STUDENT PERCEPTIONS OF GAMIFICATION IN CYBERSECURITY EDUCATION: A QUANTITATIVE STUDY GROUNDED IN LANDER'S THEORY OF GAMIFIED LEARNING

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Abstract:

This quantitative study examines students' perceptions of gamification in cybersecurity education, guided by Landers' Theory of Gamified Learning, which suggests that game elements affect learning indirectly through motivational and behavioural mechanisms. As cybersecurity concepts are abstract and demanding, understanding learner responses to gamified instructional strategies is essential for designing effective pedagogical interventions. Accordingly, data were collected from 143 undergraduate students enrolled in a cybersecurity fundamentals course at Politeknik Sultan Idris Shah after they participated in a gamified learning module that incorporated points, levels, challenges, and immediate feedback. Following this, descriptive analyses revealed consistently high mean scores across all constructs, indicating strong enjoyment, attention, creativity, perceived learning, and sustained motivation. Moreover, reliability testing demonstrated excellent internal consistency across all scales ($\alpha \geq .80$). Key game elements, such as challenges, levelling systems, points, and instant feedback, were perceived as the most motivating and contributed substantially to Behavioural and Cognitive Engagement. Pearson correlation analysis exhibited strong, significant associations among Gamification Experience, Learning Motivation, Perceptions of Game Elements, and Engagement ($r = .71$ to $.87$). These support Landers' theoretical proposition that game elements influence learning primarily through motivational pathways. Overall, these findings provide empirical evidence that well-designed gamification can enhance students' cognitive, affective, and behavioural engagement in cybersecurity learning environments. In addition, the study underscores the

significance of aligning game mechanics with learners' motivational needs to maximise engagement and learning outcomes. Limitations include reliance on self-reported data and the short duration of the intervention. Therefore, future research should investigate long-term effects, examine individual game elements in depth, and explore adaptive or Artificial Intelligence (AI)-driven gamification to personalise cybersecurity learning.

Introduction

Gamification refers to the integration of game design elements, such as points, levels, challenges, and feedback, into non-game contexts to enhance motivation, engagement, and participation (Morais et al., 2022; Shahzadi et al., 2025). The concept, introduced by Pelling (2002), uses selected mechanics to influence behaviour without developing a full game environment. In education, gamification aims to make learning more interactive and enjoyable by providing meaningful goals, progress indicators, and timely feedback that encourage learners to stay engaged. Concurrently, recent studies demonstrate that gamification can effectively improve student motivation and participation, particularly through elements such as badges, rewards, and leaderboards (García-Iruela et al., 2021). The Theory of Gamified Learning (Landers, 2014; Ahmad & Maat, 2023) further explains that game elements influence learning indirectly by enhancing learners' motivational states, which, in turn, affect Behavioural and Cognitive Engagement.

Although gamification has been widely explored in general education, its application in cybersecurity education remains underexamined. This gap is significant due to the fact that cybersecurity learning requires sustained engagement, critical thinking, and behavioural awareness, areas in which gamification has strong potential (Baxter et al., 2016). With rising cyber threats and the need for digital resilience, students must be equipped with engaging and effective learning experiences that help them recognise risks and adopt safe online practices (Sodikin & Hikmawan, 2023).

Thus, this study aims to investigate students' perceptions of gamification as a motivational strategy in cybersecurity education and to identify which game elements most effectively contribute to their engagement and willingness to participate. Notably, the efficacy of specific gamified approaches in fostering deeper understanding and skill development in cybersecurity

contexts, particularly among diverse student populations, remains an area requiring further investigation (Karagiannis & Magkos, 2020; Waluyo & Tran, 2023).

Problem Statement

Gamification is increasingly employed in higher education. However, its effectiveness within technical fields such as cybersecurity remains insufficiently understood, particularly regarding how students perceive and respond to gamified learning (Huitema & Wong, 2025). Although past studies highlight the general benefits of gamification, there is limited evidence identifying which specific game elements genuinely motivate cybersecurity learners and foster sustained engagement rather than short-term participation (Jaramillo-Mediavilla et al., 2024; Morais et al., 2022). Notably, existing reviews indicate that gamification outcomes vary depending on contextual and learner-related factors (Pham, 2022), suggesting that its success cannot be assumed across all settings.

Furthermore, cybersecurity education presents additional challenges, as students often perceive the content as abstract and complex, requiring pedagogical strategies that meaningfully support motivation and engagement (Ahmed et al., 2024; Sendjaja et al., 2024). Concerns have also been raised with regard to the declining effectiveness of gamification over time, particularly when novelty fades or extrinsic rewards overshadow intrinsic learning goals (Shahzadi et al., 2025). Given these issues, a clear gap remains in understanding students' perceptions of gamification in cybersecurity learning, and which elements are most effective in sustaining engagement. Without this insight, gamified interventions risk becoming superficial, misaligned with learner needs, and ultimately pedagogically ineffective.

Research Questions

1. What are students' perceptions regarding the efficacy of gamified interventions as motivational tools within cybersecurity education?
2. Which specific gamified elements are perceived by students to significantly enhance engagement and foster willingness to participate in cybersecurity learning?

Research Objectives

1. To explore students' perceptions of gamification in cybersecurity education.
2. To identify game elements perceived as most motivating and engaging for cybersecurity learners.

Literature Review

This section reviews studies on gamification in education, with emphasis on its use in technical areas such as cybersecurity. Accordingly, gamification enhances learning using elements such as points, badges, and challenges that encourage participation and interest (Morais et al., 2022; Gwenhure & Nam, 2025).

Recent international research further demonstrates that gamification has been widely explored across different educational systems, particularly in Western contexts. Papadakis and Karakose (2025) highlight that gamification can improve student achievement and classroom participation when aligned with pedagogical goals, although its effectiveness varies depending

on implementation design and learner characteristics. Similarly, Zourmpakis et al. (2023) found that adaptive gamification approaches significantly enhance student motivation when game elements are tailored to learners' needs. These findings suggest that gamification outcomes may differ across contexts and therefore require investigation within specific educational and cultural settings.

