Impact of Gamification and Outdoor Learning Approach on Higher Education in Understanding and Awareness; A Case Study on Universiti Malaysia Pahang Al-Sultan Abdullah Students in Information Security Subject

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ABSTRACT

There are many campaigns of cyber security awareness being done to the public by many parties, educational institutions, cyber security industries, government agencies, financial institutions, and many more. Among the popular campaign methods is a talk or a forum. An 'Explorace' game has been introduced as an alternative way for students of the Information Security subject from the Faculty of Computing, Universiti Malaysia Pahang AlSultan Abdullah with the aim to convey the knowledge of cyber-attacks to spread awareness to the public while practicing the skills they have learned in the class and practicing how to campaign confidently. The encouragement to the students to spread awareness is the challenge of getting the top place in the game, and the pressure of having been asked by the public about the attacks they are conveying. The 'Explorace' game as a learning activity in the class will be more challenging, and the knowledge acquired by the students will be faster and longer-lasting with them. As a result, the students from this subject scored 61.2% as the average results in the mid-term test, while another batch of students who did not use this approach scored 58.94% in the previous semester. While in the final exam, 61.46% is the average result for this semester, compared to only 41.09% as the average result from the previous batch, which did not use this approach in learning. These results show that outdoor activities have a significant impact on enriching the understanding of cyber-attacks and the encryption concept among students. In another aspect of awareness, as many as 110 people had been approached to listen to the awareness campaign during the two-hour session of 'Explorace'. 98% of the students are also satisfied with spreading the knowledge using this way.

Keywords: Cyber Attacks, Explorace, Outdoor Learning, Awareness Campaign, Encryption, Gamification

INTRODUCTION

Having knowledge of Internet security matters is advantageous for everyone, regardless of their level of experience with technology. It applies to seasoned systems administrators, as well as to home users who carry out tasks such as paying bills or streaming movies online. Even users who are just beginning to learn about computers and the Internet can benefit from this knowledge. Protecting our personal information and preserving our ownership of the goods and services we buy are challenges that affect us all. Cybersecurity awareness is a foundational element in building a resilient digital environment, making it a top priority for both individuals and organizations (Bélanger et al., 2022).

Because of this, an awareness campaign is kind of compulsory for all security professionals to ensure as many

people as possible know about the cyber-attacks and the trends. Many parties are doing campaigns through the talk, seminar, or forum approach, which is quite conventional. The effectiveness can be high and can be low, depending on the speakers as well as the readiness of the audience to listen to it.

(Chaudhary et al., 2022) suggested posters as a method to spread cybersecurity awareness that need to be read. It was not easy to ensure the public reads about the contents inside these materials, as it depends on the attractiveness of the material as well as the readiness of the viewers to digest the content.

There is also an issue among students of Information Security where they must learn many facts and concepts about cyber-attacks and encryption which makes it hard to master the knowledge. According to (Ali et al., 2023), passive approach to learning where students are expected to absorb information rather than actively engage with it hinder long term retention and the ability to apply knowledge in a practical context.

Thus, an 'Explorace' game is introduced as an outdoor physical activity in learning to let the student compete without them realizing they are learning and enhancing their knowledge. At the same time, the students can spread the awareness of the subject to other people in a fun way.

LITERATURE REVIEW

Learning using Explorace Game

Explorace is a portmanteau of "explore" and "race," and it refers to a type of outdoor adventure or scavenger hunt game that involves exploration, teamwork, and problem-solving. Typically, participants are divided into teams and given a series of tasks or challenges to complete within a set timeframe. These challenges might include solving puzzles, finding hidden objects, or completing physical activities. The goal of the game is to be the first team to complete all of the tasks and reach the finish line. Explorace games can be organized as a recreational activity or as a team-building exercise for groups in various settings, such as schools, companies, or community events.

