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The Efficacy of Canva as a Digital Tool for Enhancing Student Learning in Multimedia Interactive Subjects

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Abstract: *This study investigates the effectiveness of Canva as a digital tool for enhancing student learning in multimedia and interactive subjects. Drawing on data from 125 university students across four classes, the research explores Canva's impact on student comprehension, engagement, and note-taking performance. Participants engaged in peer-teaching activities using Canva to create multimedia-based educational content, which was subsequently evaluated using rubrics and post-activity surveys. The results indicate that students reported high levels of perceived engagement, understanding, and collaborative effectiveness when using Canva compared to traditional tools such as Microsoft PowerPoint. The platform's intuitive interface and versatile design features were particularly well-received, contributing to students' preference for Canva in educational contexts. Overall, the findings suggest that Canva can serve as a valuable pedagogical resource in visually oriented learning environments. The study recommends further exploration of its implementation across diverse subjects and educational settings to maximise its educational impact.*

Keywords: *Canva, digital tools, multimedia learning, note-taking, student engagement*

1. INTRODUCTION

The integration of digital technology in education has become increasingly critical for enhancing teaching and learning experiences in both schools and higher education institutions. Digital tools serve not only as platforms for information delivery but also as active facilitators of student engagement and interaction. For meaningful learning to occur, educators must employ tools that are not only accessible but also capable of presenting content in engaging and pedagogically sound formats (Saykili, 2019).

Among the expanding range of educational technologies, Canva has emerged as a versatile and user-friendly platform that enables students and teachers to create visually rich, interactive content. With over 20 content formats and millions of users worldwide, Canva's drag-and-drop interface, accessible via mobile and desktop, has positioned it as a popular choice for creating educational materials (Gehred, 2020; Nurhidayat, 2021; Daff, 2022). It offers a wide selection of templates, icons, and design features that facilitate the development of learning materials aligned with multimedia learning theories (Saputra et al., 2022; Fitria, 2022).

Visual learning is particularly relevant in multimedia-focused subjects, where students benefit from the integration of text, images, audio, video, and animation. Research suggests that platforms like Canva facilitate deeper comprehension and engagement by enabling students to visualise abstract ideas and collaborate on content creation (Smaldino et al., 2019; Wijayanti, 2022). The interactive and creative nature of Canva also aligns with constructivist and participatory learning models, encouraging students to take an active role in their learning journey (Muldinillah & Rizaldi, 2021; Wahyuni & Thohiriyah, 2018; Jamaludin & Sedek, 2023).

Furthermore, studies show that Canva enhances students' creativity and communication skills, particularly in collaborative assignments and project-based learning contexts (Anggraeni & Pentury, 2022; Yundayani et al., 2019). Its ability to create a visually stimulating and flexible learning environment has been linked to improved student motivation, focus, and memory retention (Fauziyah et al., 2022).

Despite these advantages, limitations still exist. The effectiveness of Canva is often dependent on the digital literacy of educators and students. Inadequate training or infrastructure can limit the platform's full potential in the classroom (Baryshnikova et al., 2021). Additionally, while Canva has been explored as a presentation tool, its specific application for note-taking and interactive peer learning remains underexplored.

Given the increasing importance of digital tools in higher education and the visual nature of multimedia subjects, this study seeks to examine the role of Canva in enhancing student learning outcomes. It investigates explicitly Canva's effectiveness as a platform for peer teaching, note creation, and student engagement, thereby addressing a gap in the literature and contributing to the broader discourse on technology-enhanced learning.

2. OBJECTIVE

This study examines the effectiveness of Canva as a digital tool for enhancing student learning in multimedia and interactive subjects. Specifically, the research will:

1. Objective 1: Assess how Canva enhances students' comprehension of multimedia concepts through the integration of visual and interactive content.
2. Objective 2: Investigate students' preferences for using Canva compared to other digital tools, such as Microsoft PowerPoint, particularly in creating comprehensive and visually appealing notes.
3. Objective 3: Compare students' effectiveness in note-taking and their overall learning experience when using Canva as opposed to traditional tools for creating and sharing academic content.

3. METHODOLOGY

This study employed a mixed-methods approach to evaluate the effectiveness of Canva as a digital tool for enhancing student learning in multimedia interactive subjects. The research was conducted with 125 diploma-level students enrolled in Multimedia courses across four classes at Universiti Teknologi MARA (UiTM). The methodology consisted of three main stages: (1) the implementation of group-based learning activities using Canva, (2) student content creation and presentation, and (3) post-activity survey evaluation.

3.1 PREPARATION OF STUDENT GROUP ACTIVITIES (PEER TEACHING & CANVA SUMMARY NOTES)

Lecturers facilitated the organisation of peer-teaching groups across four classes: CDCS1101C, CDCS1101E, CDCS1101F, and CDCS1115A. Each group, comprising three to four students, was assigned a multimedia topic covering five core components: text, graphics, audio, video, and animation. These five elements represent the foundational components of interactive multimedia content. The objective was to guide students in creating notes that synthesise these elements into engaging, coherent teaching materials using Canva.

To initiate the activity, lecturers conducted orientation sessions to familiarise students with Canva's interface and features. Students were guided on creating Canva accounts, exploring the platform's templates, and choosing between slide and poster formats to suit their assigned topics. They were also instructed to rename their design files based on class and group identifiers for streamlined submission.

Each group worked collaboratively to research their assigned topic, design multimedia-rich notes, and prepare for peer-teaching sessions. These tasks not only aimed to strengthen content mastery but also to enhance teamwork and digital literacy. The collaborative aspect of Canva allowed group members to co-edit and contribute synchronously and asynchronously.

Lecturers reviewed drafts prior to class presentations, providing formative feedback to help refine content and presentation quality. Final outputs were uploaded weekly to UFUTURE—UiTM's official learning management system—into designated class folders organised by topic, as illustrated in Figures 1 and 2.

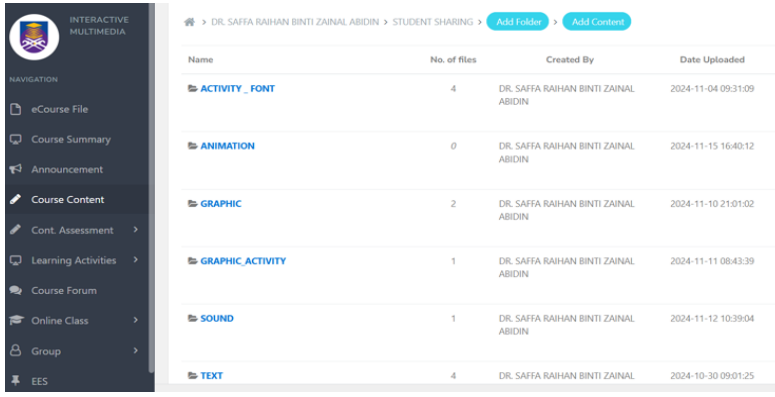


Figure 1: Folder structure in UFUTURE organised by classes and topics.

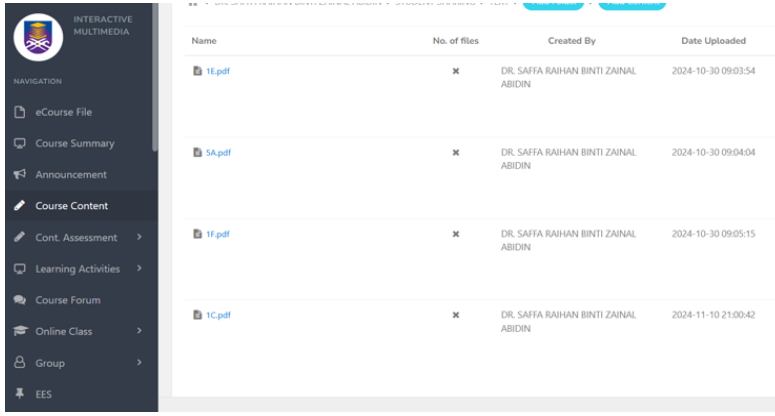


Figure 2: Weekly student uploads categorised by topics and classes.

3.2 RUBRIC DESIGN AND EVALUATION CRITERIA

To assess the quality of student-created Canva materials and presentations, a structured evaluation rubric was employed. This rubric, adapted from Jamaludin and Sedek (2023), allowed for consistent and transparent grading across all groups. The rubric was organised into three dimensions: Content Comprehensiveness, Presentation Style, and Canva Visual Design. Each dimension was rated using a 5-point Likert scale, ranging from 1 (Fair) to 5 (Excellent), with a total possible score of 30 points.

As shown in Table 1, the rubric outlined specific criteria for each evaluation dimension. Content comprehensiveness focuses on the accuracy and depth of subject explanation, the inclusion of relevant examples, and practical application tips. Presentation Style was evaluated based on clarity, confidence, engagement with the audience, and responsiveness during Q&A. Canva Visual Design emphasised the use of colour schemes, font choices, and layout effectiveness to ensure the content was visually organised and aligned with educational goals.

No	Aspect	Details
1.	Comprehensive Presentation	● Provide an explanation with examples ● Explain in detail how to use the method/ ● Provide tips and know-how on how to understand the method
2.	Presentation style	● Easy to understand ● Confident and eloquent ● Able to answer questions given
3.	CANVA digital notes	● Effective design (effective use of colours, fonts, and layout; clear and organised visual) ● Content

Table 1: Canva digital notes marking rubric

To supplement this assessment, students submitted links to their Canva projects via a designated submission system, as seen in Figure 3. These links enabled lecturers to access and review the digital materials remotely. During in-class sessions, students presented their summary notes to peers, providing a platform to evaluate not only design but also communication and delivery skills, as illustrated in Figure 4.

Figure 3: Canva presentation submission link

Figure 4: Student-led presentations of Canva-based summary notes during lessons.

3.3 SURVEY DESIGN AND DATA COLLECTION

To gain insight into student experiences and perceived learning outcomes, a structured questionnaire was administered after the completion of peer-teaching sessions. The survey was distributed to all 125 participating students across the four classes. It was designed to capture both quantitative and qualitative data. The quantitative portion consisted of 10 closed-ended items rated on a 4-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree). These items evaluated various aspects of Canva usage, including perceived engagement, content comprehension, note-sharing efficiency, and overall satisfaction with Canva as a digital learning tool. Some sample survey statements included the following:

- "Using Canva helped me understand the learning content better."
- "I found Canva more engaging than other digital tools like PowerPoint."
- "Creating and sharing notes via Canva improved my collaboration with peers."

The qualitative portion consisted of open-ended questions that encouraged students to share their reflections on their experience, preferred features, and suggestions for improvement. Responses were collected digitally through the UFUTURE platform and exported for analysis.