The Theory of Gamified Learning by Landers (2014) explains that game elements influence learning through motivation and behaviour. Building on this, gamification is highly relevant in cybersecurity education since the field requires active involvement and problem-solving. Students' perceptions, including their motivation, interest, and technology acceptance, shape how effectively gamified activities support learning.

In technical domains such as cybersecurity, structured challenges, feedback mechanisms, and reward systems can support learners in mastering complex tasks while maintaining engagement. However, much of the existing empirical work has focused on general Science, Technology, Engineering, and Mathematics (STEM) education or Western learning environments, with relatively limited research examining cybersecurity education in Southeast Asian contexts. This highlights the need for context-specific evidence to determine whether patterns observed internationally are similarly present in Malaysian higher education.

Accordingly, this review summarises current research on educational gamification, its theoretical foundations, applications in cybersecurity, and the importance of learner perceptions in influencing engagement.

Gamification in Education

Gamification involves the strategic integration of game design elements, such as points, badges, leaderboards, feedback mechanisms, and challenges, into educational contexts (Mao & Lucas, 2024; Qudsi, 2024). This approach aims to enhance student motivation and engagement, ultimately improving learning outcomes across various academic disciplines (León et al., 2021). Furthermore, the application of gamification extends beyond general engagement to specialised fields such as cybersecurity, in which it is used to foster interest and address the shortage of professionals (Balon & Baggili, 2023; Kim et al., 2025).

International reviews also indicate that gamification can support both cognitive and behavioural engagement when instructional design is carefully aligned with learning objectives, although the magnitude of its impact varies across disciplines and implementation strategies (Papadakis & Karakose, 2025).

Although gamification is designed to enhance motivation and engagement, research on its direct influence on learning outcomes presents a complex picture. Nevertheless, evidence suggests that gamification can enhance enjoyment, increase persistence, and improve learning outcomes (Panmei & Waluyo, 2022).

At the same time, game-based learning incorporates features that have been demonstrated to sustain students' focus, enhance motivation to achieve goals, encourage constructive competition, support productive teamwork, and facilitate effective communication. Specifically, its primary objective is to increase student participation throughout the teaching and learning process (Balalle, 2024; Zakaria & Mahat, 2024).

Theoretical Frameworks of Gamified Learning

The integration of game elements can indirectly influence learning by shaping students' motivational states, consistent with Landers' (2014) Theory of Gamified Learning. Consequently, this theoretical framework emphasises that effective gamification design addresses psychological needs, such as autonomy, competence, and relatedness, to optimise intrinsic motivation (Zeng & Fisher, 2023). According to Landers (2014), game elements exert an indirect influence on learning by modulating psychological or behavioural mediators, including motivation, attention, and time-on-task. Similarly, empirical findings support this perspective, for example, demonstrating that leaderboards can increase the duration of learning engagement (Landers & Landers, 2014). Still, some studies indicate that while gamification may enhance engagement, it does not consistently result in significant improvements in learning outcomes, particularly in complex technical subjects (Rokhaniyah et al., 2025).

Additionally, Landers (2014) also highlighted the importance of establishing a theoretical framework specific to gamification, drawing from research on serious games. The author argued that when two concepts share substantial similarities, it is necessary to identify their distinguishing features and explore their theoretical connections rather than creating separate definitions, taxonomies, or models. This approach aligns with the principle of parsimony in scientific inquiry, which posits that researchers should avoid introducing multiple theoretical constructs when a single well-defined construct suffices (Cole et al., 2012). Such a framework prevents the fragmentation of resources in developing parallel constructs and promotes a unified effort to advance knowledge within the field (Le, Schmidt, Harter, & Lauver, 2010).

This aligns with broader international findings suggesting that gamification effectiveness depends less on the presence of game elements themselves and more on how these elements interact with instructional context and learner characteristics (Zourmpakis et al., 2023).

Gamification in Cybersecurity Education

Gamification is not equivalent to developing fully featured video games. Instead, its focus is on engaging users through game mechanics that support meaningful learning progress and enjoyment (Kappen & Nacke, 2013; Deloitte, 2019). When structured effectively through well-designed quests and learning activities, gamification can encourage learners to develop problem-solving skills and progress through content at their own pace (Birk et al., 2016; Hinton et al., 2019; Wood & Reiners, 2014). In particular, various tools are available for creating gamified learning environments, including learning management systems (e.g., Moodle, Blackboard, and eClass), which facilitate the development of interactive educational content (Kim & Werbach, 2016; Triantafyllou et al., 2025).

Within this framework, gamified learning, including activities such as escape room simulations, has indicated promise as a pedagogical approach for teaching and reinforcing cybersecurity knowledge and skills across educational levels (Srivatanakul, 2024). These methods often incorporate competitive elements, such as leaderboards and points, which can enhance student engagement and promote self-regulation (Mao & Lucas, 2024). However, the perceived effectiveness of specific gamified elements in cybersecurity education varies, as students respond differently to competitive features depending on their individual motivational profiles (Sisson & Whalen, 2021).

Moreover, the extent to which these findings apply across cultural and institutional contexts remains underexplored, particularly in Southeast Asian higher education environments, reinforcing the need for local empirical evidence.

Overall, enhanced student interaction and collaboration, improved learning experiences, and higher engagement levels contribute to better academic performance and student achievement (Ahshan, 2021).

Student Perceptions and Motivational Theories

Research reveals that gamification can enhance student engagement, yet more evidence is needed to understand its long-term effects on knowledge retention and sustained motivation. Moreover, recent studies call for further investigation into how specific game elements such as leaderboards, badges, and rewards shape learning experiences. Personalised learning is also becoming a vital focus in digital education, as technology can support adaptive activities that meet individual needs (Idowu, 2024; Othman et al., 2024). With the rise of hybrid learning environments, researchers highlight the importance of identifying effective ways to combine online and face-to-face instruction to strengthen participation and performance. Teacher readiness is another critical factor, as educators require appropriate preparation for technology-integrated teaching to support student engagement (Ahshan, 2021). Consistent with this, digital equity must also be considered to ensure all learners have fair access to technological resources and learning opportunities (Balalle, 2024).