(Francisco et al., 2022) stated that an engaging activity such as 'Explorace' can be utilized to leverage the content of the syllabus and captivate students, encouraging them to actively engage with the learning process. Recent surveys have demonstrated that these methods can expand students' learning horizons, ultimately boosting their motivation as they explore new knowledge while remaining physically active. Despite the potential benefits, these approaches are seldom adopted by schools and teachers, resulting in a challenge for their widespread implementation.

So, the first aim is to analyse the readiness and the interest of students to learn in a specific course, namely Information Security, that uses an outdoor learning approach. This is our first research question:

• RQ1: Are the degree and diploma students ready and have an interest to learn in an outdoor learning approach, such as 'Explorace'?

Outdoor Learning and Gamification Approach of Understanding the Encryption and Cyber-Attacks Concepts in Students

There is no denying that games can be an effective means of motivating and facilitating learning. To this end, educators are increasingly integrating game design features into the learning process. According to (Khaldi et al., 2023), gamification in education involves incorporating elements of game design into an educational context to make learning more captivating and stimulating.

A study conducted by (Md Rashid et al., 2023) found that game-based learning activities provide a fun and effective means for students to review topics taught in class. Compared to the conventional teaching method, this approach was shown to enhance student engagement during classroom instruction. The students of the study sample showed an increase in marks in the exploration activity as well as the marks of continuous assessments. The respondents agree with the statements that the Explorace programme helps them review

topics taught in class and prepares them for the upcoming continuous assessment, which was held in Weeks 8 and 13 of the current semesters.

(Essam et al., 2020) also studied the impact of gamification among students at Lim Kok Wing University and found a strong result to support the hypothesis of their research, 'There is a positive relationship between students' learning behavior and their intrinsic motivation in learning'. By adopting this approach, the learning process can be made more engaging and captivating, thereby enhancing its effectiveness.

Thus, our second research question will focus on the result after implementing the proposed outdoor and gamification approach of learning, which is 'Explorace'. We intend to find the answer to this research question:

• RQ2: Can the proposed approach help the understanding of the selected topics among Information Security students?

The Impacts of Awareness Among the People Approached by The Students in The 'Explorace'

According to the National Institute of Standards and Technology (NIST) (Hansche et al., 2024), the definition of awareness is:

"Awareness is not training. The purpose of awareness presentations is simply to focus attention on security. Awareness presentations are intended to allow individuals to recognize IT security concerns and respond accordingly. In awareness activities, the learner is the recipient of information. Awareness relies on reaching broad audiences with attractive packaging techniques."

Accordingly, adopting an interesting method in spreading the awareness, with not just using talks and webinars, or written form such as posters and guides, this approach is seen to be a fresh idea where students who have the knowledge of cyber security should share with public to nurture the awareness and in the same time, recognize the importance of data security, maintaining data integrity, and confidentiality.

In order to develop awareness campaigns that are effective, it is crucial to comprehend how people perceive risks. Simply providing information about risks and reactive behaviors is not enough to modify people's behavior. Two additional factors are essential for this purpose: 1) People need to comprehend and implement the guidance provided to them, 2) They must have the incentive and willingness to do so, which necessitates a change in attitudes and intentions.

Therefore, we try to measure the impact on awareness among people that had been approached by the students during the 'Explorace' game. Finally, we aim to address the following research questions:

• RQ3: What is the impact of spreading awareness using an 'Explorace' game among the public?

METHODOLOGY

Context And Study Design

This study utilizes a quasi-experimental design to evaluate the effectiveness of a gamified outdoor learning approach compared to traditional teaching methods. The study was conducted at Universiti Malaysia Pahang AlSultan Abdullah within the "Information Security" course. This course is a core requirement for Computer Science degree students and an elective for diploma students.

The course learning outcomes focus on three domains: cognitive knowledge, practical skills, and ethical values. Historically, students have demonstrated difficulty retaining complex concepts regarding cyber-attack symptoms and encryption algorithms, as evidenced by low performance in previous mid-term and final examinations. To address these challenges, a gamified intervention known as "Explorace" was developed.