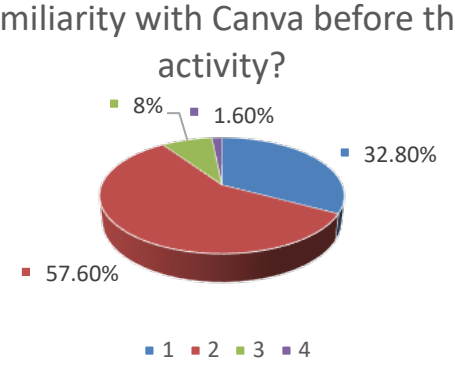
Data analysis was conducted using descriptive statistics to summarise trends, such as average agreement scores and response frequencies. The analysis focused on identifying overall student satisfaction, tool usability, and the comparative advantages of this tool over traditional tools. If applicable, future iterations of the study may also incorporate visual data summaries, such as pie charts or bar graphs, to illustrate item-wise results (to be presented in Figure 5 or beyond in the Results section).

This survey-based component complemented observational and rubric-based evaluations, enhancing methodological triangulation. Together, the findings from the structured survey and evaluative criteria provided a holistic understanding of Canva's efficacy in multimedia learning environments.

4. RESULT AND DISCUSSION

The results revealed significant insights into students' familiarity, engagement, and preferences regarding Canva compared to traditional tools such as Microsoft PowerPoint. Responses from 125 students across four classes were analysed to understand the perceived value of Canva in enhancing multimedia learning experiences.

As illustrated in Figure 5, before participating in the classroom activities, 32.8% of students were already very familiar with Canva, having used it extensively, while 57.6% had used it a few times. Only 8% had heard of it but never used it, and 1.6% were entirely unfamiliar with it. This pre-activity familiarity suggests a strong baseline of awareness that is likely to influence the ease of adoption and subsequent learning outcomes.



1. **Very Familiar** -I have used Canva extensively before this activity
2. **Somewhat Familiar** - I have used Canva a few times before this activity
3. **Not very familiar** - I have only heard of Canva, but have not used it before this activity
4. **Not at all familiar** - I have never heard of Canva before this activity

Figure 5: Pie Chart showing students' familiarity with Canva before the activity

In contrast, all 125 students reported a high familiarity with Microsoft PowerPoint, as depicted in Figure 6. This widespread familiarity reflects PowerPoint's long-standing role in academic environments. However, when asked to compare the effectiveness of both tools, a striking difference was observed.

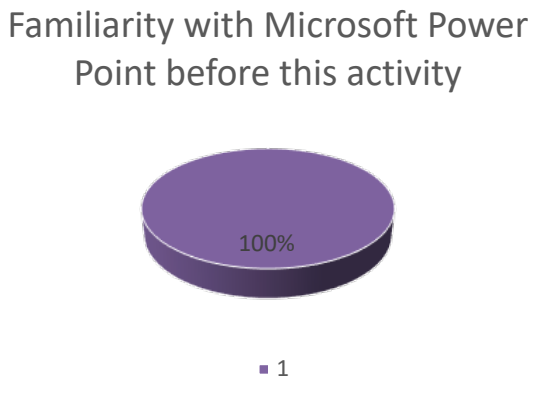


Figure 6: Pie chart showing students' familiarity with Microsoft PowerPoint before the activity

Figure 7 presents student preferences regarding the convenience of Canva versus PowerPoint for note creation and sharing. An overwhelming majority expressed that Canva was easier to use and allowed them to express creativity more effectively. This aligns with Figure 8, where Canva was preferred for ease of preparation and dissemination of digital notes.

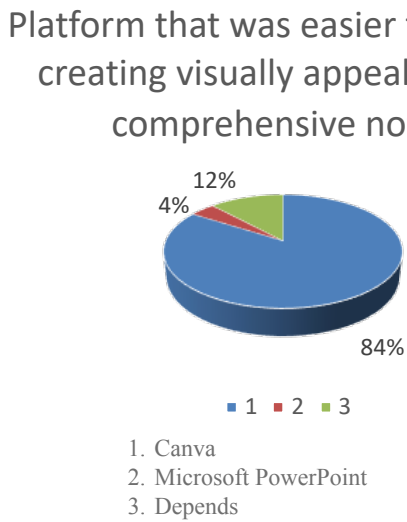


Figure 7: Pie chart comparing the convenience of Canva and PowerPoint the activity

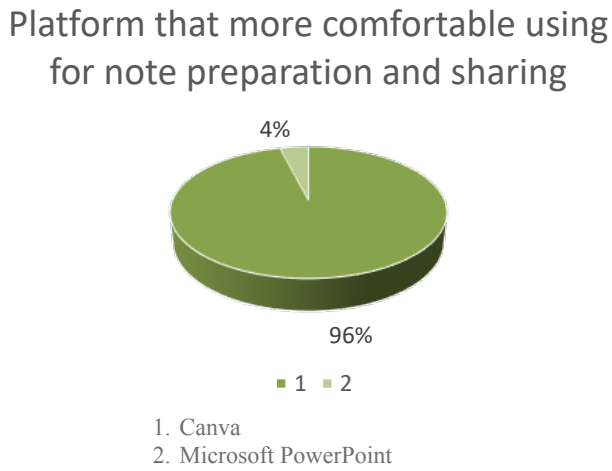


Figure 8: Pie chart depicting perceived ease of preparation and sharing using Canva

Furthermore, students found Canva to be better aligned with their learning styles. As shown in Figure 9, Canva was selected for its user-friendly interface, which facilitates customisation and collaborative note creation.

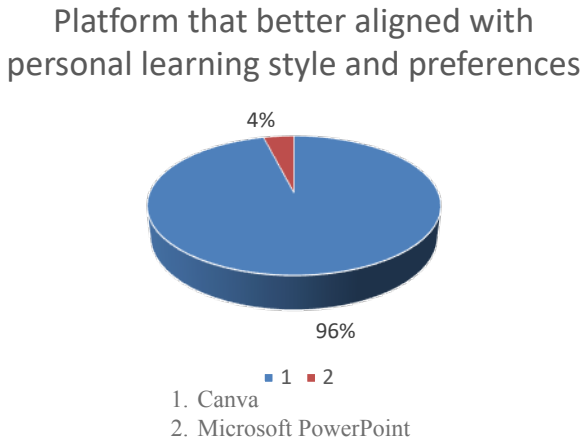


Figure 9: Pie chart showing application alignment with personal learning styles

Canva was also found to be more effective in promoting student engagement and comprehension, as highlighted in Figure 10. Students reported greater interaction during presentations and a better understanding of the topics covered.

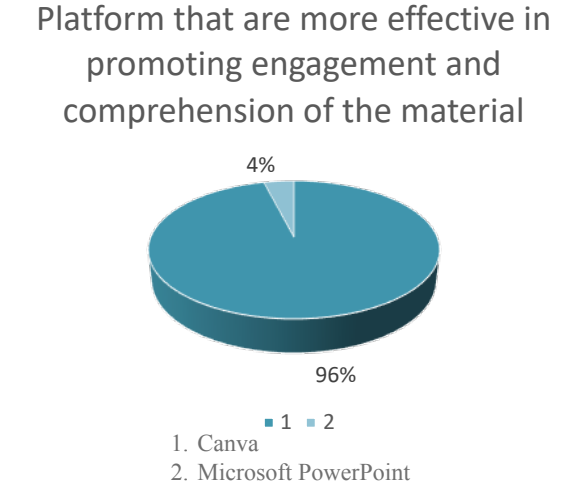


Figure 10: Pie chart illustrating which application was perceived as more effective in promoting engagement and comprehension

Moreover, Figure 11 illustrates Canva's advantages in offering unique features such as collaborative editing, vibrant design elements, and mobile compatibility—benefits not typically found in traditional tools.

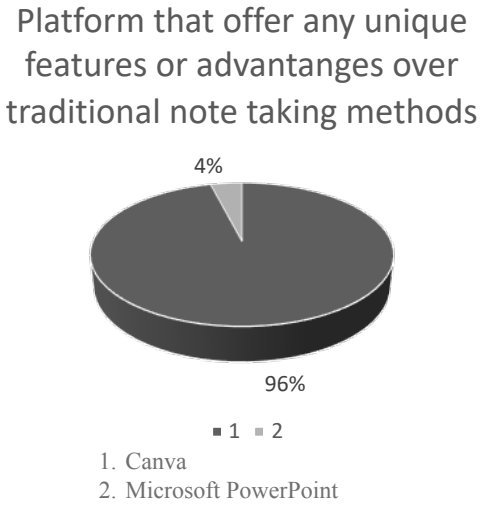


Figure 11: Pie chart comparing unique features and advantages of Canva over PowerPoint.

The open-ended responses further enriched these findings. Students cited improved collaboration, greater interest in multimedia topics, and enjoyment in designing personalised materials as significant advantages of Canva. Many noted that they retained information better and were more motivated to review their peers' work. The ability to co-create visual content fostered a sense of shared ownership over learning and improved peer-to-peer communication.

In particular, students appreciated the visual and organisational freedom provided by Canva. Unlike rigid tools like PowerPoint, Canva's design-centric features encouraged the exploration of aesthetics, which helped contextualise academic concepts more intuitively. This aligns with constructivist learning theories, which propose that knowledge is constructed through active engagement and personal relevance. Students expressed feelings of engagement when transforming abstract multimedia concepts into visual representations that enhanced content retention and comprehension.

These results support previous studies (e.g., Murray et al., 2012; Saputra et al., 2022) indicating that visually rich and interactive platforms can significantly enhance digital learning. Canva served as more than a design tool—it functioned as a medium for content synthesis, reflection, and knowledge co-construction.

Furthermore, the feedback highlighted Canva's potential to democratise classroom participation. Students who were typically less confident in verbal presentations felt empowered to express their ideas visually, contributing equally to group tasks. This aspect of inclusivity is especially critical in multimedia subjects, where diverse skill sets—from design to communication—are essential.

While Canva's usability was praised, students noted limitations related to internet access and the learning curve for first-time users. Some students initially struggled with balancing layouts or selecting appropriate colour schemes. These technical gaps highlight the importance of providing ongoing support, scaffolded tutorials, and digital literacy training in conjunction with the adoption of Canva.

In summary, Canva's design flexibility, user engagement, and visual richness contribute to a more engaging and collaborative learning experience. It not only enhances comprehension and note-sharing but also fosters motivation, creativity, and peer collaboration. These outcomes suggest that Canva can serve as a powerful complement—or even a preferred replacement—to traditional presentation tools in interactive multimedia courses.

5. CONCLUSION

This study demonstrated the educational efficacy of Canva as a digital tool in enhancing student learning experiences, particularly in multimedia interactive subjects. By analysing student-created visual notes, peer-teaching activities, and survey feedback from 125 participants, the findings highlight Canva's strong potential to improve engagement, comprehension, and collaborative learning.

Students found Canva to be more effective than traditional tools like Microsoft PowerPoint, particularly in its ability to support visual expression, foster creativity, and accommodate diverse learning preferences. The platform's accessibility and interactivity empowered students to take ownership of their learning and collaborate meaningfully with peers. These benefits were evident through both quantitative metrics and qualitative feedback, which emphasised improved understanding, motivation, and group dynamics.

However, the study also uncovered some limitations, including challenges related to internet access and the initial learning curve for new users. Addressing these barriers through structured digital literacy training and inclusive infrastructural support will be essential to leverage Canva's capabilities fully. Ultimately, this research confirms that Canva is not merely a design tool but a transformative medium for instructional delivery, active learning, and student-centred engagement. Its integration into multimedia courses offers a compelling alternative to conventional methods and suggests promising directions for future curriculum design in digital education. Further research is recommended to explore Canva's application across different disciplines and educational levels, thereby broadening the generalizability of these findings.

