

The Implementation of H5P in Interactive Games for Cyber Security Awareness Learning Facilities for Elementary and Junior High School Students

Mazura Binti Mat Din ¹, Shaifizat Mansor ¹, Siti Rafidah Muhamat Dawam ¹, Andria ², Ridam Dwi Laksono ², Kelik Sussolaikah ²

¹UiTM Cawangan Kedah, 08400 Merbok Kedah Malaysia

²University of PGRI Madiun, Jl Auri 14-15 Kanigoro, Madiun, 63117 Indonesia

ARTICLE INFO

Article history:

Received June 24, 2023
Revised July 10, 2023
Published July 14, 2023

Keywords:

Cyber Security;
H5P;
Interactive Game;
Learning Management System;
Moodle

ABSTRACT

The importance of digital security awareness is not only related to privacy protection but also includes responsible use, protection from cyberbullying, and understanding the consequences of online actions. In primary and secondary schools, understanding regarding cyber security awareness is still lacking; students must realize that what they do in the digital world can have long-term impacts on their real lives. An introduction and understanding of digital security awareness need to be given to elementary and junior high school students. This study intended to provide a vehicle (learning tool) and introduce cyber security awareness using interactive games. By using the Moodle platform and the H5P plugin to make games more interactive, interesting, effective, and efficient. This activity was carried out using the RnD method. With the RnD method, the development of awareness and the many ways to protect oneself on the internet can be developed significantly, according to the level of understanding of students. Game platform development uses a Moodle-based learning management system. Then do the customization using H5P. Meanwhile, games are developed by taking into account cyber security awareness indicators. Game applications that are compiled can run well. The trial was conducted on 4 elementary schools and 4 junior high schools. During the trial, the platform's reliability can run smoothly when accessed by users. There were no obstacles in using games by the user during the trial. User features related to achievement badges, as an indication of the level of play each player can achieve responsively. Interactive games about cyber security awareness can be formed and run according to the design set. The contribution of this research is to increase students' understanding of internet safety awareness through interactive games and to increase students' knowledge about how to protect themselves while surfing the internet through interactive games.

This work is licensed under a [Creative Commons Attribution-Share Alike 4.0](https://creativecommons.org/licenses/by-sa/4.0/)



Corresponding Author:

Andria, Ridam Dwi Laksono, Kelik Sussolaikah, University of PGRI Madiun, Jl. Auri 14-15, Kanigoro, Madiun, 63117 Indonesia
Email: andria@unipma.ac.id¹, ridam.dl@unipma.ac.id², kelik@unipma.ac.id³

1. INTRODUCTION

Information and communication technology has become integral to everyday life in the ever-evolving digital era. The internet, mobile devices, and social media have changed how we interact, learn and communicate. [1], [2]. However, these technological advances also bring new challenges regarding digital security. Therefore, digital security awareness is crucial, especially among primary and secondary school students [3], Education regarding digital security awareness is a must in dealing with today's complex digital world. Applications that are increasingly found and presented are able to attract children to try them without

them knowing that not all of these applications are useful and safe for them, and can even be a threat to their mental development, for example cyber bullying. Digital security awareness is the level of understanding and awareness of individuals or organizations about the threats and risks associated with the use of digital technology, including an understanding of safe practices in using devices and networks, awareness of potential cyber attacks and ways to protect themselves from them [4], [5]. Students, who grow up in a highly connected environment, are often unaware of the risks and threats in cyberspace; they need to understand how to protect and keep themselves safe in a digital environment [6], [7], [8].

The importance of digital security awareness is not only related to privacy protection but also includes responsible use, protection from cyberbullying, and understanding the consequences of online actions [9], [10], [11]. Students should know that what they do in the digital world can impact their real-life long-term [12]. In addition, knowledge of digital security will also assist students in preparing themselves for future challenges [13], [14]. In an era that is increasingly dependent on technology, digital security skills are invaluable. [15] Students with this knowledge will be better equipped to deal with risks such as online fraud, personal data loss, and cyberattacks [16].

As educational institutions, schools have an important role in ensuring that students have the necessary knowledge and skills to become smart and safe users in the digital world [17], [18]. They need to be educated about the threats and risks they may face online and the steps they can take to protect themselves [19], [20], [21].

At primary and secondary school age, it is necessary to have appropriate media for their age to introduce digital safety awareness, one of which is the use of interactive games in the Moodle online learning platform [22]. Interactive games are a learning approach incorporating game elements into an educational context [23]. In Moodle, interactive games can increase student engagement, motivate them to learn, and increase their understanding of learning material [24]. In Moodle interactive games, educators can use game elements like game boards, missions, points, rewards, challenges, and competitions to create more engaging learning experiences. Students can participate in activities designed in an interactive and fun way while staying focused on the learning objectives [25], [26].

One of the main advantages of interactive games in Moodle is that they can provide students with instant feedback [27], [28]. In a game, students can view their progress, identify areas for improvement, and improve their strategy in real-time. It allows them to learn from mistakes and improve their understanding more effectively. Another advantage, there is an increase in student involvement in the learning process, increased learning motivation, and increased understanding of learning material. In addition, to further enhance an interesting learning experience, it is necessary to have a more interactive framework, namely H5P.