Participants

The study involved two distinct cohorts of students across two academic sessions. A total of 103 students participated. Group 1 (n=33) served as the control group during the 2021/2022 session, while Group 2 (n=70) participated in the 2022/2023 session. Table 1 details the demographic distribution of the target groups.

Table 1. Demographic Characteristics of Study Participants

Variable	**Group 1 (Control)**	**Group 2 (Experimental)**
Semester	Semester 2	Semester 1
Academic Session	2021/2022	2022/2023
Sample Size (N)	33	70
Intervention Type	Traditional	Gamified

The Educational Intervention: "Explorace"

The "Explorace" activity was designed to reinforce theoretical concepts through active outdoor learning. The activity structure is visualized in Figure 1. The game consists of a starting point, four distinct checkpoints, and a finishing point. Figure 2 shows the examples of tasks for each checkpoint.

1. Standardization of Test Items: To ensure the validity and reliability of the learning tasks, the game content was standardized through a series of workshops involving subject matter experts and lecturers. These discussions focused on aligning game tasks with course learning outcomes and ensuring the difficulty level was appropriate for the students' readiness.

2. Game Mechanics: Students were required to complete tasks at each checkpoint to advance. Checkpoints 3 and 4 introduced practical cryptography skills, where instructions were encrypted. Students were required to decrypt these messages using specific algorithms (e.g., Vigenère Cipher) to reveal the task instructions.

3. Knowledge Dissemination Tasks: A core component of the game involves social learning. Students were required to verbally explain specific security concepts (e.g., Trojan Horse, Social Engineering, Identity Theft) to bystanders, including other students and staff. By the end of the game, each participant had disseminated knowledge to approximately 14 individuals.