At the same time, student perceptions play a central role in gamified learning. Gamified elements such as rewards, competitions, and interactive challenges have been demonstrated to enhance engagement when aligned with learners' needs (Smirani & Yamani, 2024). These effects are often driven by intrinsic motivation, as Self-Determination Theory (SDT) emphasises the importance of autonomy, competence, and relatedness for deep and sustained learning (Kwok & Childers, 2022).

However, studies also caution that perception-based research relying on self-reported data may be influenced by response bias. Lavidas et al. (2022) demonstrate that social desirability can affect students' evaluations, particularly when learning activities are conducted within their own course context. Therefore, highly positive perception scores should be interpreted cautiously, as they may reflect favourable attitudes toward instructional innovation rather than objective learning gains.

Nonetheless, studies also caution that poorly designed gamification, particularly when competitive pressure becomes overwhelming, can lead to stress and reduced motivation (Lazarov et al., 2025). Therefore, understanding these varying perceptions is essential for designing effective gamified activities that support intrinsic motivation and improve learning outcomes in cybersecurity education.

Methodology

This study employed a quantitative approach to examine students' perceptions of gamification in cybersecurity education. Specifically, data were collected through a structured questionnaire to explore how specific game elements influence motivation and engagement. This methodological design facilitates statistical analysis of the relationships among Gamified

Experiences, Learning Motivation, and Student Engagement, providing evidence-based insights for designing effective gamified learning interventions.

As the study relies on self-reported perception data, the findings should be interpreted within the limitations commonly associated with questionnaire-based research, including potential response bias and social desirability effects. As the study relies on self-reported perception data, the findings should be interpreted within the limitations commonly associated with questionnaire-based research, including potential response bias and social desirability effects.

Figure 1: Methodology

Research Design

This study employed a quantitative correlational research design to examine the relationships between students' perceptions of gamification, their motivational states, and their engagement in cybersecurity education. This design aligns with Landers' (2014) Theory of Gamified Learning, which posits that game elements indirectly influence learning through mediating psychological and behavioural constructs. Following this, a quantitative approach enables statistical analysis of these associations and supports the identification of significant predictors of both Behavioural and Cognitive Engagement in a gamified cybersecurity fundamentals course.

Participants and Sampling

The study involved Semester 2 and Semester 3 undergraduate students enrolled in or who had previously completed a cybersecurity course at Politeknik Sultan Idris Shah. The total population consisted of N = 226 students. Based on Krejcie and Morgan's (1970) sample size guidelines, approximately 140 participants were required, and 143 students were successfully recruited, meeting the recommended threshold for correlational analysis. Convenience sampling was utilised to target students with direct exposure to the gamified module, a commonly used approach in technology-enhanced learning studies (Etikan, 2016). Note that participation was voluntary, and anonymity was ensured, providing sufficient responses for statistical analysis of students' perceptions of the gamified cybersecurity instruction. Ethical approval for this study was obtained from the Unit Penyelidikan, Inovasi dan Pengkomersialan (UPIK), Politeknik Sultan Idris Shah. Prior to data collection, students were informed about the purpose of the study, assured that participation was voluntary, and notified that their responses would remain confidential and anonymous. Completion of the questionnaire was considered as informed consent.

Data Collection Instruments

The study employed a structured questionnaire comprising four validated components to measure students' perceptions, motivation, and engagement in gamified cybersecurity learning. Figure 2 provides an overview of the four instruments used in this study, including their theoretical origins, subdimensions, and sample constructs. All items were measured using a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The use of validated scales supports construct reliability, although perception-based instruments may still be influenced by subjective interpretation and response tendencies.
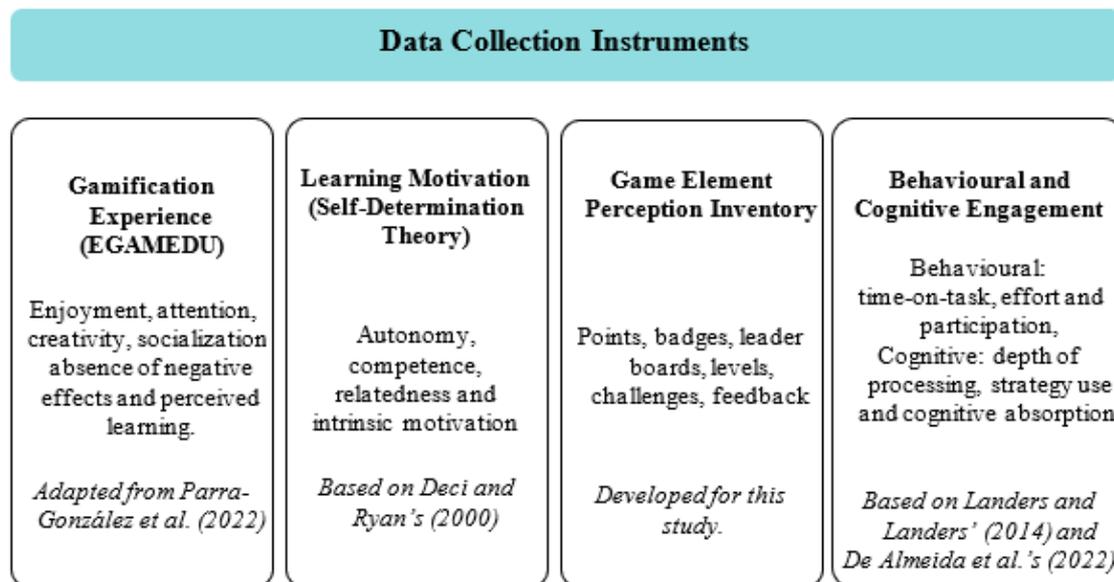
Data Collection Instruments

Gamification Experience (EGAMEDU)	Learning Motivation (Self-Determination Theory)	Game Element Perception Inventory	Behavioural and Cognitive Engagement
Enjoyment, attention, creativity, socialization absence of negative effects and perceived learning.	Autonomy, competence, relatedness and intrinsic motivation	Points, badges, leader boards, levels, challenges, feedback	Behavioural: time-on-task, effort and participation, Cognitive: depth of processing, strategy use and cognitive absorption
Adapted from Parra-González et al. (2022)	*Based on Deci and Ryan's (2000)*	*Developed for this study.*	*Based on Landers and Landers' (2014) and De Almeida et al.'s (2022)*