H5P is a framework that allows users to create and share interactive content easily [29], [30]. Implementing H5P in interactive games with Moodle enables teachers to create engaging learning experiences by leveraging various interactions, such as multiple-choice questions, puzzles, drag and drop, simulations, and many more [31].

By using the features of H5P, teachers can design learning activities that hold students' attention and encourage them to participate actively. One of the main advantages of using the H5P in interactive games in Moodle is its ease of use. The H5P provides an intuitive and user-friendly interface so educators of all technical expertise can create interactive content without complex programming skills. It allows educators to focus on the design and content of learning materials, thereby saving time and effort in developing interactive games. In addition, the H5P supports responsiveness, meaning that content created with the H5P can be easily accessed and used across various devices, including desktop computers, laptops, tablets, or smartphones. It allows students to study flexibly according to their preferences [32].

Previous research conducted by Isabella *et al.* with the title Cyber security education is as essential as "the three R's, the results of the study showed that awareness and knowledge about cyber security must be taught early in elementary schools and integrated into the curriculum as a whole, to be able to overcome gender disparity in digital security awareness [33].

Subsequent research conducted by Hiroshi *et al.* with the title Data Analysis for Evaluation on Course Design and Improvement of "Cyberethics" Moodle Online Courses found that Moodle is a learning management system with global standards and can be used to analyze learning data that can provide real-time feedback [34].

David Lebeaux *et al.*, in their research entitled Introducing an Open-Source Course Management System (Moodle) for Blended Learning on infectious diseases and Microbiology: A Pre-post Observational Study, stated that the use of Moodle for blended learning of infectious diseases and microbiology could increase student satisfaction and attendance at each course session, compared to 2016, 2017 and 2018 has increased by 81.9% [35]. The use of moodle in the current research is able to increase students' motivation in learning.

Previous research by Stephan Hart *et al.* in titled Riskio: A Serious Game for Cyber Security Awareness and Education implemented a game named Riskio, a tabletop game to increase cyber security awareness for people who do not have a technical background working in an organization [36]. Interactive games in current research make it easier for students to understand what is conveyed regarding cyber security.

From the description of various backgrounds and several previous studies, this research aimed to design an effective and interactive game media with Moodle-based H5P to be implemented in learning the introduction of digital security to elementary and middle school students. By increasing this awareness, it is hoped that students can become smart, responsible, and safe users in an ever-evolving digital world.

This study aims to design an effective and interactive game media using Moodle-based H5P to introduce digital safety to elementary and middle school students, with the aim of promoting their awareness and responsible use in the digital world.

2. METHODS

Research and Development (R & D) was used in the research. With the RnD method, the development of awareness and the many ways to protect oneself on the internet can be developed significantly. This research focused on developing the Moodle platform as an open source Learning Management System (LMS) by adding and activating the H5P plugin to create interactive content containing digital literacy material, especially regarding cyber security awareness. The system development flow in this study can be shown in Fig. 1. The tools and materials used in this study are shown in Table 1. In developing the system, it is necessary to test and access it online, requiring a hosting server. The hosting server specifications used in this study are shown in Table 2.

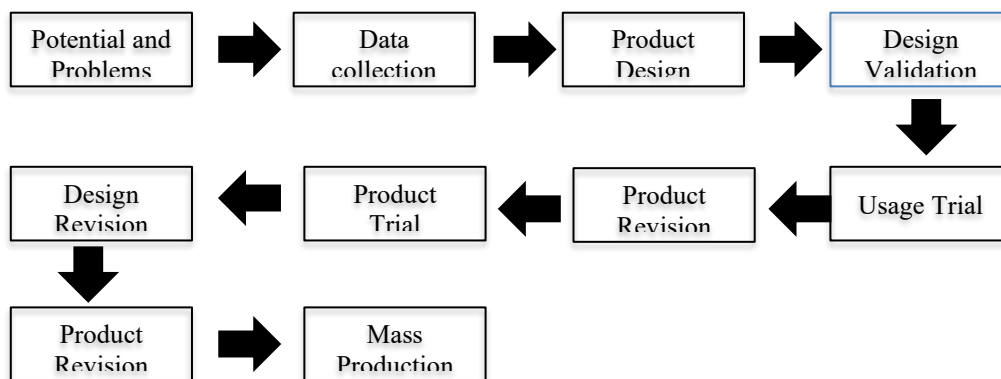


Fig. 1. System Development Flow

Table 1. Materials and tools

No	Tools/Media	Explanation
1	Visual Studio Code	As a programming code editor, it is used to configure the program code contained in the Moodle LMS
2	XAMPP	Local (offline) web server, for development and testing on a local PC before the system is online
3	Adobe Photoshop	Design icons and images for e-learning web content
4	WinSCP	File transfer protocol, used for file management on hosting such as uploading, downloading, editing or deleting files
5	Server Hosting	Used to store data and web file properties from the developed e-Learning
6	Domain	Used for names or web address extensions, in this study the web.id domain was used.
7	SSL	Secure Socket Layer as an internet security protocol, so that data traffic from the web client to the web server becomes encrypted
8	Moodle	Used as a Learning Management System or educational media platform in this study
9	H5P	Interactive content plugins used to create quizzes are in the form of interactive videos, animated content and so on.