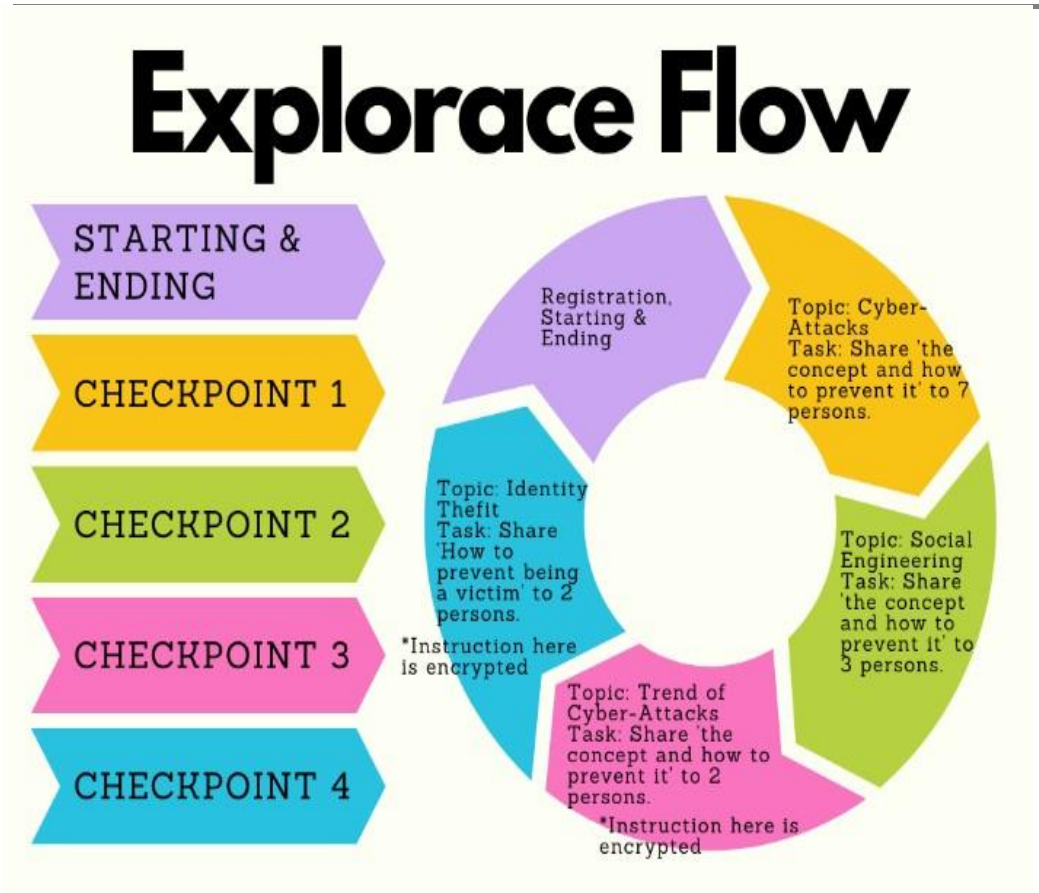

Figure 1. The Proposed Explorace Flow as the Outdoor Learning

CP1d (You need a paper and a pen for this task):

1. Your theme is Trojan Horse. You have to explain about this attack to 5 undergraduate students, 1 lecturer, and 1 postgraduate student until they understand about the concept and how to prevent from being a victim to this attack.
2. Prove your task is done by taking their name, category (undergraduate student/staff/postgraduate student), sign, and comment about your explanation.
3. Find Ms. Syifak Izhar Hisham at the Security Lab Level 3 to submit the proof and get the second task.

Figure 2. (a) The example of Checkpoint 1 task (copyrighted)

CP2a (You need a paper and a pen for this task):

1. Your theme is Social Engineering. You have to explain about this attack to 3 persons who their names start with A.
2. Prove your task is done by taking their name, category (undergraduate student/staff/postgraduate student), sign, and comment about your explanation.
3. Find Ms. Aidel Fitry at Level 5 to submit the proof and get the third task.

Figure 2. (b) The example of Checkpoint 2 task (copyrighted)

Cipher: qskse Algorithm: Vigenere Key: lemon	1. Share to 2 persons at the location you have decrypted about 'Macau Scam'. 2. Find your next task at the same place after you get the signs.

Figure 2. (c) The example of Checkpoint 3 task (copyrighted)

Cipher: vwxq Algorithm: Vigenere Key: kiwi	1. Share to 2 persons at the location you have decrypted about 'How to prevent from being a victim of Identity Theft'. 2. Get back to the starting point after you finish the task.

Figure 2. (d) The example of Checkpoint 4 task (copyrighted)

Data Collection and Analysis

Data were collected using a mixed-method approach comprising three instruments:

1. Academic Performance Records: To measure cognitive retention, scores from the Mid-term Test and Final Examination were collected for both the Control Group (Group 1) and the Experimental Group (Group 2).

2. Post-Activity Survey: A survey measuring "Readiness and Acceptance" was administered to Group 2 immediately following the intervention.

3. Public Feedback Logbooks: To assess the "Awareness" component, the students maintained a logbook recording qualitative feedback and signatures from the public audience they approached during the game.

The data was then analyzed using Microsoft Excel. Descriptive statistics (mean and percentages) were calculated for survey responses. To evaluate the intervention's impact on performance, an Independent Samples t-test was performed to compare the mean examination scores between the Control and Experimental groups, with a significance level set at $p < 0.05$.

RESULTS AND DISCUSSION

Result 1: Student Readiness and Acceptance (Survey Results)

The first phase of analysis focused on student acceptance of the "Explorace" gamified learning approach. Post-intervention survey data (Figure 3) indicate a high level of readiness among participants.

- 97% of students expressed that they were "ready and liked the approach," citing that the active nature of the module helped improve their understanding of encryption and decryption processes.
- 1% of respondents remained neutral.
- 1% expressed a lack of readiness or interest in the approach.