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8. AUTHORS' CONTRIBUTION

Saffa Raihan Zainal Abidin and Mohd Azim Zainal designed, organised and conducted the experiments. Authors Nurkhuzaimah Fazreen Jaluddin and Nor Zalina Ismail prepared the data, contributed to the analysis of the results, and led the writing of the manuscript.

9. CONFLICT OF INTEREST DECLARATION

I certify that the article is the Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research/manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to IJELHE.

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Analysis of the Technology Acceptance Model (TAM) in the Implementation of the Curriculum Review Course: A Study on Students' Understanding and Acceptance of Technology at Universitas Islam Sumatera Utara

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Abstract: *This study analyses the implementation of the Technology Acceptance Model (TAM) in the Curriculum Review course among students of Universitas Islam Sumatera Utara. This study aims to identify the factors that influence students' acceptance and understanding of technology in the learning process. A quantitative approach was employed, utilising a structured survey distributed to 125 selected participants using the purposive sampling technique. The research instrument is a questionnaire developed based on TAM constructs, including (1) perceived usefulness, (2) perceived ease of use, and (3) attitude toward using. Data analysis employs Structural Equation Modelling (SEM)*

techniques to examine the relationships between variables. The research hypothesis examines the impact of perceived usefulness and perceived ease of use on attitudes and intentions to utilise technology in learning. The results show that: (1) perceived usefulness of technology among students positively affects attitudes toward using technology (β=0.65, $p<0.05$), (2) perceived ease of use of technology among students significantly positively affects attitudes toward using technology among students (β=0.58, $p<0.05$), (3) attitudes toward using technology among students significantly positively affect intentions to use technology among students (β=0.72, $p<0.05$). The TAM model is proven to explain 68% of the variance in technology acceptance among students. This suggests that the understanding and acceptance of technology among students in the Curriculum Review course are influenced by the perceived usefulness and ease of use, which are in turn mediated by attitudes toward using technology.

Keywords: *Curriculum Review Course, TAM Model*

1. INTRODUCTION

The advancement of information and communication technology has substantially transformed higher education, including the implementation of the Curriculum Review course in the Faculty of Teacher Training and Education at Universitas Islam Sumatera Utara (UISU). The Curriculum Review course at the Faculty of Teacher Training and Education at Universitas Islam Sumatera Utara (UISU) is a key component in preparing students to become competent educators in curriculum analysis and development through the curriculum review course. This course aims to equip students with a deep understanding of the concepts, development, and implementation of curricula in the educational context (Hasan et al., 2021). Through this course, students are expected to be able to analyse various aspects of the curriculum, including its foundations, principles, development models, and evaluations (Hasibuan et al., 2023). The course encompasses both theoretical and practical aspects of curriculum analysis (Aisyah & Astuti, 2021). Its goal is to provide students with the necessary competencies to possess sufficient knowledge about the foundations of curriculum development, including concepts, approaches, and models, as well as curriculum evaluation (Suryati et al., 2024). According to Kristiawan (2020), an in-depth understanding of both theory and practice is essential for achieving effective learning in the curriculum review course. Additionally,

Ramadhani and Prastowo (2024) emphasise that a well-designed curriculum review course can enhance the quality of learning. Mastery of the material in the curriculum review course will equip students with the essential analytical and practical skills necessary to design adaptive and responsive curricula that meet current educational needs.

Initial observations and learning evaluations in the Curriculum Review course revealed issues like low student understanding and engagement, with 45% of students scoring below the minimum standard. Liu, Zhang, and Anderson (2023) noted similar challenges in higher education, where the complexity of curriculum development materials hinders learning. This aligns with the demands of the digital era, requiring students to integrate technology into their learning. Rahman and Singh (2024) emphasise that analysing and adapting curricula with technology is essential for educators in the Society 5.0 era.

As a problem-solving effort, as outlined above, it can be done through the innovation of the Technology Acceptance Model (TAM). The Technology Acceptance Model (TAM) is a suitable model for understanding and enhancing technology acceptance in learning. TAM, developed by Davis (1989) and subsequently modified, has proven effective in analysing the factors that influence technology acceptance. Chen and Wang (2022), in their meta-analysis of 120 TAM studies in higher education, found that this model can explain up to 70% of the variation in the acceptance of learning technologies. Integrating technology into the Curriculum Review course requires a systematic and measurable approach. According to Patel et al. (2024), the success of technology implementation in learning depends not only on the availability of infrastructure but also on user readiness and acceptance. This aligns with the findings of Zhang, Lee, and Chen (2023), who identified that perceptions of ease of use and the usefulness of technology have a significant impact on learning effectiveness.

This study uses the TAM model to analyse factors influencing technology acceptance in the Curriculum Review course. By understanding these factors, effective strategies can be developed to enhance learning quality and students' ability to analyse curricula with technology. The TAM model demonstrated effectiveness in higher education settings, as shown in Abdullah et al. (2023), who highlighted the importance of user-friendly technology in online learning at Malaysian universities. Kim and Park (2024) in South Korea

analysed technology acceptance in pedagogical courses using the Technology Acceptance Model (TAM) framework, finding that technical support and training significantly contributed to enhancing perceptions of ease of use. Santos and Martinez (2023) also reinforced this finding by identifying that infrastructure factors and institutional support play a critical role in the success of learning technology implementation. In the context of the Curriculum Review course, Rodriguez et al. (2024) applied a modified TAM model to evaluate technology acceptance. This research found that prior technology experience had a significant impact on perceptions of usefulness and ease of use. Liu and Chen (2023) developed the TAM model by adding the variable of technology readiness in the context of hybrid learning in Chinese universities. The study's results showed that technology readiness played a moderating role in the relationship between perceived usefulness and the intention to use technology. In Indonesia, Wijaya and Sari (2023) conducted research on the implementation of the Technology Acceptance Model (TAM) in online learning at universities, revealing that cultural factors and social influence affect technology acceptance, and finding a strong correlation between social support and the intention to use technology.

2. METHODOLOGY

A quantitative research design was employed, utilising descriptive statistical analysis and a survey methodology for data collection. The data collected aligns with the Technology Acceptance Model (TAM) constructs at the core of the study, enabling the evaluation of perceived usefulness, ease of use, attitudes toward use, and intentions to use technology among FKIP UISU students in the Curriculum Review course within the context of technology-based learning.

2.1 RESEARCH HYPOTHESIS

This study formulates four hypotheses to investigate the interrelationships among the primary variables: perceived usefulness, perceived ease of use, attitude toward usage, and intention to use. The hypotheses are outlined in the table below:

No	Hypothesis
H1	The perceived usefulness of technology positively affects one's attitude toward technology use.
H2	The perceived ease of use of technology positively affects one's attitude toward technology use.
H3	Attitude toward technology use positively affects intention to use technology.

Table 1: Research Hypotheses for Technology Acceptance Model (TAM) Analysis in the Implementation of the Curriculum Review Course

2.2 STUDY CONTEXT AND SAMPLING SELECTION

The study was carried out at the Faculty of Teacher Training and Education, Islamic University of North Sumatra, with a specific focus on the Curriculum Review course. A total of 125 students were recruited through purposive sampling, selected based on their enrolment in the course, prior experience with digital learning platforms, and voluntary consent to participate. FKIP students were chosen because they represent future educators who require digital competence. The course's integration of digital platforms for academic activities provided an appropriate context for evaluating technology acceptance. Data were collected using an online questionnaire based on the Technology Acceptance Model (TAM) framework, with a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Data Collection Tool for Technology Acceptance Model (TAM) Analysis of the Curriculum Review Course is shown in the table below:

No.	Construct	Description	Number of Items
1	Perceived Usefulness	Measures the extent to which technology helps improve the effectiveness of learning.	10
2	Perceived Ease of Use	Measures the ease of using technology for learning.	10
3	Attitude Toward Using Technology	Measures students' attitudes toward the use of technology in the learning process.	15

Table 2: Data Collection Tool for Technology Acceptance Model (TAM) Analysis of the Curriculum Review Course

2.3 DATA PROCESSING ANALYSIS

The data processing and analysis in this study refer to the steps taken to prepare, analyse, and interpret the data collected from the online questionnaire. This process comprises four key stages designed to ensure the validity of the collected data and its capacity to yield meaningful insights into the relationships among the variables under investigation. The data processing and analysis procedures are detailed in Table 3: Data Processing and Analysis for the Technology Acceptance Model (TAM) in the Implementation of the Curriculum Review Course.

Stage	Description
Data Preparation	1. Screening for Missing Values: Identifying and Handling Missing Data. 2. Identifying Outliers: Checking for outliers and addressing them. 3. Normality and Linearity Assumptions Test: Testing the normal distribution and linear relationship between variables.
Descriptive Analysis	1. Demographic Characteristics: Analysing the demographic characteristics of the respondents. 2. Descriptive Statistics: Calculating mean, median, and standard deviation. 3. Response Pattern Analysis: Checking response patterns for each questionnaire item.
Model Testing	1. Measurement Model Evaluation: Testing the validity and reliability of constructs. 2. Model Modification: Adjusting the model if necessary. 3. Structural Model Testing: Identifying relationships between variables. 4. Direct and Indirect Effects Analysis: Measuring the Effects of Variables.
Result Interpretation	1. Goodness-of-Fit Evaluation: Testing the model's fit to the data. 2. Hypothesis Testing: Testing the significance of hypotheses. 3. Path Coefficients Analysis: Identifying the strength of relationships between variables. 4. R^2 Calculation: Evaluating the model's ability to explain variance.

