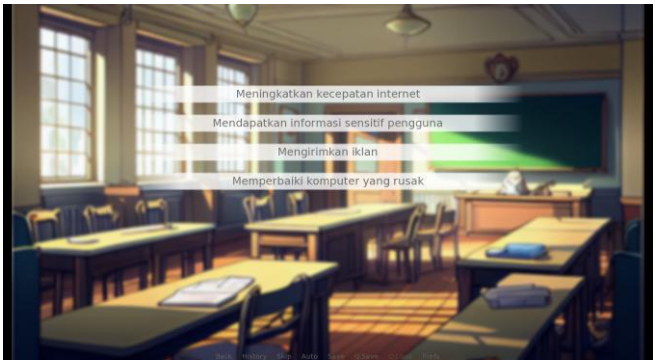

Fig. 7. Multiple Choices Question

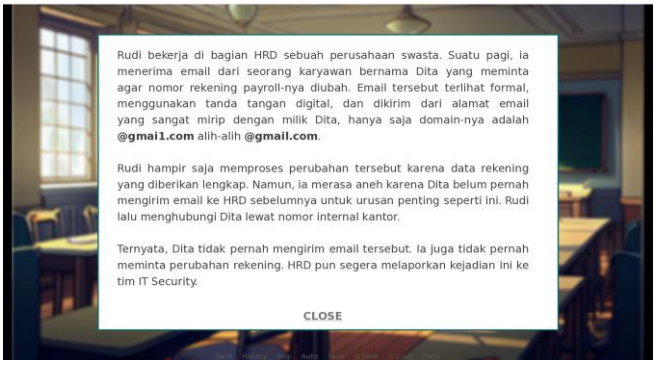

Fig. 8. Study Case Question

D. Testing

During the Alpha Testing phase, the game underwent extensive testing to identify any bugs and ensure that all features functioned correctly. Feedback was collected from participants, and adjustments were made based on their responses. Testing ensured that all questions were clear and that the game ran smoothly, providing a seamless experience for the players. The test result can be seen in the following table I.

TABLE I. ALPHA TESTING RESULT

ID	*Test Description*	*Expected Result*	*Test Outcome*	*Conclusion*
1	User opens the **Main Menu** and selects **Play**	User can transition from the **Main Menu** to the Gameplay	User successfully transitioned from the **Main Menu** to the **Gameplay**	Successful

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ID	*Test Description*	*Expected Result*	*Test Outcome*	*Conclusion*
2	User answers the **quiz** that appears after the learning topic	User can select the correct answer and receive feedback, even it's wrong answer	User successfully selected the correct answer or wrong can receive appropriate feedback	Successful
3	User restarts the game or returns to the **Main Menu**	User can return to the **Main Menu** or restart the game from the beginning	User successfully returned to the **Main Menu** after completing the game	Successful
4	User interacts with the **Case Study** in the game	User can select the correct solution based on the scenario	User successfully selected the correct solution and continued to the next topic	Successful

E. Release

Following successful testing, the final build of NetGuardians was created. The game was packaged as an .EXE file that will make it easy to distribute to schools for classroom use. A user guide will also be provided to help teachers and students navigate the installation and gameplay process.

F. Qualitative Analysis

The qualitative findings, derived from thematic analysis of interviews with 25 high school students, reveal several recurring themes related to the educational impact of NetGuardians as a narrative-driven serious game for cybersecurity awareness. First, participants reported a significant increase in cybersecurity awareness, particularly regarding phishing risks, personal data protection, and the consequences of unsafe online decisions. Many students expressed that the decision-based narrative of the game played a crucial role in helping them reflect on their own digital behavior, with one participant noting, "I became more cautious about opening emails after playing, especially when I see suspicious links." This reflection highlights how the game encouraged students to actively think about their online actions, an essential outcome for educational tools aiming to influence real-world behavior.

Second, narrative engagement emerged as a central theme, with participants emphasizing how the storyline and interactive choices made the learning process more immersive and less monotonous compared to traditional, lecture-based methods. As one student shared, "The story made me feel more involved in the learning process, and I wanted to continue playing to see what happened next." This suggests that the narrative structure not only captured students' attention but also provided a more engaging way to present complex cybersecurity topics.

Third, participants perceived learning gains, particularly through the situational examples embedded in the narrative, which made cybersecurity concepts easier to understand and remember. Several students mentioned that they were able to apply the lessons from the game to their own digital practices, such as creating stronger passwords and avoiding phishing attempts. One participant noted, "I now understand the importance of a strong password, and I can see how that applies in real life." This perception of increased learning highlights the effectiveness of the game's educational design in making abstract concepts more tangible and actionable for students.

Additionally, the majority of participants found the game mechanics to be easy to understand, although a few students suggested that the game could benefit from more explicit instructions at the start, particularly for those new to game-based learning. The feedback provided during gameplay was generally viewed as helpful in reinforcing correct decisions and clarifying misunderstandings, which contributed to the overall learning experience. However, some students mentioned that more detailed explanations for key decision points would enhance their understanding and decision-making process.