Table 2. Hosting Specifications

No	Type	Explanation
1		Disk Space 8 GB, used to store files and web properties
2		MySQL Disk Space 2.43GB, used for database storage media
3		Unmetered Bandwidth is data sent within a certain time and is measured in seconds. Unmetered means that the data transfer limit will not be counted, the limitation is only on the maximum speed.
4	Shared Hosting	Physical Memory Usage 768MB, is a feature that informs how much the hosting resource is using against the physical memory on the server that is currently being used.
5		I/O uses 20 MB/s, which refers to disk input and output (I/O). Disk I/O speed determines how fast a website or script is allowed to perform input and output operations per second on the hosting server.
6		Email Account Unlimited, is an email service on web hosting that can be used to create unlimited webmail accounts.

This research begins with the identification of potential problems related to the level of cyber security awareness, the rise of cases of hacking and misuse of information technology requires a role in providing education regarding the importance of understanding cyber security as early as possible. Data collection was obtained by observation, then the product design was in the form of educational media by utilizing the Moodle LMS platform which was customized by the plugin and then the design was validated with the research team for further use trials and improvements through feature and content revisions to the final stage in the form of product launch. Development of game content by paying attention to indicators following the terms in the term security cyber awareness. 5 indicators become 5 parts in the game, namely (1) Email and Gadget Usage Security, (2) Password Security, (3) Social Media Security, (4) Security in Buying and Selling Online & Digital Banking, (5) Personal Data Security. As seen in [Table 3](#), each of these indicators is made into an interactive game with different challenges and levels of challenge. Each achievement will get a reward in the form of a badge. Every user who can complete the game and challenges in each part of the game will get a badge.

Table 3. Cyber Security Awareness Interactive Game Indicator

Term Indicator	Interactive Games
1. Security Using Email and Gadgets	What is Electronic Mail?
	Google email
	Gadget
	Unlock Screen
2. Password/Password Security	Gadget safety from Dr. Evil
	Preferably Password Email
	Crossword "Password"
3. Social Media	Powerful Password
	Crossword Puzzle II Password
	People & Social Media
4. Buying and Selling Online & Digital Banking	Get to know fake / fraud WA chats
	Social Media
	Application permissions
	Digital Market & e-Money
5. Personal Data Security	OTP, what is it?
	Personal Data

Moodle-based interactive games by utilizing H5P features follow the following steps:

1. Planning the learning game design, the type of interaction desired, and the content to be used and registering some of the features needed.
2. Moodle Installation: Verify Moodle installation is running.
3. Create an activity within Moodle using the installed game plugin. For example, creating interactive quizzes or puzzles using a plugin selected according to your needs.
4. Add interactive content like images, videos, audio, or other elements. For example, using click images to answer questions, adding videos as challenges, or integrating other elements relevant to the subject matter.

5. Determine the game rules, points, and ratings to be applied. For example, giving points to participants who answered correctly or scoring based on how quickly they completed an activity.
6. Test and repair. Before implementing a game into a class, test it to ensure its performance.
7. Implement in Moodle. Create custom activities for interactive games, give instructions to participants, and monitor participant progress.
8. Evaluation and feedback. After participants complete the game, they are given relevant feedback and an evaluation of their performance. It can help enhance learning and motivate participants to participate in more advanced games.

3. RESULTS AND DISCUSSION

The implementation of H5P in LMS-based interactive games using Moodle has several stages. So interactive games are created that can be used for learning about digital security for elementary and junior high school students [37]. H5P was implemented in the Learning Management System, which previously had been successfully built by researchers under the name SiCermat.

Before using H5p in Moodle LMS, it is necessary to understand user problems; researchers design interactive content that can attract and is easily understood by users, in this case, elementary and high school students. The researcher changed the interactive game content on the LMS by adding several features found on H5P. Users can only access the LMS as needed to study material and play games on the LMS that has been designed, while researchers have access rights as admin so they can see the system being used by the user.

User problems related to how a game will be more interesting and easy to understand the game presented. H5P is embedded in a learning management system built by researchers using Moodle. In the interactive game that was built, each participant created an account to access the LMS on the device they were using and study the various game content provided while playing the game from start to finish. The displayed game content is related to cybersecurity awareness, wherein each game session, information will be provided, followed by interactive games with the H5P.

Seen in Fig. 2 is the initial appearance of Moodle-based e-learning, which will later be used as a medium for delivering cyber security awareness material and interactive games that are attractive to elementary and junior high school students.