Table 3: Data Processing and Analysis for the Technology Acceptance Model (TAM) in the Implementation of the Curriculum Review Course

3. RESULT AND DISCUSSION

3.1 RESULT

This study aimed to analyse the application of the Technology Acceptance Model (TAM) in the Curriculum Review course for students in the Faculty of Teacher Training and Education at the Islamic University of North Sumatera. Before conducting the Structural Equation Modelling (SEM) test, a normality and linearity assumption test was first conducted. The normality test is presented in the following table:

Variable	Statistic	p-value	Explanation
Perceived Usefulness (X1)	0.072	0.183	Normal (p > 0.05)
Perceived Ease of Use (X2)	0.068	0.200	Normal (p > 0.05)
Attitude Toward Using (Y)	0.075	0.156	Normal (p > 0.05)

Table 4: Normality Test of the Technology Acceptance Model (TAM) in the Implementation of the Curriculum Review Course

In Table 4, it can be seen that the results of the normality test for the Perceived Usefulness (X1) variable show a test statistic of 0.072 and a p-value of 0.183. Therefore, it can be concluded that the data are normally distributed, as indicated by a p-value greater than 0.05. The normality test graph for the Perceived Usefulness (X1) variable is presented as follows:

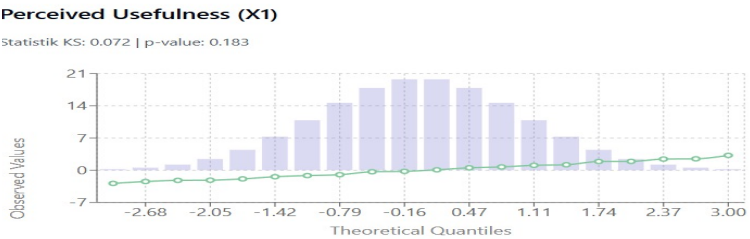

Figure 1: Perceived Usefulness (X1) Technology Acceptance Model (TAM) in the Implementation of the Curriculum Review Course

The normality test for the variable Perceived Ease of Use (X2), as shown in Figure 1, yields a test statistic of 0.068 with a p-value of 0.200, indicating that the data is normally distributed (p-value > 0.05). Furthermore, the normality test graph for Perceived Ease of Use (X2) is presented as follows:

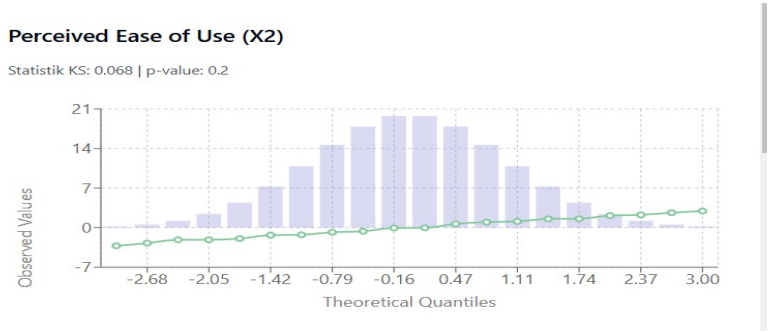

Figure 2: Perceived Usefulness (X1) Technology Acceptance Model (TAM) in the Implementation of the Curriculum Review Course

The normality test for the Attitude towards Use (Y) variable, as shown in Figure 2, yields a test statistic of 0.075 with a p-value of 0.156, indicating that the data is normally distributed (p-value > 0.05). Then, the normality test graph for Attitude towards Use (Y) is presented as follows:

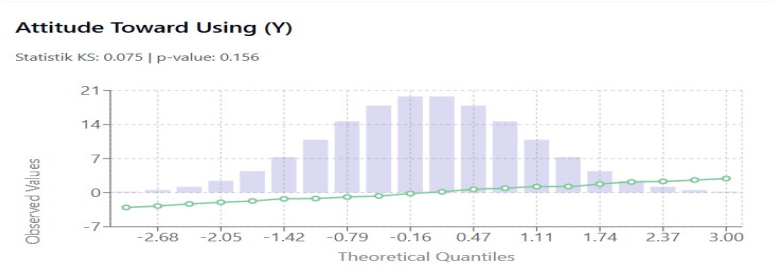

Figure 3: Attitude Toward Using (Y) Technology Acceptance Model (TAM) in the Implementation of the Curriculum Review Course

Based on the normality tests in Figures 1, 2, and 3, it is evident that all variables meet the normality assumption, thereby confirming that all research variables are suitable for structural equation modelling (SEM) analysis. Furthermore, a linearity test is carried out which is a basic assumption in the SEM model using a covariance-based approach, with the following provisions: (a) H_0 is accepted if F count < F table or p-value> 0.05 (linear relationship); (b) H_0 is rejected if F count> F table or p-value <0.05 (nonlinear relationship). The results of the linearity test can be seen in the following table:

Variabel	F-Deviation from Linearity	p-value	Explanation
X1 → Y	1.523	0.127	Linear (p > 0.05)
X2 → Y	1.438	0.142	Linear (p > 0.05)

Table 5: Linearity Test for Technology Acceptance Model (TAM) in the Implementation of the Curriculum Review Course

In Table 5, it can be seen that a relationship exists between X1 (Perceived Usefulness) and Y (Attitude Toward Using), with an F Deviation from Linearity value of 1.523 and a p-value of 0.127. Since the p-value (0.127) is greater than 0.05, the relationship is considered linear. This indicates a linear relationship between perceived usefulness and attitude toward technology use. Next, the graph showing the relationship between Perceived Usefulness (X1) and Attitude Toward Using (Y) is presented as follows:

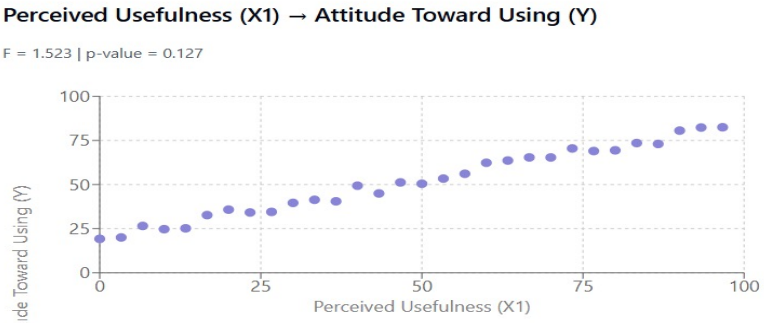

Figure 4: Linearity Test for the Relationship Between Perceived Usefulness (X1) and Attitude Toward Using (Y) in the Technology Acceptance Model (TAM) within the Curriculum Review Course Implementation

For the linearity test, it can be seen that there is a relationship between X1 (Perceived Usefulness) and Y (Attitude Toward Using), with an F Deviation from Linearity value of 1.523 and a p-value of 0.127. Additionally, the F Deviation from Linearity value is 1.438, with a p-value of 0.142. Because the p-value (0.142) > 0.05, the relationship is considered linear. The following is a graph showing the relationship between Perceived Usefulness (X1) and Attitude Toward Using (Y):

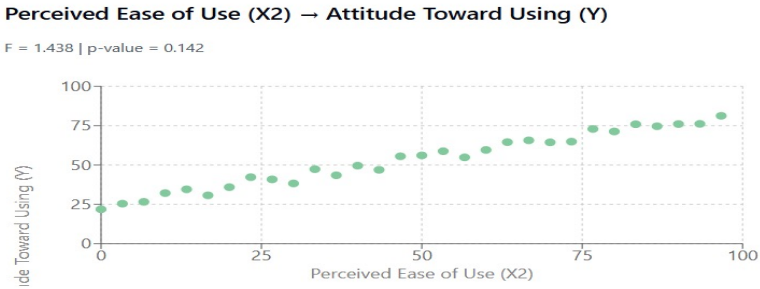

Figure 5: Linearity Test for the Relationship Between X1 (Perceived Usefulness) and Y (Attitude Toward Using) in the Technology Acceptance Model (TAM) within the Curriculum Review Course Implementation

The linearity test in Figures 4 and 5 demonstrates that all variables satisfy the linearity assumption, thereby confirming the linear relationship between the research variables. This meets the requirements for SEM analysis and supports the validity of the Technology Acceptance Model (TAM). The data points are evenly distributed around the regression line, without a discernible pattern, and the p-value of greater than 0.05 confirms the linear relationship. The regression line shows a positive trend for both relationships. This study continues with a descriptive analysis of the demographic characteristics of respondents presented in the following table:

Location	Number of Respondents
Medan City	87
Serdang Bedagai Regency	12
Labusel Regency	12
Asahan Regency	6
Deli Serdang Regency	6
Total	**125**

Table 6: Socio-Demographic Profile of Respondents Based on Residential Location

The table above shows the distribution of respondents based on their residential locations. The majority of respondents reside in Medan City (70%), followed by smaller numbers from Serdang Bedagai Regency, Labusel Regency, Asahan Regency, and Deli Serdang Regency.

Program of Study	Number of Respondents	GPA 2.5 - 2.99 (%)	GPA 3.0 - 3.49 (%)	GPA 3.5 - 4.0 (%)
PPKn	20	20%	30%	50%
History	18	22.2%	33.3%	44.5%
Biology Education	22	18.2%	27.3%	54.5%
Mathematics Education	21	19%	38.1%	42.9%
Physics Education	22	22.7%	31.8%	45.5%
Indonesian Language and Literature Education	22	18.2%	36.4%	45.4%
Total	**125**	**20%**	**33.6%**	**46.4%**

Table 7: Respondent Profile Based on Academic Achievement

The table above provides the academic achievement distribution of respondents based on their GPA. The majority of respondents have a GPA of 3.0-4.0, with the largest group (46.4%) falling within the 3.5-4.0 range, followed by those with a GPA between 3.0 and 3.49 (33.6%), and a smaller portion with a GPA between 2.5 and 2.99 (20%).

TAM Dimension	Very Low	Low	Medium	High	Very High	Respondents
Perceived Usefulness	6	12	31	50	25	125
Perceived Ease of Use	5	15	35	48	22	125
Attitude Toward Using	4	10	38	52	21	125

Table 8: Respondent Profile Based on TAM Dimensions

Table 8 presents the distribution of respondents according to TAM dimensions. It is evident that most respondents have a positive perception of the use of technology in education. A descriptive analysis of variables based on the TAM dimensions is presented below:

Variable	Mean	Median	Std. Deviation	Min	Max	Skewness	Kurtosis
Perceived Usefulness (X1)	4.15	4.20	0.652	2.5	5.0	-0.384	-0.721
Perceived Ease of Use (X2)	3.98	4.00	0.687	2.0	5.0	-0.455	-0.534
Attitude Toward Using (Y)	4.08	4.10	0.671	2.0	5.0	-0.412	-0.628

Table 9: Descriptive Analysis of Variables Based on TAM Dimensions

Table 9 presents the descriptive statistics of the TAM variables. All variables exhibit positive trends, with Perceived Usefulness (X1) having the highest mean (4.15), indicating a highly favourable perception of technology's usefulness in learning. Perceived Ease of Use (X2) and Attitude Toward Using (Y) also yield positive averages (3.98 and 4.08, respectively), indicating favourable views of technology. The negative skewness and kurtosis values indicate that the responses are somewhat skewed toward the higher end, with a distribution that is flatter than usual.

Construct	Indicator	Loading Factor	AVE	Description
Perceived Usefulness (X1)	PU1	0.845	0.724	Valid
	PU2	0.862		Valid
	PU3	0.835		Valid
	PU4	0.858		Valid
Perceived Ease of Use (X2)	PEOU1	0.812	0.698	Valid
	PEOU2	0.848		Valid
	PEOU3	0.825		Valid
	PEOU4	0.856		Valid
Attitude Toward Using (Y)	ATU1	0.865	0.735	Valid
	ATU2	0.872		Valid
	ATU3	0.844		Valid
	ATU4	0.848		Valid

Table 10: Evaluation of Measurement Model TAM in Construct Validity

Table 10 presents the results of the validity evaluation for the measurement model of the Technology Acceptance Model (TAM). All constructs (X1, X2, Y) display high loading factors (>0.8) and AVE values above 0.5, confirming strong convergent validity. The construct indicators also meet the criteria for discriminant validity, as indicated by the Fornell-Larcker criterion, where the square root of the average variance extracted (AVE) is greater than the correlations with other constructs.