Qualitative feedback supports these findings; students reported that the module allowed them to "practice what they have learned in a fun way". This suggests that the outdoor setting reduced the anxiety often associated with complex topics like Cryptography.

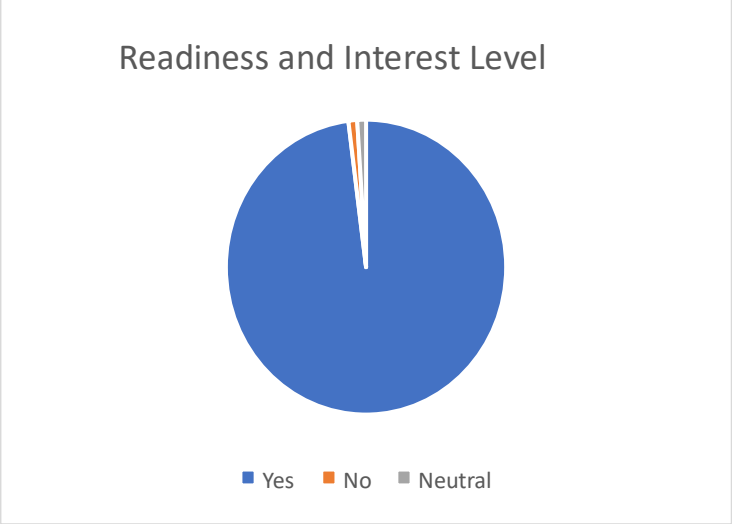

Figure 3. Readiness and interest level of having 'Explorace' as a learning approach

Result 2: Impact On Academic Performance

To address the primary research objective, the academic performance of the Experimental Group (Group 2, n=70) was compared to the Control Group (Group 1, n=33). Table 2 presents the comparison of Mid-term and Final Examination scores.

Table 2. Comparison of Academic Performance between Control and Experimental Groups

Assessment Item	Group	N	Mean Score (%)
Mid-term Test	Group 1 (Control)	33	58.94
	Group 2 (Experimental)	70	61.20
Final Exam	Group 1 (Control)	33	41.09
	Group 2 (Experimental)	70	61.46

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Note: Maximum score is 100. Significance tested at $p < 0.05$.

As shown in Table 2, the Experimental Group outperformed the Control Group in both assessments. While the Mid-term improvement was marginal (2.26% difference), the impact on the Final Examination was substantial. The Experimental Group achieved a mean score of 61.46% compared to 41.09% in the Control Group. This significant increase demonstrates that the "Explorace" module effectively aided retention of complex topics such as Cryptography.

Figure 4 illustrates samples of student answers, showing that students in Group 2 were able to apply encryption algorithms (e.g., Vigenère Cipher) more accurately in exam settings compared to previous cohorts.

While raw data for significance testing was not available for this retrospective analysis, the difference in mean scores (20.37%) suggests a substantial practical impact. It is particularly noteworthy that these results were achieved despite a significantly larger class size in the Experimental Group (n=70) compared to the Control Group (n=33). Typically, larger cohorts present greater pedagogical challenges regarding student attention and comprehension. The fact that the larger group performed better suggests that the gamified approach effectively mitigated the challenges of large-group instruction.

Furthermore, qualitative observations revealed that the game mechanics lowered the cognitive barrier for Cryptography, a subject historically perceived as abstract and difficult. By physically interacting with encryption algorithms (e.g., Vigenère Cipher) at checkpoints, students transitioned from passive theoretical learning to active application, resulting in the higher accuracy observed in the final examination."