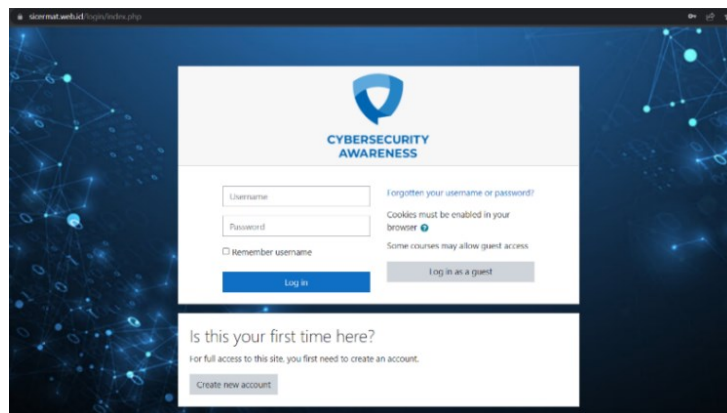


Fig. 2. Initial Screenshot of Cyber Security Awareness LMS Moodle

It can be seen in Fig. 2 that there is an initial menu; the user will be asked to enter a username and password to be able to access the LMS so that they can study and play the interactive games that have been provided while the teacher can enter various materials into the LMS and use the H5P to make it more interactive. As shown in Fig. 3, the Moodle LMS dashboard display is called the SiCermat website.

It can be seen in Fig. 3, that several elementary and junior high schools in the city of Madiun will implement the SiCermat Moodle with this H5P. The trial was conducted on 4 elementary schools and 4 junior high schools. Researchers use the features in Moodle and combine them with h5p content to become more interactive, such as videos, a collection of presentation questions, and others. It can be seen in Fig. 4.

Fig. 4 shows the menu of one of the cyber security awareness interactive games by implementing H5P. The video menu is created by activating the change mode, and making sure you are logged in as a teacher, then choose the H5P menu where interactive videos are selected later, so that you can include learning videos while adding several questions, quizzes or summaries of the videos watched. Learning videos can be played, and

when listening to them, students can answer questions that arise, increasing their understanding of the material shown in the video. Several questions that arise will be accumulated at the end of the video, accompanied by a summary of what has been listened.

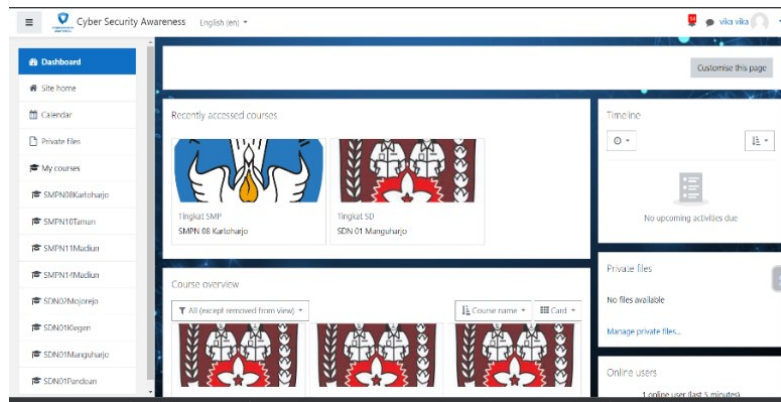


Fig. 3. SiCermat Dashboard display

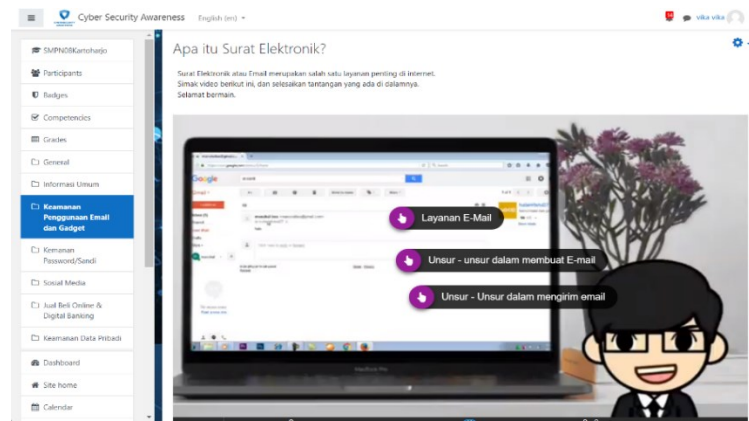


Fig. 4. H5P view on Moodle SiCermat

The interactive game built has several indicators to see how much the participants understand the various games being played. Each of these indicators has a different level of challenge. Fig. 5 shows that each challenge category has levels, where each user who successfully completes the game will get a badge.