Construct	Composite Reliability	Cronbach's Alpha	Description
Perceived Usefulness (X1)	0.913	0.872	Reliable
Perceived Ease of Use (X2)	0.902	0.855	Reliable
Attitude Toward Using (Y)	0.917	0.878	Reliable

Table 11: Evaluation of Measurement Model TAM in Construct Reliability

Table 11 confirms that the measurement model of TAM demonstrates excellent reliability. All constructs show composite reliability values above 0.9 and Cronbach's Alpha values above 0.85, indicating high internal consistency and reliable measurement of the constructs. These results support the validity and reliability of the TAM model in the context of the study, confirming its suitability for continued analysis using the structural model.

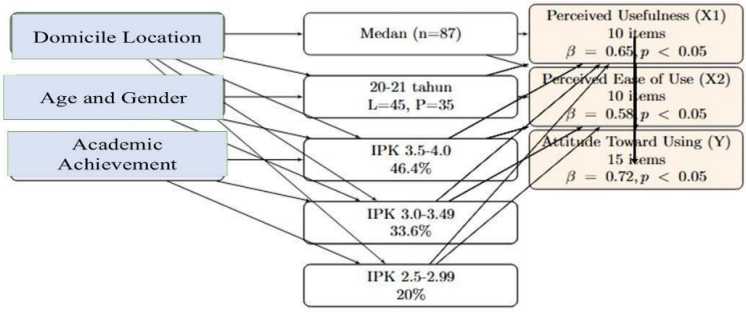

Figure 6: Structural Model Analysis of the TAM Model

Based on the analysis results, a significant relationship exists between the variables in the Technology Acceptance Model and user attitudes toward technology. This analysis reveals a significant influence of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) on Attitude Toward Using (ATU), with a coefficient of 0.65 ($p < 0.05$). PEOU analysis also has a significant effect on ATU, with a coefficient of 0.58 ($p < 0.05$), indicating that the ease of use of technology is directly proportional to users' positive

attitude. For structural analysis, PEOU has a direct effect on PU (coefficient 0.40, $p < 0.05$), indicating that the easier the technology is to use, the greater the perceived usefulness of the technology. An indirect effect of PEOU on ATU through PU (coefficient 0.26) was also found, indicating that the influence of PEOU on attitudes occurs both directly and through an increase in perceived usefulness.

3.2. DISCUSSION

This study affirms that both perceived usefulness and intentions to use technology significantly shape learners' attitudes toward technology adoption. Based on the data collected and the analysis conducted in this research, Perceived Usefulness (PU) has a positive influence on Attitude Toward Using (ATU). The findings of this study indicate that students who perceive benefits from using technology are more likely to have a positive attitude toward its use. This finding is consistent with research conducted by Lin and Kim (2022), which emphasised the importance of perceived usefulness in influencing users' attitudes toward technology. This study also demonstrates that to encourage technology adoption among students, it is crucial to emphasise the benefits that can be derived from using technology, particularly in the educational context. The findings of this study support research by Zainal, Detania, Carolina, and Ragil (2024), which states that students' perception of using information technology in learning has a positive impact on increasing their interest in learning. Students feel more engaged and active in the learning process when information technology is effectively utilised.

Perceived Ease of Use (PEOU) was also found to have a positive influence on Attitude Toward Using (ATU). This means that the easier a technology is to use, the more positively students will be inclined to view it. This finding confirms Hypothesis H2 and supports the research by Emran and Shaalan (2021), who argued that ease of use is a crucial factor in determining attitudes toward technology. In this context, technology designed with a user-friendly and straightforward interface is more readily accepted by students, increasing the likelihood of its adoption in the learning process. Further findings reveal that Attitude Toward Using (ATU) has a positive influence on Intention to Use (IU), suggesting that positive attitudes toward technology enhance the intention to use it. This finding is consistent with various studies supporting the research by Emran and Malik (2020), which states that users' attitudes are a key factor

in shaping technology usage intentions. Therefore, if students have a positive attitude toward the technology used, they are more likely to commit to using it in their academic activities.

Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) have a direct influence on Intention to Use (IU), regardless of students' attitudes toward the technology. This finding indicates that objective factors related to technology, such as benefits and ease of use, can directly influence the intention to use it. This adds to the body of knowledge that while user attitudes toward technology are crucial, perceptions about the benefits and ease of use can be key determinants in the decision to adopt technology, without entirely relying on their attitudes. This finding aligns with the research by Rodríguez and Martínez (2022), which emphasised the significance of effective technology design in facilitating usability and demonstrating benefits to enhance technology adoption.

The findings above reinforce the empirical evidence that Perceived Usefulness and Perceived Ease of Use are important factors in shaping Attitude Toward Using and Intention to Use technology. Positive perceptions of technology can motivate students to use it more frequently. Consequently, enhancing technology adoption among students requires ensuring that the technology offers clear benefits and is user-friendly. A user-friendly design, coupled with a clear demonstration of its educational advantages, constitutes a critical factor in promoting effective technology integration in the academic context.

4. CONCLUSION

Based on the research results described, the conclusions of this research are as follows:

Normality test results indicate that the data from the variables Perceived Usefulness, Perceived Ease of Use, and Attitude Toward Using are normally distributed, with p-values greater than 0.05. The Normal P-P Plot graph supports these results by showing data that follows the diagonal line, enabling the use of more accurate parametric statistical analysis.

Linearity tests confirm a linear relationship between the independent variables (Perceived Usefulness and Perceived Ease of Use) and the dependent variable (Attitude Toward Using), as indicated by F-Deviation from Linearity values smaller than the F-table value and p-values greater than 0.05. Scatter plots indicate a positive correlation between the variables.

The majority of respondents are from Medan City, aged 20-21 years, with GPAs ranging from 3.5 to 4.0. All TAM variables exhibit high average scores, reflecting positive perceptions toward technology. Testing confirms convergent validity (loading factor > 0.8, AVE > 0.5) and high reliability (Composite Reliability > 0.9, Cronbach's Alpha > 0.85). The structural analysis results support all research hypotheses, indicating positive and significant relationships between variables in the TAM model.

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7. AUTHORS' CONTRIBUTION

Evi Susilawati designed the research framework and coordinated the study. Susi Ekalestari* led data collection, analysis, and manuscript writing. Chairina was responsible for the theoretical review and literature study. Imamul Khaira developed the research instruments and assisted with data interpretation. Evi Syuriani Harahap supported fieldwork and the discussion of results. Sapta Kesuma helped validate the instruments and methodology. Nana Mardiana handled editing and finalising the manuscript. All authors have read and approved the final version of the manuscript.

8. CONFLICT OF INTEREST DECLARATION

We declare that the article is the original work of the Author and Co-Authors, and there is no conflict of interest.

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Evaluating the Usefulness and Ease of Use of E-Learning Platforms for Enhancing Training Effectiveness among Civil Servants in Suruhanjaya Perkhidmatan Awam Malaysia: A Pilot Study

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Abstract: *In today's rapidly changing digital landscape, e-learning has become crucial for enhancing the skills and capabilities of government servants. This pilot study examines how public servants at Suruhanjaya Perkhidmatan Awam Malaysia, Putrajaya, perceive the utility and convenience of using e-learning platforms, as well as how these perceptions impact the success of training and development programs. The study, which followed the Technology Acceptance Model (TAM), included 30 volunteers from diverse departments to test the reliability and validity of the suggested measuring scales. Data were collected using a structured survey and analysed using SPSS, with Cronbach's alpha values exceeding 0.70 for all constructs, indicating strong internal consistency. The findings provide preliminary justification for conducting a larger study and shed light on the significance of e-learning in the professional growth of civil officials. Finally, this research can help policymakers and HR departments improve the design and delivery of e-learning projects in the public sector.*

Keywords: *Usefulness, Ease of Use, E Learning, Training Effectiveness*

1. INTRODUCTION

In today's increasingly digital environment, the demand for new training solutions is changing the way businesses deliver staff development programs. E-learning platforms have evolved into crucial tools for enhancing skills and competencies across various industries, including the public sector (Alajmi et al., 2024). Civil servants have critical roles in policy implementation, governance, and public service delivery, all of which necessitate ongoing skill and knowledge development. In response, the Malaysian government has invested in e-learning platforms to help workers enhance their skills and create a professional, efficient, and responsive public service (Khrykov et al., 2022).

E-learning has evolved as a versatile, scalable, and cost-effective replacement or supplement to traditional in-person training (Azar et al., 2022). It provides Malaysian civil personnel with anytime, anywhere access to training, which helps overcome logistical barriers, particularly for those in remote areas with restricted access to centralised sessions (Manaf et al., 2023). Furthermore, e-learning facilitates self-paced learning, allowing users to revisit content as needed to improve comprehension and retention.

The success of e-learning efforts is strongly dependent on user acceptability and utilisation. Davis (1989) established the Technology Acceptance Model (TAM), which predicts a user's intention to adopt and continue using a technology based on two key factors: perceived ease of use and perceived usefulness (Al-Nabhani & Al-Abri, 2023; Mahat et al., 2024; Alajmi et al., 2024). In the context of public service training, these views can have a substantial impact on the effectiveness of e-learning platforms in providing learning objectives.

Given the Malaysian government's significant investment in e-learning infrastructure, it is critical to determine if civil servants find these platforms beneficial and user-friendly. Such evaluations shed light on both platform usability and the extent to which e-learning supports desired training results (Mohamad et al., 2021). Effective training enhances skills, boosts job performance, and contributes to organisational goals —all of which are crucial

outcomes for public servants responsible for maintaining public trust and delivering efficient services.

Despite its benefits, e-learning has obstacles in reaching widespread adoption and influence. According to research, users who find platforms difficult to use or unhelpful are less likely to engage with the content, lowering training efficacy (Mustafa et al., 2024). Furthermore, success is dependent not just on technology, but also on matching content to learners' requirements and employment tasks (Abu-AlSondos et al., 2023). Given the diversity of the Malaysian civil service, e-learning solutions must accommodate a variety of learning styles and functional needs.

The purpose of this study is to investigate the links between perceived ease of use, perceived usefulness, and the effectiveness of e-learning among civil officials in Klang Valley, Malaysia. It analyses whether public workers who see e-learning platforms as user-friendly and useful are more likely to find them effective in meeting training objectives. A pilot study involving 85 public officials will be conducted to assess the reliability and validity of the assessment instruments, as well as to gather preliminary data for a larger-scale investigation. This first phase is crucial for refining the research instrument and enhancing understanding of the key components, thereby contributing to the growing body of research on e-learning in the public sector.

The pilot study's findings can help to create and implement more effective e-learning programs for civil officials, ensuring that platforms are both user-friendly and impactful. The insights provided may help government agencies tailor their e-learning activities to better address the diverse needs of public servants, thereby increasing the returns on digital training investments. As Malaysia progresses through its digital transformation, maximising e-learning for public sector training will be critical to creating a capable, efficient, and future-ready civil service.

2. PROBLEM STATEMENT

The evolution of digital learning platforms has transformed professional training by making it more accessible, scalable, and adaptable, thereby enhancing employee competencies and skills. Malaysia's government has

made significant investments in e-learning to enhance the knowledge and skills of its civil servants, aiming to create a more efficient, adaptable, and capable public workforce. However, there is still limited evidence on how government servants perceive these platforms and whether they are effective in meeting their training needs (Salimon et al., 2021). Without concrete evidence of perceived usefulness and simplicity of use, it is challenging to determine whether these programs are achieving their objectives.