Figure 2: Data Collection Instruments

Data Analysis

Data were analysed using IBM Statistical Package for the Social Sciences (SPSS) Statistics. Descriptive statistics were first generated to summarise students' responses across all constructs. Subsequently, normality was assessed using skewness and kurtosis, and all variables fell within acceptable ranges, indicating that the data met parametric assumptions. Furthermore, reliability analysis using Cronbach's Alpha revealed that all scales demonstrated acceptable internal consistency ($\alpha \geq 0.70$). In addition, Pearson correlation analysis was performed to examine the relationships among Gamification Experience, Motivation, and Behavioural and Cognitive Engagement. In particular, this analytical approach aligns with Landers' Theory of Gamified Learning, which posits that gamification influences learning indirectly through motivational and behavioural pathways. Correspondingly, the combined use of descriptive, normality, reliability, and correlational procedures ensured analytical rigour and supported a valid interpretation of the findings.

However, as the study relies on perception-based Likert responses, high mean scores may reflect response clustering or ceiling effects commonly observed in educational surveys. Therefore, results are interpreted as indicators of perceived engagement rather than direct measures of learning effectiveness.

Results and Findings

Descriptive Statistics

A descriptive analysis was conducted to examine students' perceptions of the gamified cybersecurity module across six sub-constructs of the Gamification Experience scale: Enjoyment, Attention, Creativity, Socialisation, Absence of Negative Effects, and Perceived Learning. The interpretation of mean values was guided by the recommended Likert-scale categorisation proposed by Pallant (2020). Table 1 summarises the range of interpretations used to classify the mean scores for each construct.

Table 1: Mean Score Interpretation

Mean Range	Interpretation
1.00–2.33	Low
2.34–3.66	Moderate
3.67–5.00	High

Source: Pallant (2020)

Descriptive statistics were computed for the six components of Gamification Experience, namely Enjoyment, Attention, Creativity, Socialisation, Absence of Negative Effects, and Perceived Learning. As depicted in Table 2, students reported consistently high levels of positive perception across all six sub-constructs, with mean scores ranging from 4.23 to 4.63.

Table 2: Descriptive Statistics for Gamification Experience

Sub-Construct	No. of Items	Mean (M)	Interpretation
Enjoyment	3	4.63	High
Attention	3	4.48	High
Creativity	3	4.49	High
Socialisation	3	4.44	High
Absence of Negative Effects	3	4.23	High
Perceived Learning	3	4.41	High

The results indicate that students reported consistently high perceptions of the gamified learning environment, with mean scores ranging from 4.23 to 4.63 on a 5-point scale. Interestingly, Enjoyment was rated highest, with a mean (M = 4.63), implying that students identified the activities as engaging and enjoyable. Moreover, Attention (M = 4.48) and Creativity (M = 4.49) also scored highly, suggesting that the gamified design supported focus and encouraged creative problem-solving during cybersecurity tasks. Perceived Learning (M = 4.41) and Socialisation (M = 4.44) further revealed that students felt the module enhanced understanding and supported peer interaction. Absence of Negative Effects, on the other hand, recorded the lowest mean (M = 4.23), though they remained within the high range, indicating minimal stress or cognitive overload. Overall, these findings reflect strong acceptance of the gamification strategy. These results reflect that features such as points, levels, challenges, and immediate feedback effectively enhanced students' learning experiences in the cybersecurity module.

Descriptive statistics were computed for the four components of learning motivation based on the SDT framework: Autonomy, Competence, Relatedness, and Intrinsic Motivation. As presented in Table 3, students reported high levels of motivation across all sub-constructs, with mean scores ranging from 4.40 to 4.49.

Table 3: Descriptive Statistics for Motivation

Sub-Construct	No. of Items	Mean (M)	Interpretation
Autonomy	3	4.46	High
Competence	3	4.44	High
Relatedness	3	4.40	High
Intrinsic Motivation	3	4.49	High

Autonomy recorded a mean of 4.46, indicating that students felt a strong sense of choice and control during the gamified learning activities. Furthermore, Competence (M = 4.44) also scored highly, suggesting that students perceived themselves as capable of completing the gamified cybersecurity tasks. Relatedness, with a mean of 4.40, implies that students generally felt connected and supported during the learning process, while intrinsic motivation emerged as the highest motivation dimension (M = 4.49). This finding reflects that students were intrinsically motivated to engage with the cybersecurity activities due to the interest, enjoyment, and personal satisfaction derived from the gamified environment. Overall, the results demonstrate that the gamified learning approach successfully enhanced students' psychological needs of autonomy, competence, and relatedness. It also fostered strong intrinsic motivation consistent with the core principles of SDT.

Additionally, descriptive statistics were computed for the Game Element Perception Inventory, which consists of two sub-constructs: Game Motivation and Game Engagement. As presented in Table 4, students reported high levels of positive perceptions of the game elements embedded in the cybersecurity learning module.

Table 4: Descriptive Statistics for Game Element Perception

Sub-Construct	No. of Items	Mean (M)	Interpretation
Game Motivation	9	4.50	High
Game Engagement	9	4.48	High

Game Motivation recorded a mean score of 4.50, indicating that students identified elements such as points, challenges, levelling systems, and rewards as highly motivating. These game features appear to support goal setting, persistence, and a sense of achievement throughout the learning activities. On the other hand, Game Engagement also recorded a high mean score (M = 4.48), suggesting that students perceived the game elements as effective in maintaining attention, encouraging active participation, and sustaining interest during cybersecurity tasks. In general, these findings demonstrate that the game mechanics incorporated into the module were well-received and positively contributed to learners' engagement and motivational states. This supports the view that well-designed gamified components can enhance both the motivational appeal and the interactive quality of learning experiences.

Notably, descriptive statistics were also computed for the Behavioural and Cognitive Engagement construct, which reflects the extent to which students actively participated and invested mental effort in the gamified cybersecurity learning module. As depicted in Table 5,

both dimensions had high mean scores, characterising strong student engagement throughout the learning process.