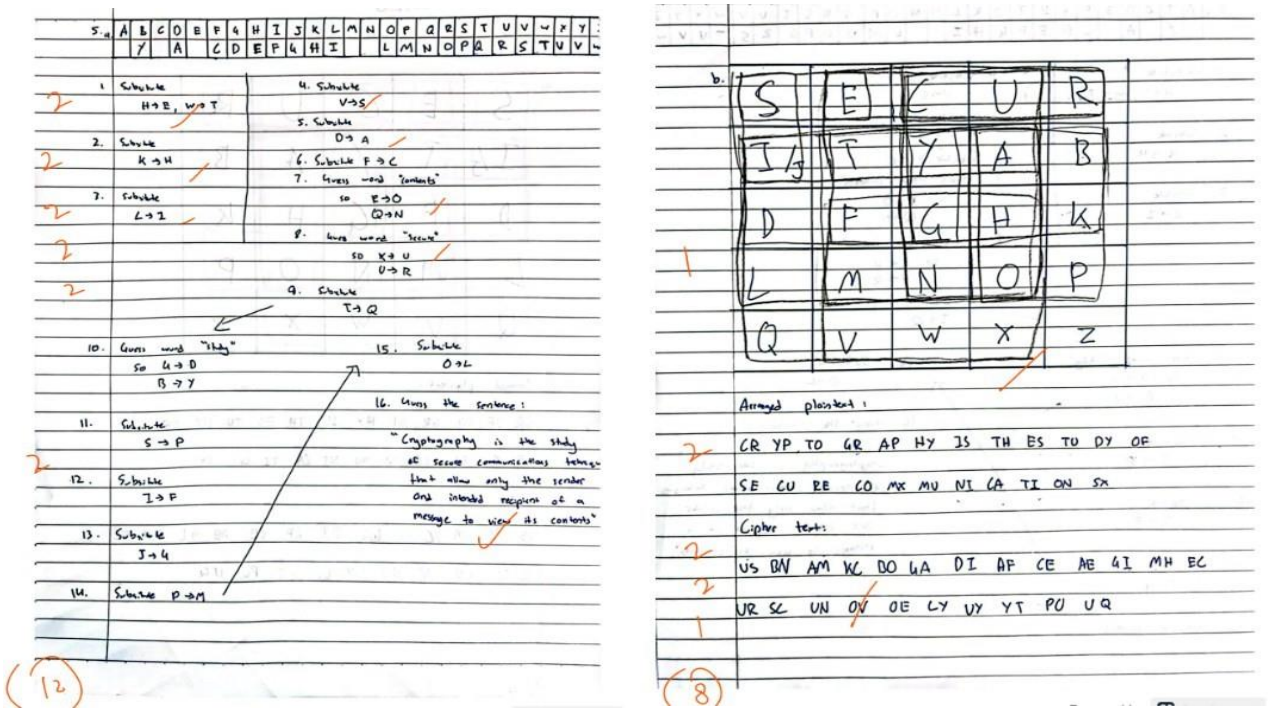

Figure 4. (a) Samples of Mid-term Test Answers from Group 2 students

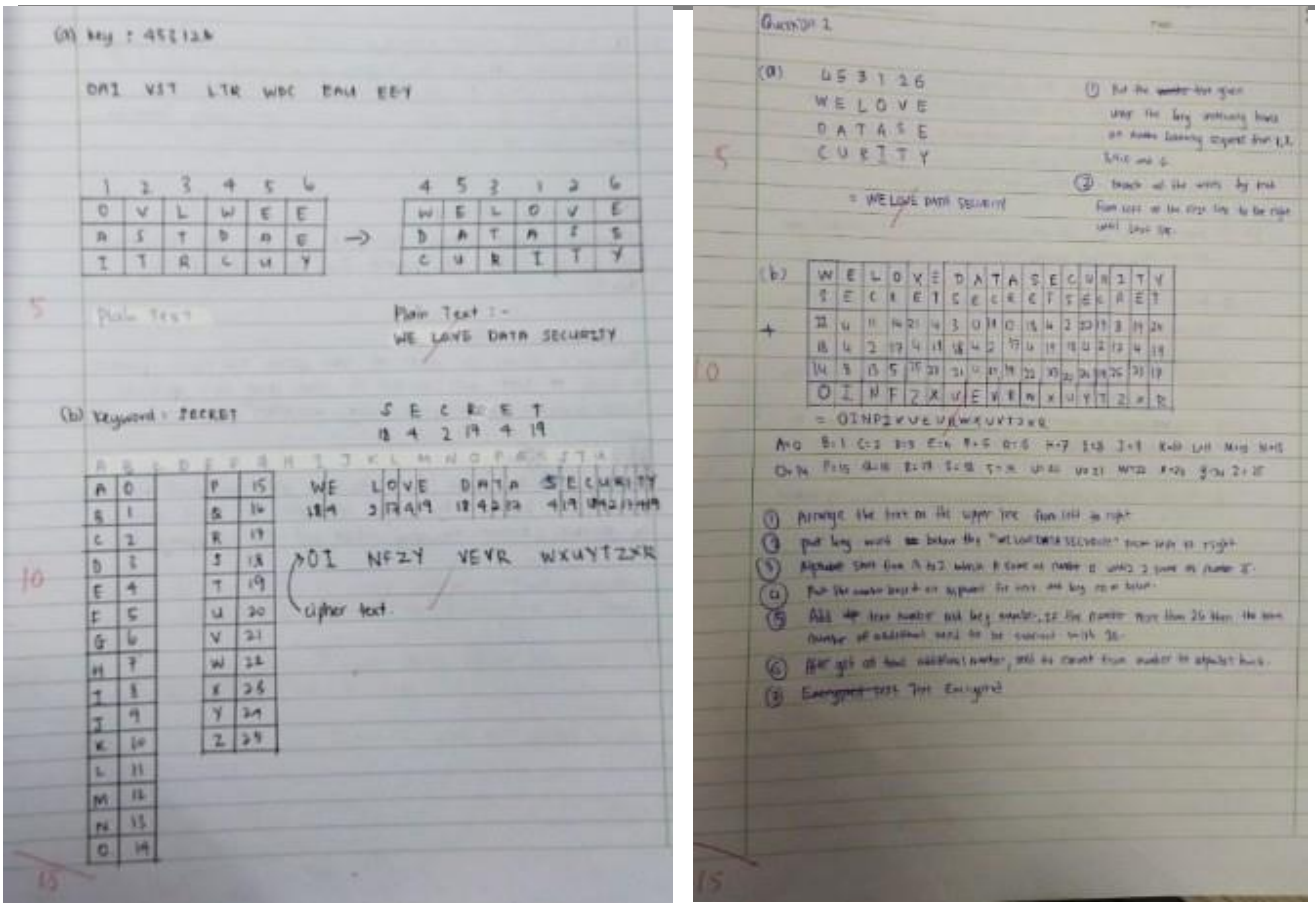

Figure 4. (b) Samples of Final Exam Answers from Group 2 students

Result 3: Public Awareness and Social Impact

The final component of the study evaluated the students' ability to disseminate information to the public. During the sessions, 15 student groups approached a total of 210 individuals (staff and students) to explain cybersecurity threats.

As evidenced in the feedback logbooks (Figure 5), 80% of the audience provided positive or meaningful feedback. Figure 5 displays samples of these interactions, where audience members signed off to indicate their understanding of concepts such as "Social Engineering" and "Identity Theft". This process not only spread awareness but also reinforced the students' own understanding through the "learning by teaching" mechanism.