Image	Name *	Description	Criteria
	Lencana Keamanan Scomed	Lencana Keamanan Scomed	Users are awarded this badge when they complete the following requirement: • ALL of the following activities are completed: • "Interactive Content - Manusia & Media Sosial" • "Interactive Content - Mengenal chat WA palsu / penipuan" • "Interactive Content - Sosial Media"
	Lencana Keamanan Password & Lock Screen	Lencana Keamanan Password & Lock Screen	Users are awarded this badge when they complete the following requirement: • ALL of the following activities are completed: • "Interactive Content - Gadget" • "Interactive Content - Membuka Lockscreen" • "Interactive Content - Keamanan gadget dari Dr. Bill" • "Interactive Content - Sebaliknya Password E-mail itu..." • "Interactive Content - Password Crossword" • "Interactive Content - Powerful Password/andi" • "Interactive Content - Password Crossword 2"
	Lencana Keamanan Online Market & M-Bank	Lencana Keamanan Online Market & M-Bank	Users are awarded this badge when they complete the following requirement: • ALL of the following activities are completed: • "Interactive Content - Perilaku apikah!" • "Interactive Content - Digital Market & e-Money"
	Lencana Keamanan Data Pribadi	Lencana Keamanan Data Pribadi	Users are awarded this badge when they complete the following requirement: • The following activity has to be completed: • "Interactive Content - Data Pribadi"
	Keamanan OTP	Keamanan OTP	Users are awarded this badge when they complete the following requirement: • The following activity has to be completed: • "Interactive Content - OTP, Apakah Itu?"
	Keamanan Email	Keamanan Email	Users are awarded this badge when they complete the following requirement: • ALL of the following activities are completed: • "Page - FITUNGKUK UMBUNG PERMAINAN" • "Interactive Content - Apa Itu Surat Elektronik?" • "Interactive Content - Google e-Mail" • "Interactive Content - Gadget"

Fig. 5. Cybersecurity Awareness Achievement Badge

The picture shows that each user will get a badge according to their respective levels. Each badge will be obtained when you have completed several activities as shown in the description of the image on the right. Each activity is adjusted to the ability level of students, made as attractive as possible so that they are excited to complete each of these levels. It is a reward for the participants' hard work in completing each challenge in the interactive game. Participants will be more interested and excited to complete the challenges given.

H5P has many advantages; apart from being a content creation tool, H5P can also be used to Import Export files found on other sites that will support the H5P feature itself so that it can be reused and shared effectively and efficiently [38], [39]. Moodle-based LMS with a modification of the H5p can improve participants' ability to understand what is learned, whether in doing questions, playing games, or taking interactive quizzes [40], [41]. Cybersecurity awareness material is delivered in various games adapted to elementary and middle school ages. It can attract students' interest in working on it, and when they have completed all of these games, they will receive a digital certificate on each student's account. In addition, the certificate will be automatically sent to each teacher's email, and the teacher can monitor student learning outcomes, how many grades are obtained, how many times they try to do it and whether all participants have completed all the questions provided.

This learning management system is very effective and efficient in helping the teaching and learning activities of teachers and students, especially the implementation of H5P in the LMS is very helpful for the progress of participant learning, attracting interest to find out more about the material being studied, especially in this case is the introduction of cyber security awareness at the elementary and junior high school level. At this age, modification of teaching and learning activities is needed, where the delivery of material can be more flexible and interesting.

4. CONCLUSION

The implementation of H5P used in Moodle-based interactive games has many advantages. It can increase the interest of elementary and junior high school students in learning about cybersecurity awareness in an interesting and fun way. A learning experience that is not boring makes it easier for students to understand the material presented. In addition, several complete H5P features make it easier for teaching staff to explore learning media more optimally, effectively, and efficiently. The presence of SiCermat, a Moodle-based interactive game with H5P features in learning cyber security, makes it an easy-to-use and fun learning medium for elementary and junior high school students with a high interest in learning about cyber security, which is packaged in the form of interactive games capable of increasing awareness to digital security. The contribution of this research is to increase students' understanding of internet safety awareness through interactive games and to increase students' knowledge about how to protect themselves while surfing the internet through interactive games.

REFERENCES

- [1] A. A. P. Cattaneo, C. Antonietti, and M. Rauseo, "How digitalised are vocational teachers? Assessing digital competence in vocational education and looking at its underlying factors," *Comput. Educ.*, vol. 176, p. 104358, 2022, <https://doi.org/10.1016/j.compedu.2021.104358>.
- [2] I. D. Sánchez-García, T. S. Feliu Gilabert, and J. A. Calvo-Manzano, "Countermeasures and their taxonomies for risk treatment in cybersecurity: A systematic mapping review," *Comput. Secur.*, vol. 128, p. 103170, 2023, <https://doi.org/10.1016/j.cose.2023.103170>.
- [3] R. A. Mishra, A. Kalla, A. Braeken, and M. Liyanage, "Privacy Protected Blockchain Based Architecture and Implementation for Sharing of Students' Credentials," *Inf. Process. Manag.*, vol. 58, no. 3, p. 102512, 2021, <https://doi.org/10.1016/j.ipm.2021.102512>.
- [4] M. Safaei Pour, C. Nader, K. Friday, and E. Bou-Harb, "A Comprehensive Survey of Recent Internet Measurement Techniques for Cyber Security," *Comput. Secur.*, vol. 128, p. 103123, 2023, <https://doi.org/10.1016/j.cose.2023.103123>.
- [5] S. Srivastava, B. Paul, and D. Gupta, "Study of Word Embeddings for Enhanced Cyber Security Named Entity Recognition," *Procedia Comput. Sci.*, vol. 218, pp. 449–460, 2023, <https://doi.org/10.1016/j.procs.2023.01.027>.
- [6] N. B. Alotaibi and M. Mukred, "Factors affecting the cyber violence behavior among Saudi youth and its relation with the suiciding: A descriptive study on university students in Riyadh city of KSA," *Technol. Soc.*, vol. 68, p. 101863, 2022, <https://doi.org/10.1016/j.techsoc.2022.101863>.
- [7] N. Pattnaik, S. Li, and J. R. C. Nurse, "Perspectives of non-expert users on cyber security and privacy: An analysis of online discussions on twitter," *Comput. Secur.*, vol. 125, p. 103008, 2023, <https://doi.org/10.1016/j.cose.2022.103008>.
- [8] A. Cartwright, E. Cartwright, and E. S. Edun, "Cascading information on best practice: Cyber security risk management in UK micro and small businesses and the role of IT companies," *Comput. Secur.*, vol. 131, p. 103288, 2023, <https://doi.org/10.1016/j.cose.2023.103288>.