Table 5: Descriptive Statistics for Behavioural and Cognitive Engagement

Construct	No. of Items	Mean (M)	Interpretation
Behavioural Engagement	3	4.46	High
Cognitive Engagement	3	4.43	High

Behavioural Engagement recorded a mean score of 4.46, implying that students consistently engaged in class activities, attentively followed instructions, and actively participated in challenges integrated into the gamified module. Hence, these results suggest that the gamification features successfully encouraged students to stay focused and interact meaningfully with the learning materials. Cognitive Engagement also yielded a high mean score (M = 4.43), indicating that students exerted substantial mental effort while engaging with cybersecurity tasks. Specifically, they reported thinking deeply, applying strategies, and persisting through problem-solving activities. This suggests that the gamified module captured students' attention behaviourally and stimulated higher-order cognitive processing. These findings demonstrate that the gamified cybersecurity module effectively promoted both behavioural and cognitive dimensions of engagement. Taken together, the combination of points, challenges, immediate feedback, and goal-oriented tasks appears to encourage active participation while fostering deeper thinking and sustained Cognitive Engagement.

Reliability Analysis

Reliability analysis was conducted to assess the internal consistency of all measurement scales used in this study. Subsequently, Cronbach's Alpha coefficients were examined for each major construct: Gamification Experience, Learning Motivation, Game Element Perception, and Behavioural and Cognitive Engagement. According to Nunnally (1978), a Cronbach's Alpha value of .70 and above implies acceptable reliability for research instruments, while values above .90 reflect excellent internal consistency. Table 6 presents the reliability coefficients for all constructs.

Table 6: Reliability Coefficients for All Constructs

Construct	No. of Items	Cronbach's Alpha (α)	Interpretation
Gamification Experience	18	.958	Excellent
Learning Motivation	12	.953	Excellent
Game Element Perception	18	.971	Excellent
Behavioural and Cognitive Engagement	6	.923	Excellent

All constructs presented excellent internal consistency, with Cronbach's Alphas ranging from .923 to .971, exceeding the minimum threshold of α ≥ .70 recommended by Nunnally (1978). Gamification Experience (α = .958) and Game Element Perception (α = .971) depicted particularly high reliability, indicating stable, consistent responses to the implemented game elements. Additionally, Learning Motivation recorded strong reliability (α = .953), confirming that the SDT components were measured accurately. Meanwhile, Behavioural and Cognitive Engagement presented similarly high reliability (α = .923), suggesting consistent reporting of

students' participation and cognitive involvement. Overall, the results confirm that all measurement instruments were highly reliable and suitable for subsequent statistical analyses.

Normality Assessment

Prior to conducting the Pearson correlation analysis, the data were examined for normality using skewness and kurtosis values, which were generated alongside the descriptive statistics. According to Kline (2011), skewness values within ±2 and kurtosis values within ±7 are considered acceptable indicators of univariate normality in behavioural research.

Across all constructs, including Gamification Experience, Motivation, Game Element Perception, Behavioural Engagement, and Cognitive Engagement, the skewness values ranged from approximately -1.58 to -0.76, while the kurtosis values ranged from -0.77 to 2.82. All values fall within the recommended acceptable ranges. Consequently, these results signify that all variables exhibit acceptable univariate normality, allowing the use of parametric analyses, including Pearson correlation.

Correlation Analysis

Pearson correlation analysis was conducted to examine the relationships among the major constructs of this study: Gamification Experience, Motivation, Game Elements, and Behavioural and Cognitive Engagement. Pearson's r was selected since all variables exhibited acceptable normality (Kline, 2011), making parametric correlation appropriate. Notably, correlation strength was interpreted according to Cohen's (1988) guidelines.

Table 7: Interpretation of Correlation Strength

R Value	Interpretation
0.10 – 0.29	Weak
0.30 – 0.49	Moderate
0.50 – 1.00	Strong

Source: Cohen (1988)

As presented in Table 8 (Correlation Matrix), all correlations were strong and statistically significant at p < .001.

Table 8: Correlation Matrix between Constructs

		Experience	Motivation	Game Element	Behavioural and Cognitive
Experience	Pearson Correlation	1	.818**	.799**	.714**
	Sig. (2-tailed)		<.001	<.001	<.001
	N	143	143	143	143
Motivation	Pearson Correlation	.818**	1	.825**	.815**
	Sig. (2-tailed)	<.001		<.001	<.001
	N	143	143	143	143

Game Element	Pearson Correlation	.799**	.825**	1	.873**
	Sig. (2-tailed)	<.001	<.001		<.001
	N	143	143	143	143
Behavioural and Cognitive	Pearson Correlation	.714**	.815**	.873**	1
	Sig. (2-tailed)	<.001	<.001	<.001	
	N	143	143	143	143

**. Correlation is significant at the 0.01 level (2-tailed).

A very strong positive correlation was observed between Gamification Experience and Motivation ($r = .818$, $p < .001$). This result indicates that students who experienced the gamified module more positively were also more motivated to participate in the learning activities.

Simultaneously, Gamification Experience was strongly correlated with game elements ($r = .799$, $p < .001$), suggesting that students who enjoyed the module also perceived the points, levels, challenges, and feedback mechanisms as effective.

Additionally, Motivation reflected a strong positive relationship with Behavioural-Cognitive Engagement ($r = .815$, $p < .001$). Highly motivated students demonstrated greater involvement, attention, and cognitive effort during the gamified cybersecurity tasks.

The strongest correlation emerged between game elements and Behavioural-Cognitive Engagement ($r = .873$, $p < .001$), indicating that well-designed game mechanics significantly contributed to increased student engagement.

Overall, all key constructs depicted strong and significant interrelationships, supporting the theoretical assumptions of Landers' Theory of Gamified Learning, which proposes that game elements enhance learning outcomes through motivational and behavioural pathways. The results confirm that motivation serves as a key mechanism linking students' Gamification Experience with engagement in cybersecurity learning.