A fundamental problem in establishing e-learning for civil servants is ensuring that the platforms are both user-friendly and genuinely compelling. Research constantly demonstrates that users' perceptions influence their acceptance and involvement with new technology. In e-learning, two factors that are reported to influence ease of use are perceived usefulness and the particular influence. Suppose government workers find e-learning technologies difficult to use or ineffective in supporting their learning objectives. In that case, their motivation and engagement are likely to suffer, resulting in lower training effectiveness and return on investment (Shahrin, 2021).

Given the broad training demands of Malaysia's public sector, including policy updates and administrative duties, as well as technical and management skills, e-learning has enormous potential. However, studies indicate that this potential is frequently unfulfilled due to poor user views. According to the Technology Acceptance Model (TAM), perceived ease of use relates to the notion that a system is simple and requires little effort (Abu-Taieh et al., 2022). If public workers believe a platform is time-consuming or complicated, they may be less likely to use it. Similarly, the perceived usefulness, which is the notion that the platform enhances job performance, is crucial for motivating civil servants to apply their learning in their employment.

Furthermore, success in e-learning is frequently judged by participation rates rather than learning results. Increased usage does not ensure better skills or knowledge retention. There is an obvious need to assess how successfully e-learning platforms meet their educational objectives, rather than merely how frequently they are accessed. Without this evaluation, it is unclear whether these methods are truly beneficial in improving civil servant competencies. Training effectiveness is crucial in the public sector, as it has a direct impact on the quality of services provided. Civil servants in Malaysia serve in a variety of roles, including administrative, technical, and managerial, and must

remain prepared to meet the changing needs and expectations of the public. Ineffective training can lead to skill gaps, decreased performance, and lower service quality, particularly in areas that need new policy compliance or technological integration.

The purpose of this study is to investigate how perceived simplicity of use and perceived utility influence the success of e-learning for Malaysian civil personnel. By evaluating these aspects, the research will provide insights into what determines the effectiveness of e-learning platforms in the public sector, as well as evidence for improving their design and delivery.

This pilot project, focusing on civil officials in the Klang Valley, will assess the reliability and validity of measurement scales related to the TAM components, as well as the effectiveness of the training. The findings will provide preliminary information on their interrelationships, establishing the groundwork for a more comprehensive investigation. Ultimately, this research will aid policymakers and human resource departments in refining e-learning efforts to ensure that they are both accessible and practical, thereby contributing to the continued development of Malaysia's public sector workforce.

3. LITERATURE REVIEW

In recent years, e-learning has emerged as a vital tool for employee development across sectors, offering a flexible, scalable, and accessible alternative to traditional training methods. E-learning enables employees, including public servants, to engage with training content at any time and from any location, which is particularly beneficial for roles that require continuous upskilling and knowledge updates (Chohan & Hu, 2022). In the public sector, where civil servants are expected to adapt to evolving policies, procedures, and regulations, e-learning has gained traction as an efficient means of professional development. This literature review examines the theoretical framework underpinning technology acceptance and the empirical findings related to perceived ease of use, perceived usefulness, and training effectiveness in e-learning contexts, providing a foundation for understanding the factors that influence the success of e-learning platforms for Malaysian civil servants.

3.1 EFFECTIVENESS OF TRAINING PROGRAMS

Training effectiveness refers to the extent to which a training program achieves its intended outcomes, such as knowledge retention, skill enhancement, and improved job performance. In e-learning, training effectiveness is influenced by both the design of the platform and the level of participant engagement. Effective training programs should not only impart knowledge but also enable employees to apply what they have learned to improve performance in their roles. Several studies have highlighted that perceived ease of use and perceived usefulness positively affect the effectiveness of e-learning, as these factors drive user engagement and satisfaction with the training platform (Niati et al., 2021). E-learning can be particularly effective in the public sector, where continuous learning is crucial for staying up-to-date with policy changes, regulatory requirements, and evolving job expectations (Al Adwan et al., 2023). In Malaysia, the effectiveness of training programs for civil servants is of paramount importance, as these employees are responsible for implementing government policies and providing essential public services. As such, effective training programs should enhance their skills, knowledge, and competencies, enabling them to perform their duties more effectively and meet the public's expectations.

Studies have shown that e-learning can be as effective as, or even more effective than, traditional training methods when designed and implemented properly (Rad et al., 2022). However, the success of e-learning in achieving effective training outcomes depends on users' engagement, which is often driven by their perceptions of the platform's ease of use and usefulness. For instance, Mailizar et al. (2021) found that when users perceive e-learning as easy to use and beneficial to their job, they are more likely to engage actively with the platform, leading to better learning outcomes. Additionally, Al-Fraihat et al. (2020) found that user satisfaction, influenced by both ease of use and usefulness, directly impacts training effectiveness, suggesting that positive user perceptions are crucial for the success of e-learning initiatives.

In the context of civil servants in Malaysia, evaluating the factors that contribute to training effectiveness is crucial, as these employees require continuous development to keep up with new job demands. Ensuring that e-learning

platforms are perceived as easy to use and useful can lead to greater engagement and ultimately improve training effectiveness. Moreover, understanding these relationships can help policymakers and HR professionals make informed decisions about the design and implementation of e-learning systems to maximise their impact on civil servant training and development.

3.2 TECHNOLOGY ACCEPTANCE MODEL (TAM)

The Technology Acceptance Model (TAM), introduced by Davis in 1989, is widely recognised as a theoretical framework for predicting and explaining user acceptance of new technology. TAM posits that two key factors — perceived ease of use and perceived usefulness — determine a user's intention to adopt a technology. Perceived ease of use refers to the degree to which an individual believes that using a technology will be effortless and straightforward. In contrast, perceived usefulness is defined as the degree to which an individual believes that using a technology will enhance their job performance. Together, these factors influence users' attitudes toward the technology, shaping their behavioural intention to use it, which in turn affects actual usage behaviour. In the context of e-learning, the Technology Acceptance Model (TAM) has been widely applied to explore the determinants of e-learning adoption and the impact of user perceptions on learning outcomes. For civil servants, perceived ease of use and perceived usefulness of e-learning platforms are particularly significant, as these perceptions can determine the extent to which they engage with and benefit from online training programs.

3.3 PERCEIVED EASE OF USE IN E-LEARNING

Perceived ease of use is a critical factor in technology adoption, as it represents the extent to which a technology is perceived as user-friendly and requires minimal effort to operate. In e-learning, perceived ease of use is crucial for ensuring that users can navigate the platform comfortably and focus on learning rather than grappling with technical challenges (Hariyanto et al., 2022). Studies have demonstrated that when users find an e-learning system easy to use, they are more likely to accept and engage with it, thereby increasing the likelihood of achieving positive learning outcomes (Alassafi, 2020).

For civil servants, perceived ease of use is critical, as their familiarity with digital platforms may vary, and some may lack advanced technical skills. A user-friendly e-learning system can reduce the cognitive load associated with learning new content, allowing users to focus on absorbing information rather than dealing with operational difficulties (Kashive et al., 2020). Moreover, research indicates that perceived ease of use positively influences user satisfaction with e-learning platforms, which in turn leads to greater engagement and participation (Utomo et al., 2023). Thus, designing e-learning platforms that prioritise ease of use can improve the overall effectiveness of training programs by encouraging civil servants to utilise them fully.

Studies specifically examining e-learning in the public sector have found that ease of use is a primary factor in the acceptance and continued use of these platforms. Noor et al. (2024) found that government employees who perceived an e-learning platform as easy to use were more likely to adopt it and engage consistently with its content. This finding is supported by other studies, such as Salimon et al. (2021), which emphasise that ease of use is a crucial enabler for adopting digital learning solutions in environments where employees have varied levels of digital literacy. Therefore, improving the perceived ease of use could significantly enhance civil servants' engagement with e-learning platforms, thereby increasing the likelihood of achieving the intended training outcomes.

3.4 PERCEIVED USEFULNESS IN E-LEARNING

Perceived usefulness, as defined in the Technology Acceptance Model (TAM), refers to the extent to which individuals believe that a technology will enhance their job performance. In the context of e-learning, perceived usefulness refers to users' beliefs that the platform will facilitate learning and enhance their ability to perform their jobs effectively. Numerous studies have demonstrated that perceived usefulness is a strong predictor of e-learning adoption and continued usage (Mikić et al., 2022; Tan et al., 2024). When users view an e-learning system as beneficial and relevant to their roles, they are more likely to invest time and effort into learning through the platform, which can enhance training effectiveness.

For civil servants, perceived usefulness may play a significantly more important role due to the highly structured and often performance-oriented nature of their work. E-learning platforms that deliver relevant, job-specific training can be perceived as highly useful, motivating civil servants to engage actively with the material and apply the knowledge gained in their day-to-day tasks. This is supported by research indicating that perceived usefulness is positively correlated with both satisfaction and learning outcomes in e-learning environments (Faqih, 2020). In a study by Suryanto et al. (2023), perceived usefulness was found to be a key determinant of user satisfaction and intention to continue using e-learning in an organisational setting, further highlighting its importance in shaping attitudes toward digital learning solutions.

Research on e-learning in the public sector also highlights the importance of perceived usefulness in driving the adoption of technology. For instance, Soong et al. (2020) found that public sector employees who perceived e-learning as useful for job performance were more likely to utilise these platforms for professional development. This suggests that civil servants are more likely to engage with e-learning when they believe it directly benefits their work and career advancement. Consequently, enhancing perceived usefulness by aligning e-learning content with civil servants' specific roles and responsibilities can significantly contribute to the effectiveness of training programs.

4. METHODOLOGY

The purpose of this pilot study is to evaluate the measurement instruments and gather preliminary data on the relationships between perceived ease of use, perceived usefulness, and training effectiveness of e-learning platforms among Malaysian civil servants. This pilot study focuses on 30 civil servants in Suruhanjaya Perkhidmatan Awam Malaysia (SPA). It assesses the reliability and validity of the measurement scales to determine if the full-scale study can proceed. The methodology includes the research design, sample selection, data collection procedure, measurement instruments, data analysis, and a discussion of the reliability results obtained from the pilot test.

4.1 RESEARCH DESIGN

This pilot study utilises a quantitative, cross-sectional survey design to gather preliminary data on civil servants' perceptions of e-learning platforms. The survey method enables efficient data collection from a sample of civil servants across multiple departments, allowing for an assessment of general attitudes and experiences with e-learning. The cross-sectional nature of the study provides a snapshot of the relationships among perceived ease of use, perceived usefulness, and training effectiveness at a specific point in time. SPSS was used for the data analysis, including reliability tests and descriptive statistics, to assess the internal consistency and initial trends in the data.

4.2 SAMPLE SELECTION

The target population for this study consists of civil servants working at Suruhanjaya Perkhidmatan Awam, Malaysia, which serves as the economic and administrative centre of Malaysia. It offers a diverse representation of civil servants from different backgrounds, departments, and roles, making it an ideal location for this pilot study. A non-probability convenience sampling method was used to select 30 participants for the pilot test, as this method is practical and cost-effective for a preliminary study. The sample size of 30 is adequate for pilot testing, allowing for an initial assessment of the measurement instruments and the overall structure of the questionnaire. Respondents were invited to participate voluntarily and were informed of the study's purpose, confidentiality, and measures to ensure anonymity.