- [9] P. Yi and A. Zubiaga, "Session-Based Cyberbullying Detection in Social Media: A Survey," *SSRN Electron. J.*, vol. 36, p. 100250, 2022, <https://doi.org/10.2139/ssrn.4208013>.
- [10] S. Maji and A. H. Abhiram, "Telematics and Informatics Reports "Mental health cost of internet": A mixed-method study of cyberbullying among Indian sexual minorities," *Telemat. Informatics Reports*, vol. 10, p. 100064, 2023, <https://doi.org/10.1016/j.teler.2023.100064>.
- [11] A. Mahmud, J. B. Sweetey, A. Hossain, and M. H. Husin, "Is the digital security act 2018 sufficient to avoid cyberbullying in Bangladesh? A quantitative study on young women from generation-z of Dhaka city," *Comput. Hum. Behav. Reports*, vol. 10, p. 100289, 2022, <https://doi.org/10.1016/j.chbr.2023.100289>.
- [12] C. Doxbeck and T. Karalis Noel, "I felt truly powerless: Narrative research on cyberbullying victimization and negative outcomes in graduate education," *Int. J. Educ. Res. Open*, vol. 4, p. 100245, 2023, <https://doi.org/10.1016/j.ijedro.2023.100245>.
- [13] T. N. Lam, D. B. Jensen, J. D. Hovey, and M. E. Roley-Roberts, "College students and cyberbullying: how social media use affects social anxiety and social comparison," *Heliyon*, vol. 8, no. 12, p. e12556, 2022, <https://doi.org/10.1016/j.heliyon.2022.e12556>.
- [14] A. Alzubaidi, "Measuring the level of cyber-security awareness for cybercrime in Saudi Arabia," *Heliyon*, vol. 7, no. 1, p. e06016, 2021, <https://doi.org/10.1016/j.heliyon.2021.e06016>.
- [15] J. P. A. Yaacoub, O. Salman, H. N. Noura, N. Kaaniche, A. Chehab, and M. Malli, "Cyber-physical systems security: Limitations, issues and future trends," *Microprocess. Microsyst.*, vol. 77, 2020, <https://doi.org/10.1016/j.micpro.2020.103201>.
- [16] Z. Wang and X. Liu, "Cyber security of railway cyber-physical system (CPS) – A risk management methodology," *Commun. Transp. Res.*, vol. 2, p. 100078, 2022, <https://doi.org/10.1016/j.commr.2022.100078>.
- [17] A. Moreno-González, D. Calderón-Garrido, L. Parcerisa, P. Rivera-Vargas, and J. Jacovkis, "Survey data on Families' perceptions of ed-tech corporations, educational digital platforms and children's rights," *Data Br.*, vol. 47, 2023, <https://doi.org/10.1016/j.dib.2023.109017>.
- [18] C. O. Alordiah *et al.*, "Awareness, knowledge, and utilisation of online digital tools for literature review in educational research," *Heliyon*, vol. 9, no. 1, p. e12669, 2023, <https://doi.org/10.1016/j.heliyon.2022.e12669>.
- [19] K. N. Hampton, C. T. Robertson, L. Fernandez, I. Shin, and J. M. Bauer, "How variation in internet access, digital skills, and media use are related to rural student outcomes: GPA, SAT, and educational aspirations," *Telemat. Informatics*, vol. 63, p. 101666, 2021, <https://doi.org/10.1016/j.tele.2021.101666>.
- [20] G. Childers, C. L. Linsky, B. Payne, J. Byers, and D. Baker, "K-12 educators' self-confidence in designing and implementing cybersecurity lessons," *Comput. Educ. Open*, vol. 4, no. December 2022, p. 100119, 2023, <https://doi.org/10.1016/j.caeo.2022.100119>.
- [21] V. Švábenský, P. Čeleda, J. Vykopal, and S. Brišáková, "Cybersecurity knowledge and skills taught in capture the flag challenges," *Comput. Secur.*, vol. 102, 2021, <https://doi.org/10.1016/j.cose.2020.102154>.
- [22] W. Hachicha, L. Ghorbel, R. Champagnat, C. A. Zayani, and I. Amous, "Using process mining for learning resource recommendation: A Moodle case study," *Procedia Comput. Sci.*, vol. 192, pp. 853–862, 2021, <https://doi.org/10.1016/j.procs.2021.08.088>.
- [23] I. E. Harker-Schuch, F. P. Mills, S. J. Lade, and R. M. Colvin, "CO2peration – Structuring a 3D interactive digital game to improve climate literacy in the 12-13-year-old age group," *Comput. Educ.*, vol. 144, p. 103705, 2020, <https://doi.org/10.1016/j.compedu.2019.103705>.
- [24] Y. Udjaja and D. Ramdhan, "Experiential game learning design framework: mechanical content of serious game," *Procedia Comput. Sci.*, vol. 216, no. 2022, pp. 415–423, 2023, <https://doi.org/10.1016/j.procs.2022.12.153>.
- [25] A. David, D. Mihai, M. E. Mihailescu, M. Carabas, and N. Tapus, "Scalability through Distributed Deployment for Moodle Learning Management System," *Procedia Comput. Sci.*, vol. 214, no. C, pp. 34–41, 2022, <https://doi.org/10.1016/j.procs.2022.11.145>.
- [26] S. Yamaguchi, H. Kondo, Y. Ohnishi, and K. Nishino, "Design of Question-and-Answer Interface using Moodle DATABASE Function," *Procedia Comput. Sci.*, vol. 207, pp. 976–986, 2022, <https://doi.org/10.1016/j.procs.2022.09.153>.
- [27] A. Muñoz, R. Delgado, E. Rubio, C. Grilo, and V. Basto-Fernandes, "Forum participation plugin for Moodle: Development and Discussion," *Procedia Comput. Sci.*, vol. 121, pp. 982–989, 2017, <https://doi.org/10.1016/j.procs.2017.11.127>.
- [28] R. Obermeier *et al.*, "Stress development during emergency remote teaching in higher education," *Learn. Individ. Differ.*, vol. 98, 2021, 2022, <https://doi.org/10.1016/j.lindif.2022.102178>.
- [29] S. R. López and I. R. Ramirez, M. G., & Rodriguez, "Evaluation of the implementation of a learning object developed with H5P technology," *Vivat Acad. Rev. Comun.*, vol. 24, no. 154, pp. 1–23, 2021, <https://www.proquest.com/openview/902ef21fe569b255cf4d0fc92702f853/1?pq-origsite=gscholar&cbl=1006345>.
- [30] L. A. Killam and M. Luctkar-Flude, "Virtual Simulations to Replace Clinical Hours in a Family Assessment Course: Development Using H5P, Gamification, and Student Co-Creation," *Clin. Simul. Nurs.*, vol. 57, pp. 59–65, 2021, <https://doi.org/10.1016/j.ecns.2021.02.008>.
- [31] W. Li, H. Chen, and J. F. Nunamaker, "Identifying and Profiling Key Sellers in Cyber Carding Community: AZSecure Text Mining System," *J. Manag. Inf. Syst.*, vol. 33, no. 4, 2016, <https://doi.org/10.1080/07421222.2016.1267528>.
- [32] T. Jacob and S. Centofanti, "Effectiveness of H5P in improving student learning outcomes in an online tertiary education setting," *J. Comput. High. Educ.*, no. 0123456789, 2023, <https://doi.org/10.1007/s12528-023-09361-6>.
- [33] I. M. Venter, R. J. Blignaut, K. Renaud, and M. A. Venter, "Cyber security education is as essential as 'the three R's,'"