Discussion

This study examined students' perceptions of gamification in a cybersecurity learning context and identified the specific game elements perceived as most motivating and engaging. Remarkably, the results provide evidence that learners respond positively to gamification, which enhances motivation and engagement.

However, while the findings indicate strong acceptance of the gamified module, they should be interpreted within the broader context of perception-based research, where highly positive responses may also reflect response tendencies rather than purely instructional effects.The discussion below is structured around the two research questions and their corresponding research objectives.

Students' Perceptions of Gamification in Cybersecurity Education

Descriptive findings indicate that students consistently reported high levels of Gamification Experience, Motivation, and Engagement, reflecting strong acceptance of the gamified module. Notably, this pattern aligns with recent evidence that gamified environments can enhance interest, enjoyment, and learning satisfaction (Dawson et al., 2025; Nguyen Viet & Nguyen-Viet, 2023). Specifically, high ratings in Enjoyment, Attention, and Creativity suggest that the game elements created a more immersive and stimulating learning experience, particularly valuable in cybersecurity education, in which concepts can be abstract. Similar outcomes were noted by Khan et al. (2025), who reported improved attentiveness and persistence in gamified cybersecurity tasks.

Motivation scores were also high across autonomy, competence, relatedness, and intrinsic motivation, supporting findings that gamification strengthens psychological needs and fosters sustained motivation (Navarro-Patón et al., 2025; Sappaile et al., 2025). The strong intrinsic motivation observed implies that students were driven by both rewards and genuine interest and enjoyment. In essence, the results reinforce that gamification is an effective motivational tool in cybersecurity learning, consistent with research highlighting its benefits in technical and related domains (Babu et al., 2025).

Game Elements that Enhance Engagement and Participation

The findings indicate that students identified several game elements as particularly motivating, especially challenges, levelling systems, points, and immediate feedback. These elements recorded the highest mean scores and exhibited the strongest associations with Behavioural and Cognitive Engagement.

From a pedagogical perspective, these elements may be especially effective because they directly structure learning tasks into progressive goals, provide visible indicators of competence, and deliver rapid performance feedback. In technical subjects such as cybersecurity, where learners must repeatedly test solutions and refine problem-solving strategies, these mechanisms can reinforce persistence and support mastery-oriented learning behaviour.In particular, the results are consistent with recent evidence that game mechanics that promote challenge, mastery progression, and rapid feedback substantially improve learner engagement (Smirani & Yamani, 2024; Xu et al., 2023). Furthermore, challenges enhance focus and persistence, levelling systems strengthen perceptions of competence through clear progress structures, and immediate feedback supports continuous learning through timely guidance.

The importance of these elements in the context of cybersecurity aligns with research demonstrating that gamified cybersecurity tasks improve decision-making, engagement, and willingness to attempt complex scenarios (Hussain et al., 2020; Malone et al., 2021). Collectively, the findings suggest that integrating well-designed game elements that emphasise mastery, progression, and real-time feedback plays a central role in supporting student engagement in cybersecurity education.

Relationship Between Gamification, Motivation, and Engagement

The correlation analysis revealed strong positive relationships among Gamification Experience, Motivation, Perceptions of Game Elements, and Behavioural and Cognitive Engagement. This pattern is consistent with Landers' Theory of Gamified Learning, which explains that game elements shape learning outcomes through motivational and behavioural mechanisms (Landers, 2014). Likewise, recent research supports this view and highlights motivation as a central psychological pathway linking gamified design to improved learning behaviours and performance (Li et al., 2024; Schaper et al., 2022). The findings in this study strengthen these claims, as students who viewed the gamified module more positively also reported higher motivation and deeper engagement in cybersecurity learning.

Conclusion

This study concludes that students perceive gamification positively and that it serves as an effective motivational and engagement-enhancing tool in cybersecurity education. Concurrently, students identified several key game elements, particularly challenges, levels, immediate feedback, and points, as highly influential in fostering interest, motivation, and participation.

Notably, the strong correlations among Gamification Experience, Motivation, and Engagement support Landers' model's theoretical assumptions and reinforce the pedagogical value of gamification in technical subjects. As cybersecurity education continues to gain importance, gamified instructional approaches offer a promising strategy to improve the learning experience, sustain engagement, and facilitate deeper conceptual understanding. Such integration, by tailoring content delivery to individual learning styles and leveraging sentiment analysis for adaptive feedback, could significantly amplify the motivational and learning benefits observed in this study (Harrasi et al., 2025).

Therefore, future research is encouraged to examine the long-term effects of gamification, compare different gamification designs, and explore adaptive or Artificial Intelligence (AI)-driven approaches to personalising cybersecurity learning experiences.

Ethics Statement:	This study was conducted in accordance with ethical research standards. All procedures involving human participants were reviewed and approved by the Unit Penyelidikan, Inovasi dan Pengkomersialan (UPIK), Politeknik Sultan Idris Shah. Participation was voluntary, and respondents were assured of confidentiality and anonymity. The data collected were used solely for academic purposes.
Author Contribution Statement:	All authors contributed significantly to the development of this manuscript. Farah Waheda Othman was responsible for the conceptualisation, methodology, and overall supervision of the study. She also handled data collection, analysis, and interpretation of results. Noor Aishah Zainiar contributed to the literature review, drafting, and critical revision of the manuscript. All authors read and approved the final version of the manuscript prior to submission.