4.3 DATA COLLECTION PROCEDURE

Data was collected via a self-administered online survey distributed to the selected civil servants. The online format ensured accessibility for participants and reduced logistical challenges associated with in-person data collection. The survey link was shared with potential respondents via email, accompanied by a brief introduction that explained the study's objectives, assured them of the confidentiality of their responses, and requested their participation.

4.4 MEASUREMENT INSTRUMENTS

The survey instrument was developed to measure three primary constructs: perceived ease of use, perceived usefulness, and training effectiveness. Each construct was measured using items adapted from existing validated scales, ensuring that the questionnaire aligns with established theoretical frameworks while being relevant to the context of civil servant e-learning.

Perceived Ease of Use: This construct was measured using a 5-item scale adapted from Davis (1989). Items were designed to assess the degree to which civil servants find the e-learning platform user-friendly and easy to navigate. Sample items include "I find the e-learning platform easy to use" and "Learning to operate the e-learning system is straightforward." Responses were recorded on a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Perceived Usefulness: Perceived usefulness was measured using a 5-item scale also adapted from Davis (1989). The items assessed the extent to which civil servants believe the e-learning platform improves their job performance and enhances their productivity. Sample items include "Using the e-learning platform improves my work performance" and "The e-learning system is useful for my job tasks." This construct was measured on a 5-point Likert scale, from 1 (Strongly Disagree) to 5 (Strongly Agree).

Training Effectiveness: Training effectiveness, the dependent variable, was measured using a 6-item scale adapted from previous studies on training outcomes and e-learning effectiveness (Al-Fraihat et al., 2020). Items focused on participants' perceptions of how well the e-learning platform meets their training needs, improves their skills, and enhances their knowledge relevant to their roles. Sample items include "The e-learning platform has helped me improve my job-related skills" and "The training provided by the e-learning system is effective." Responses were recorded on a 5-point Likert scale, from 1 (Strongly Disagree) to 5 (Strongly Agree).

4.5 DATA ANALYSIS

SPSS was used to analyse the data collected from the pilot study. The analysis involved several steps:

Descriptive Statistics: Descriptive statistics, including mean, standard deviation, frequency, and percentage, were calculated to understand the general characteristics of the sample and provide an overview of participants' responses to each item.

Reliability Analysis: Reliability analysis was conducted to determine the internal consistency of each measurement scale using Cronbach's alpha. A Cronbach's alpha value of 0.70 or higher was considered acceptable, indicating that the items within each construct are consistently measuring the same concept (Nunnally, 1978).

Preliminary Assessment of Relationships: Although this is a pilot study primarily focused on testing the reliability and validity of the instrument, Pearson correlation analysis was conducted to assess preliminary relationships among perceived ease of use, perceived usefulness, and training effectiveness. This provided an initial insight into potential trends in the data and highlighted areas for further investigation in the full-scale study.

4.6 RELIABILITY RESULTS (CRONBACH'S ALPHA)

The pilot study yielded the following Cronbach's alpha results for each construct:

Perceived Ease of Use: Cronbach's alpha was 0.82, indicating strong internal consistency. This suggests that the items effectively capture civil servants' perceptions of ease of use regarding the e-learning platform.

Perceived Usefulness: Cronbach's alpha was 0.85, also indicating strong internal consistency. This result suggests that the items reliably measure civil servants' perceptions of the e-learning platform's usefulness in enhancing their job performance.

Training Effectiveness: Cronbach's alpha for training effectiveness was 0.88, reflecting high internal consistency. This suggests that the items are well-aligned and effectively measure the perceived effectiveness of e-learning training for civil servants.

These reliability results indicate that each measurement scale is internally consistent and reliable, supporting the validity of the instrument for a larger-scale study.

5. JUSTIFICATION FOR PROCEEDING WITH FULL-SCALE STUDY

The pilot study demonstrated that the measurement scales for perceived ease of use, perceived usefulness, and training effectiveness are both reliable and relevant to the context of civil servant e-learning. The high Cronbach's alpha values across all constructs indicate that the instrument has strong internal consistency, suggesting that it can reliably measure the constructs of interest in a larger sample. Moreover, the preliminary analysis of relationships among the variables provided insights into potential trends, supporting the theoretical framework and highlighting the significance of perceived ease of use and perceived usefulness in influencing training effectiveness.

Based on the positive results of the pilot study, the full-scale study can proceed with confidence, utilising the validated instrument to collect data from a larger sample of civil servants. The findings from this expanded study could provide valuable insights into optimising e-learning platforms for civil servant training, informing policy decisions, and enhancing the effectiveness of digital training programs within the Malaysian public sector.

6. CONCLUSION

This pilot study successfully established the reliability of the measurement scales for perceived ease of use, perceived usefulness, and training effectiveness of e-learning platforms among Malaysian civil servants. The high Cronbach's alpha values confirm the internal consistency of the items, and the preliminary data suggest that the constructs are relevant to the study

objectives. Consequently, the results justify proceeding with the full-scale study to investigate further the relationships among these variables in a broader sample. By expanding the study, researchers can gather comprehensive insights into how e-learning platforms can be designed and implemented to maximise training effectiveness, ultimately contributing to the professional development and performance of civil servants in Malaysia. This pilot study has several limitations that can be considered for future research. The sample size in this study is limited (n = 30), which may limit the generalizability of the findings. Furthermore, it was done at a single healthcare institution, which may not reflect the experiences of nurses in other regions or institutions. Future research should include larger and more diverse sample sizes from other institutions to enhance the validity and applicability of the findings. Overall, this study holds significant potential for further expansion to benefit all civil servants in the Suruhanjaya Perkhidmatan Awam (Public Service Commission) of Malaysia.

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9. AUTHORS' CONTRIBUTION

Ayu Kamareena Abdullah Thani is responsible for designing the survey instrument and data collection process. Atiela Amran and Nurul Nadhira Amalin Azhari contributed to the analysis of the results. Nurhidayah Rosely and Noor Rahmawati Alias contributed to the writing of the manuscript. All authors offered valuable feedback and contributed to shaping the research, analysis, and manuscript.

10. CONFLICT OF INTEREST DECLARATION

We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to IJELHE.

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Exploring Students' Satisfaction In Online Learning Using Regression Analysis

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Abstract: *Since the COVID-19 outbreak, the majority of universities have implemented an online learning system to ensure that students, particularly those pursuing diplomas, can continue their education. Transitioning from traditional in-person training to online instruction is a challenging process. Additionally, using e-learning tools exposes students to specific challenges. Due to these transitions, participation is mandatory, and students must adapt to the workload and rapid changes. The purpose of this study is to investigate the factors that affect students' satisfaction with online learning, including the course assessment, lecturer performance, and lecturer-student interaction. To determine the connection between satisfaction with online learning and the other three criteria, approximately 100 diploma students from diverse programs at UiTM Machang, Kelantan, participated in a quantitative survey. The findings demonstrated that lecturer-student interaction and course assessment could raise students' satisfaction with online learning.*

Keywords: *students' satisfaction, e-learning, online learning, interaction, lecturer performance, course assessment.*

1. INTRODUCTION

Globally, the COVID-19 pandemic, which began in 2020, has rapidly transformed conventional classroom settings into a flexible online learning environment. In the education sector, as universities and educational institutions increasingly adopt digital platforms to deliver courses and engage students, understanding students' satisfaction with online learning has become critical. Previous studies have defined satisfaction in online learning as students' perceptions of their learning experiences, including the usability of online platforms, the quality of content delivery, interaction with instructors and peers, and the overall effectiveness of the learning process (Daultani et al., 2021; Gantasala et al., 2022).

Students' satisfaction in education is deeply intertwined with the principles and targets of Sustainable Development Goal (SDG 4): Quality Education (Holmes et al., 2022). It is directly related to students' satisfaction in education, whereby lifelong learning is promoted for all learners by providing them with the necessary education. To elaborate, this goal also focuses on ensuring inclusive, equitable, and quality education for all, as well as promoting lifelong learning opportunities. Therefore, it is highly relevant to students' experiences in educational settings, particularly in the context of online learning and digital education, which have become increasingly prevalent in recent years.

According to the Ministry of Higher Education Malaysia (MOHE), around 90% of Malaysian universities switched to online education by March 2020, and until now, online learning is still in practice (Othman et al., 2022). For many students, the transition from traditional in-person classes to online modes of education has posed unique challenges, including adapting to new technologies, managing increased workloads, and maintaining motivation in a virtual environment. These challenges, combined with the potential benefits of flexibility and convenience, have led to varying levels of student satisfaction. Understanding these factors is crucial for educators and institutions to optimise the online learning experience, improve student outcomes, and ensure the long-term success of digital education initiatives. This study aims to investigate

the factors that influence student satisfaction in online learning, with a focus on the role of e-learning in shaping students' perceptions of their learning experience. By analysing students' feedback and usage patterns, educators can more effectively use online learning tools to address the diverse needs of learners in completing assigned tasks.

2. LITERATURE REVIEW

This paper focuses on two key elements of online learning: interactions and engagement. Student interaction is crucial during the online learning process as it helps create engagement within the learning community, and hence produces an effective learning environment among members (Martin & Borup, 2022; Ong & Quek, 2023). According to Wang and Baker (2015), student engagement refers to the effort a student makes to participate in the learning processes of a particular course. It has also emerged as a crucial factor in the successful conduct of online education. There are three primary forms of student involvement in an online setting: student interaction with other students, student contact with instructors, and student interaction with information. In line with this assertion, Martin & Bolliger (2018) further demonstrated that involvement can enhance satisfaction, emphasising that engagement is essential to both learning and overall student experience.

This paper examines students' satisfaction with online learning at Universiti Teknologi MARA (UiTM) Pahang, with a focus on the challenges of student participation in online activities. The study aimed to identify the types of online learning activities used, the approaches lecturers take to encourage participation, and the level of student satisfaction. The findings revealed that the most commonly used online activities were online tests or quizzes, followed by online notes and assignments. Lecturers used clear instructions and simple language during group discussions to promote participation. Overall, students were moderately satisfied with the online learning practices at UiTM Pahang. The study suggests that to improve the effectiveness of online learning, lecturers should consider these findings and make adjustments to enhance the online learning experience (Zamakhsari et al., 2015).

The study by Ngoa, J., Budiyono, & Ngadiman, A. (2021) examines student satisfaction with remote online learning during the COVID-19 pandemic in Indonesia, focusing on 65 undergraduate students of Informatics from a private university in Surabaya. Using Strachota's Student Satisfaction survey and quantitative analysis, the study finds a strong link between student satisfaction and interaction, with content interaction being the most significant predictor.

The study by Baber (2020) examines the effects of the COVID-19 pandemic on online education, focusing on perceived learning outcomes and student satisfaction. Data collected from undergraduate students in South Korea and India revealed that factors such as classroom interaction, student motivation, course structure, instructor expertise, and teaching effectiveness all positively influenced perceived learning outcomes and student satisfaction. No significant differences were observed between the two countries. The findings aim to support educators in enhancing student learning outcomes and satisfaction in online courses during the pandemic.