- Heliyon*, vol. 5, no. 12, pp. 0–7, 2019, <https://doi.org/10.1016/j.heliyon.2019.e02855>.
- [34] H. Ueda and M. Nakamura, "Data Analysis for Evaluation on Course Design and Improvement of 'cyberethics' Moodle Online Courses," *Procedia Comput. Sci.*, vol. 112, pp. 2345–2353, 2017, <https://doi.org/10.1016/j.procs.2017.08.204>.
- [35] D. Lebeaux *et al.*, "Introducing an Open-Source Course Management System (Moodle) for Blended learning on infectious diseases and microbiology: A pre-post observational study," *Infect. Dis. Now*, vol. 51, no. 5, pp. 477–483, 2021, <https://doi.org/10.1016/j.idnow.2020.11.002>.
- [36] S. Hart, A. Margheri, F. Paci, and V. Sassone, "Riskio: A Serious Game for Cyber Security Awareness and Education," *Comput. Secur.*, vol. 95, 2020, <https://doi.org/10.1016/j.cose.2020.101827>.
- [37] P. M. Neuwelt and R. A. Kearns, "Playing the game: Interactively exploring journeys into primary care," *Wellbeing, Sp. Soc.*, vol. 2, p. 100045, 2021, <https://doi.org/10.1016/j.wss.2021.100045>.
- [38] K. C. Chilukuri, "A novel framework for active learning in engineering education mapped to course outcomes," *Procedia Comput. Sci.*, vol. 172, pp. 28–33, 2020, <https://doi.org/10.1016/j.procs.2020.05.004>.
- [39] Y. H. S. Al-Mamary, "Why do students adopt and use Learning Management Systems?: Insights from Saudi Arabia," *Int. J. Inf. Manag. Data Insights*, vol. 2, no. 2, p. 100088, 2022, <https://doi.org/10.1016/j.jjime.2022.100088>.
- [40] C. Lwande, L. Muchemi, and R. Oboko, "Identifying learning styles and cognitive traits in a learning management system," *Heliyon*, vol. 7, no. 8, p. e07701, 2021, <https://doi.org/10.1016/j.heliyon.2021.e07701>.
- [41] E. Kim, H. Park, and J. U. Jang, "Development of a class model for improving creative collaboration based on the online learning system (Moodle) in Korea," *J. Open Innov. Technol. Mark. Complex.*, vol. 5, no. 3, p. 67, 2019, <https://doi.org/10.3390/joitmc5030067>.