References

Ahmad, N. A., & Maat, S. M. (2023). Kesan Penggunaan Gamifikasi Dalam Pendidikan Matematik: Tinjauan Literatur Bersistematik. *Jurnal Dunia Pendidikan*. https://doi.org/10.55057/jdpd.2022.4.4.3

Ahshan, R. (2021). *A framework of implementing strategies for active student engagement in remote/online teaching and learning during the COVID-19 pandemic*. Education Sciences, 11(9), Article 483. https://doi.org/10.3390/educsci11090483

Babu, C. V. S., Kahini, S., Fasith, J. J., & Sandhiya, K. (2025). *Assessing the Impact of Gamification in Cybersecurity on Student Learning Outcomes in Industry 4.0*. 435–464. https://doi.org/10.4018/979-8-3373-0477-9.ch017

Balalle, H. (2024). *Exploring student engagement in technology-based education in relation to gamification, online/distance learning, and other factors: A systematic literature review. Social Sciences & Humanities Open, 9*, 100870. https://doi.org/10.1016/j.ssaho.2024.100870

Balon, T., & Baggili, I. (2023). Cybercompetitions: A survey of competitions, tools, and systems to support cybersecurity education. *Education and Information Technologies*, *28*(9), 11759. https://doi.org/10.1007/s10639-022-11451-4

Baxter, R. J., Holderness, D. K., Jr., & Wood, D. A. (2016). Applying basic gamification techniques to IT compliance training: Evidence from the lab and field. *Journal of Information Systems, 30*(3), 119–133.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587

Dawson, E. M., Greene, L. M., Almutairi, H. N., & Iglesias, R. L. (2025). Gamification in Remote Learning: Enhancing Student Engagement in Virtual Classrooms. *OTS Canadian Journal*, *4*(7), 1–13. https://doi.org/10.58840/1hn5nn80

Etikan, I. (2016). *Comparison of convenience sampling and purposive sampling*. American Journal of Theoretical and Applied Statistics, 5(1), 1–4.

García-Iruela, M., Fonseca, M. J., Hijón-Neira, R., & Chambel, T. (2021). Gamification and computer science students' activity. *IEEE Access, 9*, 165546–165560. https://doi.org/10.1109/ACCESS.2021.3132763

Gwenhure, A. K., & Nam, S. (2025). Gamified Cybersecurity Initiatives: The Trend, Limits and Lessons. *Journal of Information Technology Education Research*, *24*, 24. https://doi.org/10.28945/5601

Harrasi, N. A., Subhi, N. A., Harthy, S. A., & Habsi, J. A. (2025). Learner perspectives on AI teacher effectiveness: The role of engagement, motivation, efficiency, and educational experience. *Social Sciences & Humanities Open*, *12*, 101950. https://doi.org/10.1016/j.ssaho.2025.101950

Huitema, D., & Wong, A. (2025). *A Case Study in Gamification for a Cybersecurity Education Program: A Game for Cryptography*. https://doi.org/10.48550/ARXIV.2502.06706

Hussain, A., Kuhn, K., & Shaikh, S. A. (2020). *Games for Cybersecurity Decision-Making* (pp. 411–423). Springer, Cham. https://doi.org/10.1007/978-3-030-50164-8_30

Idowu, E. (2024). *Personalised Learning: Tailoring Instruction to Individual Student Needs*. https://doi.org/10.20944/preprints202411.0863.v1

Jaramillo-Mediavilla, L., Basantes-Andrade, A., González, M. C., & Martín, S. C. (2024). Impact of Gamification on Motivation and Academic Performance: A Systematic Review [Review of *Impact of Gamification on Motivation and Academic Performance: A Systematic Review*]. *Education Sciences*, *14*(6), 639. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/educsci14060639

Karagiannis, S., & Magkos, E. (2020). Engaging Students in Basic Cybersecurity Concepts Using Digital Game-Based Learning: Computer Games as Virtual Learning Environments. In *Learning and analytics in intelligent systems* (p. 55). Springer International Publishing. https://doi.org/10.1007/978-3-030-41196-1_4

Khan, A., Maidin, A. F., Ray, S. K., & Riskhan, B. (2025). *Foundations of Gamification in Cybersecurity Education*. 65–90. https://doi.org/10.4018/979-8-3373-0477-9.ch003

Kim, J. B. J. B., Zhong, C., & Liu, H. (2025). The Impact of Gamification on Cybersecurity Learning: Multi-Study Analysis. *Communications of the Association for Information Systems*, *56*, 57. https://doi.org/10.17705/1cais.05603

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). Guilford Press.

Krejcie, R. V., & Morgan, D. W. (1970). *Determining sample size for research activities*. Educational and Psychological Measurement, 30, 607–610

Kwok, S., & Childers, R. C. (2022). Escaping the Laboratory: An Escape Room to Reinforce Biomedical Engineering Skills. *Biomedical Engineering Education*, *3*(1), 75. https://doi.org/10.1007/s43683-022-00089-w

Landers, R. N. (2014). *Developing a theory of gamified learning: Linking serious games and gamification of learning*. Simulation & Gaming, 45(6), 752–768. https://doi.org/10.1177/1046878114563660

Landers, R. N., & Landers, A. K. (2015). An Empirical Test of the Theory of Gamified Learning: The Effect of Leaderboards on Time-on-Task and Academic Performance: The Effect of Leaderboards on Time-on-Task and Academic Performance. *Simulation & Gaming, 45*(6), 769-785. https://doi.org/10.1177/1046878114563662

Lavidas, K., Papadakis, S., Manesis, D., Grigoriadou, A. S., & Gialamas, V. (2022). The effects of social desirability on students' self-reports in two social contexts: Lectures vs. lectures and lab classes. Information, 13(10), 491. https://doi.org/10.3390/info13100491

Lazarov, W., Schafeitel-Tähtinen, T., Squillace, J., Martinásek, Z., Coufalíková, A., Helenius, M., Gallus, P., & Fujdiak, R. (2025). Lessons Learned from Using Cyber Range to Teach Cybersecurity at Different Levels of Education. *Technology Knowledge and Learning*. https://doi.org/10.1007/s10758-025-09840-y

León, A. M., Camacho-Lazarraga, P., Guerrero, M. Á. G., Puerta, L. G., Aguilar-Parra, J. M., Trigueros, R., & Garcia, A. A. (2021). Between Level Up and Game Over: A Systematic Literature Review of Gamification in Education. *Sustainability*, *13*(4), 2247. https://doi.org/10.3390/su13042247

Li, H., Ke, N., Zhang, A. Q., & Huang, X. T. (2024). Unraveling the Motivational Tapestry of AI-Driven Gamification in Education. *International Journal of Global Perspective in Academic Research.*, *1*(3). https://doi.org/10.70339/znd1nk22