Finally, participants offered constructive suggestions for improvement, including the addition of more scenarios to deepen engagement, enhancing visual elements to make the game more appealing, and providing more explicit guidance for critical decisions within the game. These insights underline the importance of continuous iteration and user feedback in refining educational games to better meet the needs of learners.

Overall, these findings suggest that NetGuardians effectively supports engagement, reflection, and perceived learning in cybersecurity awareness through its narrative-driven design. The game not only enhanced students' understanding of key cybersecurity issues but also fostered critical thinking about digital behaviors. While the results indicate strong potential, further development—especially in terms of gameplay clarity and scenario variety—is needed to optimize the game's educational impact and ensure it is accessible and engaging for a broader audience.

G. Comparative Analysis

This section provides a comparative analysis of several games that used to promote Security Awareness. This Analysis is to evaluate the effectiveness and unique features each serious game about digital risks. These are some games that will be used to compare:

- Riskio [6]
- CyberHero [7]
- Cyber Security-Requirements Awareness Game (CSRAG) [5]

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The comparison for these serious games involved analyzing some elements such as: target audience, learning methodology, content, and mechanism. The games clearly segment their target audiences: Riskio is for a broad group of older students and professionals; CSRAG focuses on university students learning software security, while CyberHero is for all ages. from student to public and even professionals. NetGuardians are dedicated to educating high school students (specifically ages 15–18 for NetGuardians) about security awareness.

Next is the learning methodology, Riskio used a board game to teach security awareness by using strategic decisions related to attack and defense. CyberHero uses an adaptive role-playing system that immerses players in various cyberattack scenarios. At the same time, CSRAG uses simulation and decision making to cover real world threat like phishing and hacking. NetGuardians is a bit different, a narrative-driven route by integrating visual novel style with interactive quizzes and case studies.

Each game uses different educational content for its learning objectives. Riskio focuses more on its strategic attack and defense within the context of a fictional organization that faces cyberattacks. CSRAG is highly technical and covers secure coding techniques and vulnerability testing for software applications. Cyber Hero and NetGuardians both tackle personal data protection, Cyber Hero mainly teaches threat recognition, while NetGuardians provides practical guidance on security basics in real life, like phishing, security passwords, and Wi-Fi public use.

Lastly, the mechanism of these games, Riskio, uses conventional turn-based board game mechanics, which inherently constrain player interaction. Cyber Hero relies on decision making with a narrative structure, while CSRAG uses a quiz-based interaction to give instant feedback on learning. NetGuardians stands out, offering an experience that featuring visual novel format where player choices directly affect the plot, supplemented by quizzes and case studies.

NetGuardians offers a more fun and approachable route for high school students by using a visual novel style mixed with interactive quizzes and study cases. Riskio, which is more about strategic defense using board games in a company setting, or CyberHero uses a pretty complex role-playing situation. CSRAG centers on simulation-driven secure coding and vulnerability testing for university students. NetGuardians directly teaches the fundamental of security awareness that are highly relevant for students and focuses on practical and enjoyable learning.

Through these comparisons, it becomes clear that while all games aim to increase cybersecurity awareness, their approaches and target audiences differ significantly, making each game suitable for different contexts and learner types. By understanding these differences, we can optimize the design of serious games to educate students on the importance of cybersecurity more effectively.

V. CONCLUSIONS AND FUTURE RESERCH

NetGuardians was successfully developed using the Game Development Life Cycle (GDLC) methodology as a narrative-driven serious game aimed at introducing cybersecurity awareness to high school students. Based on the qualitative evaluation, the findings indicate that students perceived increased awareness and understanding of cybersecurity topics such as phishing, password security, and the risks of public Wi-Fi usage. The use of storytelling, interactive choices, quizzes, and case-based scenarios contributed to an engaging learning experience and supported students' reflection on digital decision-making. These results suggest that NetGuardians has the potential to serve as an accessible and engaging educational medium for delivering cybersecurity concepts in a form suitable for high school students.

Compared to existing serious games, NetGuardians offers a distinctive approach by combining narrative-driven gameplay with interactive elements and an anime-style visual presentation. While many existing cybersecurity serious games focus on simulation or technical training, NetGuardians emphasizes storytelling and practical cybersecurity tips, which may enhance engagement and comprehension for younger learners. This design approach highlights the potential of narrative-based serious games to support the learning of complex topics through contextualized experiences.

For future work, further development could expand the game content to include more advanced cybersecurity topics such as ransomware, emerging cyber threats, data privacy, and hacking scenarios. Integrating structured game levels may also provide a more progredssive learning experience. Additionally, future studies are recommended to involve larger participant groups and incorporate quantitative evaluation methods to validate learning outcomes further. The game could also be adapted for different educational levels, including elementary and university students, to reach a broader audience.

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