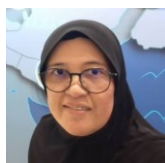
BIOGRAPHY OF AUTHORS



Mazura Mat Din, Ph.D. is a Senior Lecturer at [School of Computing](#) and Mathematics, College of Computing, Mathematics and Media, Universiti Teknologi Mara (UiTM) Kedah. She is an active member of IEEE, MBOT, and IACSIT. She is the Coordinator for the Diploma of Computer Science (CDCS110) and Degree of Information Systems (Hons.) Intelligent Systems Engineering (CDCS259) programs. Her major research interests revolve around Information Security and Assurance, including Network/Digital Forensic and Computational Engineering, Pipeline Integrity Assessment, Risk Assessment, and Data Mining. She has experience in Machine Learning, Soft Computing Techniques and Hybrid Artificial Intelligent applications. Mazura received a Bachelor's degree in Computer Systems, an MSc degree in Computer Science (Systems and Communication), and a PhD in Computer Science (Computational Engineering) from Universiti Teknologi Malaysia (UTM), Malaysia in 1997, 1998, and 2014 respectively. She also does training and consultancy on Application Development, Computer Security Awareness programs, and usability testing for various organizations, from local government agencies to software-based companies. She authorized several textbooks and research journals related to Computer Science and Computer Security. Email: mazuramd@uitm.edu.my. Orcid ID: 0000-0002-9814-1316.



Shaifizat Mansor is a Senior Lecturer at School of Computing and Mathematics, College of Computing, Mathematics and Media, Universiti Teknologi Mara (UiTM) Kedah. She is an active member of IEEE. She is the senior lecturer for the Diploma of Computer Science (CDCS110) programs at UiTM Kedah Campus. With a career spanning over two decades, her major research interests revolve around Data Communication and Networking, specifically in communication protocols and network architectures. Through her research, she aims to address critical challenges in the field and shape the future of data communication and networking. She has experience teaching subjects for Diploma students, such as Computer Organization, Digital Electronics, and Practical Approaches of Operating Systems. Shaifizat received a Bachelor of Computer Science from UPM (2001) and MSc in Information Technology from UUM (2004). Email: shaifizat@uitm.edu.my.



Siti Rafidah Muhamat Dawam is currently a Senior Lecturer and Head of School at the School of Computing and Mathematics, College of Computing, Mathematics and Media, Universiti Teknologi Mara (UiTM) Kedah. Among subjects conducted by her is Database Management, both a Diploma and degree program, Information System Development, and Computer and Information Processing. Her major research interests include Machine Learning, specifically Pattern Recognition and Database Management. Siti Rafidah received a Bachelor's degree in Psychology from the International Islamic University of Malaysia in

1997 and an MSc in Information Technology from Universiti Sains Malaysia in 2001. Email: srafidah192@uitm.edu.my.



Andria, a full-time lecturer at the Information Systems Study Program, Faculty of Engineering, University of PGRI Madiun, and also the founder of PT. Elsada Media Group. Has experience collaborating on various website and application development projects in educational, government, corporate, and MSME institutions. Published several books and journals on information systems, security testing, and digital forensics. Passed several national and international certifications, such as MTA, MCE, MOS, MTCRE, IC3 Digital Literacy, and CITPM. Actively fills various IT workshops and seminars as a resource person. Email: andria@unipma.ac.id. Orcid ID: <https://orcid.org/0000-0002-4581-7167>.



Ridam Dwi Laksono, a Full-time lecturer in Electrical Engineering at FT University of PGRI Madiun, has experience in IT Technology Research in education. Passed international certification for proxy networks to MTCRE. He actively developed the world of student affairs and PASKIBRAKA scouting until he won the Purple MPG Badge from the Ministry of Youth and Sports in 2015. Email: ridam.dl@unipma.ac.id. Orcid ID : <https://orcid.org/0000-0002-0445-2309>.



Kelik Sussolaikah, a Full-time lecturer in the Informatics Engineering Study Program, Faculty of Engineering, University of PGRI Madiun. Apart from actively teaching at the Informatics Engineering Study Program, he is also active in managing scientific journals as a reviewer and editor. Email: kelik@unipma.ac.id. Orcid ID: <https://orcid.org/0000-0002-7401-622X>.