Malone, M., Wang, Y., James, K., Anderegg, M., Werner, J., & Monrose, F. (2021). To Gamify or Not?: On Leaderboard Effects, Student Engagement and Learning Outcomes in a Cybersecurity Intervention. *Technical Symposium on Computer Science Education*, 1135–1141. https://doi.org/10.1145/3408877.3432544

Mao, J., & Lucas, T. (2024). Gamification elements and their impacts on education: A review [Review of *Gamification elements and their impacts on education: A review*]. *Multidisciplinary Reviews*, *8*(5), 2025155. https://doi.org/10.31893/multirev.2025155

Morais, J., Simões, J., Lourenço, J., & Lopes, S. F. S. F. (2022). Perceptions on gamification towards cybersecurity literacy: social sustainability of educative projects. *Revista EDaPECI*, *22*(3), 63. https://doi.org/10.29276/redapeci.2022.22.318247.63-77

Navarro-Patón, R., Campo-Vázquez, J., & Mecías-Calvo, M. (2025). Can a Gamified Proposal Increase the Motivation, Satisfaction of Basic Psychological Needs, and Enjoyment of Primary Education Students? *Advances in Educational Marketing, Administration, and Leadership Book Series*, 67–88. https://doi.org/10.4018/979-8-3693-6084-2.ch004

Nguyen Viet, B., & Nguyen-Viet, B. (2023). Enhancing satisfaction among Vietnamese students through gamification: The mediating role of engagement and learning effectiveness. *Cogent Education*, *10*. https://doi.org/10.1080/2331186x.2023.2265276

Nunnally, J. C. (1978). *Psychometric theory*. New York: McGraw-Hill Inc.

Othman, F. W., Nashir, I. M., Saad, M. S. M, Rokeman, N. R. M., & Nor, M. A. A. M. (2024). Kesan Modul Pembelajaran Augmented Reality AR-MicroC Terhadap Pencapaian Pelajar di Kolej Komuniti Malaysia. *INTERNATIONAL JOURNAL OF MODERN EDUCATION (IJMOE)*, *6*(23), 571-584. https://doi.org/10.35631/ijmoe.623039

Pallant, J. (2020). *SPSS Survival Manual* (7th ed.). McGraw-Hill Education.

Papadakis, S., & Karakose, T. (2025). Gamification and Student Achievement: Potential Benefits, Limitations, and Effective Use in Educational Environments. Educational Process: International Journal, 19, e2025529. https://doi.org/10.22521/edupij.2025.19.529

Pelling, N. (2002). *The (short) prehistory of "gamification"*. Retrieved from http://nanodome.com/gamification/

Qudsi, H. (2024). Gamification in education: boosting student engagement and learning outcomes. *ShodhKosh Journal of Visual and Performing Arts*, *5*(4). https://doi.org/10.29121/shodhkosh.v5.i4.2024.2542

Sappaile, B. I., Jenheri, J., Sari, A., & Nampira, A. A. (2025). Gamification and Student Motivation: Evaluating E-Learning Engagement from an Educational Psychology Perspective. *Darussalam.*, *4*(1), 73–82. https://doi.org/10.70363/djpe.v4i1.308

Schaper, P., Riedmann, A., Semineth, M., & Lugrin, B. (2022). *Addressing Motivation in an E-Learning Scenario by applying Narration and Choice*.

Sendjaja, T., Irwandi, I., Prastiawan, E., Suryani, Y., & Fatmawati, E. (2024). Cybersecurity In The Digital Age: Developing Robust Strategies To Protect Against Evolving Global Digital Threats And Cyber Attacks. *International Journal of Science and Society*, *6*(1), 1008. https://doi.org/10.54783/ijsoc.v6i1.1098

Shahzadi, A., Ishaq, K., Nawaz, N. A., Rosdi, F., & Khan, F. (2025). Unveiling personalised and gamification-based cybersecurity risks within financial institutions. *PeerJ Computer Science*, *11*. https://doi.org/10.7717/peerj-cs.2598

Sisson, A. D., & Whalen, E. (2021). Exploratory study on the perceptions of event gamification on positive behavioral outcomes. *Journal of Hospitality and Tourism Insights*, *5*(5), 822. https://doi.org/10.1108/jhti-04-2021-0085

Smirani, L., & Yamani, H. (2024). Analysing the Impact of Gamification Techniques on Enhancing Learner Engagement, Motivation, and Knowledge Retention: A Structural Equation Modelling Approach. *Electronic Journal of E-Learning*. https://doi.org/10.34190/ejel.22.9.3563

Sodikin, R. A., & Hikmawan, R. (2023). Analysis of gamification in cybersecurity education for students: A systematic literature review. *Jurnal Educative: Journal of Educational Studies*.

Srivatanakul, T. (2024). Designing Cybersecurity Escape Rooms: A Gamified Approach to Undergraduate Learning. *Journal of Cybersecurity Education Research and Practice*, *2024*(1). https://doi.org/10.62915/2472-2707.1192

Triantafyllou, S. A., Georgiadis, C., & Sapounidis, T. (2025). *Gamification in education and training: A literature review.* Education and Information Technologies. https://doi.org/10.1007/s10639-024-13227-5

Waluyo, B., & Tran, H. M. (2023). Implementing Gamified Vocabulary Learning in Asynchronous Mode. *TEFLIN Journal - A Publication on the Teaching and Learning of English*, *34*(1), 136. https://doi.org/10.15639/teflinjournal.v34i1/136-156

Xu, D., Read, J. C., & Allen, J. (2023). *Exploring the Effects of Progression Mechanics in Competitive and Collaborative Gamified Learning*. *17*, 730–738. https://doi.org/10.34190/ecgbl.17.1.1788

Zakaria, N., & Mahat, H. (2024). Exploring gamification elements in education: a bibliometric study. *INTERNATIONAL JOURNAL OF MODERN EDUCATION (IJMOE)*, *6*(23), 769–784. https://doi.org/10.35631/ijmoe.623052

Zourmpakis, A. I., Kalogiannakis, M., & Papadakis, S. (2023). Adaptive gamification in science education: An analysis of the impact of implementation and adapted game elements on students' motivation. Computers, 12(7), 143. https://doi.org/10.3390/computers12070143