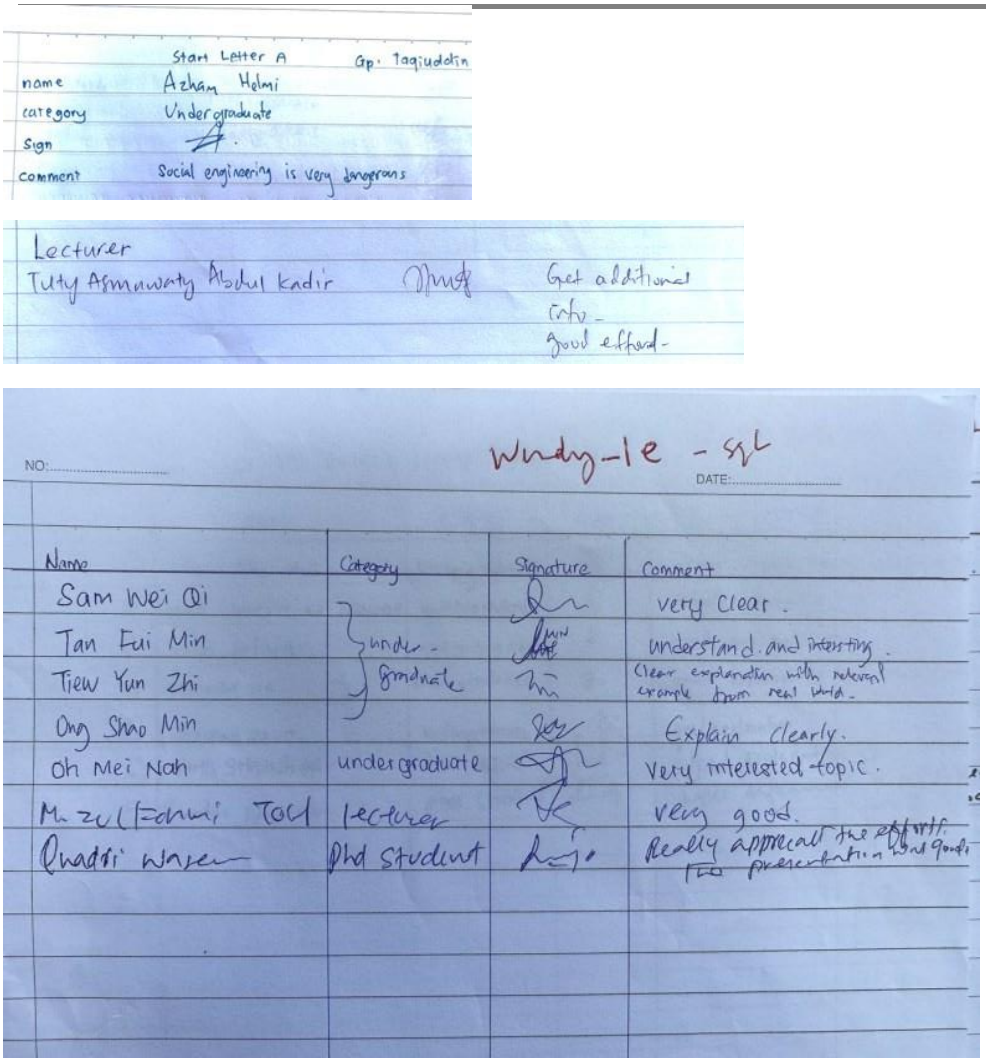

Figure 5. Feedback from students and staff

This initiative provides some sequences for good practices in teaching and learning strategies. this initiative covers the attributes of ethical value in the affective domain of this subject too by nurturing the ethics among students to explain properly and correctly. they need to be responsible for what they are spreading as it will be used as a guide by the audience later. Some of the students also commented that this activity pushes them to be brave to communicate with others, to greet people, to ask for their time, and to convince others that the input they want to convey is very important and useful.

However, there are challenges to implement this approach in the universities. the obvious challenge is to encourage lecturers to spend more time in preparation as this kind of activity should be designed and customized based on the students of the particular semester.

CONCLUSION

Educators in the cybersecurity field can use this approach to have an active session of awareness sharing as well as to encourage students to enhance their input of knowledge by sharing to others. Research Question 1 is answered positively as students are comfortable with the proposed learning style. Research Question 2 is answered by the big increment of average marks in the test and exam. Research Question 3 is answered with the proof of audience feedback, as demonstrated by Figure 5. Hence, this initiative is useful and applicable to this subject and possibly other subjects with the same nature like Information Security.

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