A study by Kee, D. M. H. T. et al (2021) aimed to assess student satisfaction with e-learning and their learning experiences during the COVID-19 pandemic. A quantitative approach was employed, utilising an online questionnaire survey that involved 150 students from institutions in India and Malaysia. The findings revealed that most students were satisfied with e-learning, as it effectively facilitated their studies. The study also found that convenience and flexibility were significantly linked to positive learning experiences.

According to Bismala, L., & Manurung, Y. H. (2024), the study aimed to assess student satisfaction with e-learning as a method of distance learning during the COVID-19 pandemic, using Importance Performance Analysis (IPA). The findings revealed several areas for improvement, including the quality of materials presented on e-learning platforms, interaction with lecturers, the availability of necessary facilities, and lecturer engagement.

Research by Thoo, A. C. (2021) showed that both the delivery method by lecturer and content of e-learning positively and significantly influenced students' satisfaction at Universiti Teknologi Malaysia (UTM), emphasising its role in fostering digital and data literacy in the context of Industry 4.0.

However, system operations did not significantly impact satisfaction. The study aims to provide insights for developing effective teaching models for general education schools.

Additionally, a study by Wahidin, I.S. (2024) examined the impact of ease of use and students' behavioural engagement on their satisfaction with Padlet as an e-learning tool at UiTM. A total of 170 students from three elective courses participated, with data collected via a questionnaire. The results revealed that both the ease of use of Padlet and students' engagement positively influenced their satisfaction with classroom activities. The study highlights Padlet's role in enhancing collaborative learning by fostering active participation, connectivity, and personalised learning, ultimately improving student satisfaction in higher education through the use of e-learning tools.

3. METHODOLOGY

This study employed a quantitative research approach. The study population consisted of 100 diploma students from various programs at the UiTM Kelantan Branch, Machang Campus. A stratified random sampling method was used to collect samples from the study population. The study sample included 100 diploma students. These students were chosen because they began their studies using blended learning, a combination of face-to-face and online classes. Most of these students experienced online learning as a result of the shift caused by the COVID-19 pandemic, which began in 2020. The research instrument was a questionnaire distributed to each participant via Google Forms. Statistical analyses, including descriptive statistics, Cronbach's Alpha, and multiple regression analysis, were used to analyse the data quantitatively.

4. RESULTS AND DISCUSSION

4.1 RESPONDENT DEMOGRAPHICS

Table 1 below presents the demographic profiles of the respondents (n = 100) in Section A. The first six questions of the survey asked about students' gender, age, program code, medium for online learning, e-learning tools and time spent on online learning among diploma program students at UiTM Kelantan.

Item	Number of Items	Cronbach's Alpha
1. Gender	Male Female	26% 74%
2. Age	18-20 years old 21-23 years old 24-27 years old 28 above	73% 15% 11% 1%
3. Program Code	BA111 BA119 CS111 AM110 BA132	21% 23% 25% 21% 10%
4. Medium of online learning	Google meet Team teaching Zoom Cisco Webex Others	68% 22% 3% 5% 2%
5. The most popular e-learning tool among students in an online class	Smartphones Computer Tablets Laptop	45% 3% 5% 47%
6. How much time is spent (student learning time) for online learning?	Less than one hour per day 2-3 hours per day 4-5 hours per day More than 6 hours per day	66% 31% 2% 1%

Table 1: Demographic Profile

It can be concluded from Table 1 that most of the respondents are female (74%). In addition, most participants are aged between 18 and 20 years (73%), and the most represented program code involved in this online learning survey is CS111 (25%). Google Meet is the primary platform used for online learning, accounting for 68%. Based on the analysis, the most popular e-learning tool among students is the laptop (47%), although many students still use smartphones as their primary device for online learning. It was also found that most respondents (66%) spent less than one hour per day on online learning activities. These results indicate a relatively low percentage of students allocating sufficient time to online learning.

4.2 RELIABILITY TEST

The consistency of the interval items in the questionnaire for this study was tested using Cronbach's Alpha analysis. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items is as a group. According to Hair et al. (2007), each item is reliable if Cronbach's Alpha coefficient value is greater than 0.60.

	Items	Cronbach's Alpha
Cronbach Alpha	24 questions	0.971

Table 2: Cronbach's Alpha

Table 2 shows that the Cronbach's Alpha coefficient obtained for the 24 items was 0.971. The interpretation of this value is classified as excellent. Therefore, these items are reliable for further analysis.

4.3 MULTIPLE LINEAR REGRESSION ANALYSIS

Multiple linear regression is an effective statistical technique for determining the relationship between each independent variable and a linear dependent variable. This analysis is used to test all of the hypotheses. Additionally, it allows the researcher to identify which independent variable has the most significant impact on the dependent variable.

Based on Model 1.1 below, there are three independent variables: the interaction between the lecturer and students, lecturer performance, and course assessment. Student satisfaction is the dependent variable in this study.

y = b0 + b1X1 + b2X2 + b3X3 + ..bXbY……...(model 1.1)

Student satisfaction = 0.507 + 0.374*X*1 (interaction between lecturer and students) +-0.143*X*2 (lecturer performance) + 0.636*X*3 (course assessment)

Based on Table 3, the R-squared value of the study is $R^2 = 0.55$, indicating that all independent variables (interaction between lecturer and students, lecturer performance, and course assessment) collectively contribute 55.3%

of the variation in students' satisfaction with e-learning on an online class platform. The other 44.7% of the variation cannot be explained by this model, indicating that there are additional factors that can be used to describe students' satisfaction.

Regression Statistics	
Multiple R	0.744043081
R Square	0.553600107
Adjusted R Square	0.53965011
Standard Error	0.563098385
Observations	100

Table 3: R Square

The results in Table 4 indicate that the model used is acceptable, as evidenced by an F value of 39.6846. The model is also significant, with a p-value of 0.0000, which is significant at the 10% level.

ANOVA

	F	*Significance F*
Regression	39.6846	9.08511E-17*

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.507658919	0.201969	2.513551	0.013617
Interaction	0.374254837	0.120611	3.102997	0.002517 *
Lecturer Performance	-0.143624216	0.128875	-1.11445	0.26787
Course Assessment.	0.636029734	0.102666	6.195164	1.45E-08 *

**significant at 0.05 significance level*

Table 4: ANOVA and t-test

Based on the coefficient table in Table 4, only two independent variables – interaction between lecturers and students (0.0025; p-value less than 10% significant level) and course assessment (0.000; p-value less than 10% significant level) – were significant. As a result, student satisfaction with online learning was positively influenced by the two variables. The most crucial variable in this study is course assessment, as its coefficient value is the highest (0.63). Meanwhile, lecturer performance had no significant effect on student satisfaction.

4.4 DISCUSSION

Course assessment is the most significant variable in this study. This finding is consistent with a previous study by Baber, H. (2020), which found that course structure has a positive influence on perceived learning outcomes and student satisfaction. A mix of assessment types, including quizzes, assignments, discussions, and projects, helps keep students engaged and allows them to demonstrate their understanding in various ways. Receiving prompt feedback on assignments, quizzes, and exams is vital for student satisfaction. It helps students understand their progress, correct mistakes, and stay motivated to improve. Compared to the traditional method, a delay in feedback can lead to dissatisfaction, as students may feel disconnected from the learning process.

Interaction between lecturers and students is also statistically significant in relation to student satisfaction in online classes. The result is consistent with previous studies by Zamakhsari et al (2015) and Blasco-Arcas et al. (2013). In online classes, students may be more passive due to the lack of face-to-face interaction. Lecturers who encourage active participation in discussion forums, group projects, or live sessions, such as webinars or collaborative teaching, foster a more interactive and engaging environment. This makes students feel more connected to the course and to their peers, which positively influences satisfaction. Additionally, in a virtual setting, this kind of emotional intelligence can help create a more welcoming and supportive learning environment, which in turn boosts student satisfaction.

In conclusion, course assessment and interaction between lecturers and students are the main factors influencing student satisfaction in online classes. Clear, fair assessments; an engaging, knowledgeable lecturer; and meaningful interaction can create an environment where students feel valued, supported, and motivated.

5. CONCLUSIONS AND RECOMMENDATION

This research has found that students are satisfied with using e-learning tools in online classes due to the interaction between students and lecturers, as well as the support for continuous course assessments. Course assessment is the most influential factor, as most course assessments have undergone significant changes since the COVID-19 pandemic, particularly with final exams being replaced by final assessments. Policies should encourage the development of more varied and formative assessments in online learning. Traditional exams may not fully capture students' abilities in an e-learning environment; therefore, alternative assessments, such as project-based learning, peer reviews, and continuous assessments, should be considered.

Therefore, lecturers should address students' current levels to increase participation in online learning activities at UiTM Kelantan by using a variety of e-learning tools. As far as the researchers are concerned, this research was conducted to identify how much students spend on online learning, and the result shows that it is about 66% less than one hour per week. Most students use laptops as their e-learning tool to participate in online classes.

Further research could focus on the effectiveness of different teaching methods in online environments, such as flipped classrooms and gamification. This research aims to identify the pedagogical strategies that have the most positive impact on student satisfaction. Research should focus on how emerging technologies, such as artificial intelligence (AI), can be integrated into e-learning platforms to enhance student engagement and satisfaction. Evaluating the impact of these technologies on learning outcomes would be crucial.

From the perspective of policy implications and stakeholders, governments and educational institutions should invest in improving the technological infrastructure for online learning, ensuring that students have access to high-quality devices, reliable internet connectivity, and user-friendly learning platforms. All of this will help increase student satisfaction with learning in the modern era.

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8. AUTHORS' CONTRIBUTION

This study was conceptualised by Nor Sabrina, who identified the study's focus and selected the methodological approach. Noorihan carried out data collection. Noorihan also focused on related work, and Nor Sabrina conducted the survey and analysis. Another author, Mohd Fahmi, assisted in searching for the literature review and identifying the appropriate methodology for the study.

9. CONFLICT OF INTEREST DECLARATION

I confirm that the article represents the original work of the author(s) and has not been previously published or submitted for publication elsewhere. This manuscript is not under review by any other journal, in whole or in part. I further affirm that the author has made a substantial contribution to the research, including the integrity and interpretation of the data, and fully supports its submission to IJELHE.

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Enhancing 3D Graph Visualisation in Multivariable Calculus Using Graphica3D

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Abstract: *One of the biggest challenges in learning multivariable calculus, particularly multiple integrals, is developing the skills to visualise, interpret and illustrate 2-dimensional (2D) and 3-dimensional (3D) graphs. These skills are crucial, as students must accurately identify integration regions and determine the limits of integration. However, many existing teaching materials for multivariable calculus often lack technological integration to support 3D graph visualisation, making it difficult for students to develop these essential skills. To address this gap, Graphica3D, an interactive educational module, has been created. The module integrates GeoGebra, an open-source mathematical software, to provide an interactive learning environment for exploring 2D and 3D graphs. In addition to explanatory notes on 3D graphs, Graphica3D features a GeoGebra applet that allows students to visualise various 3D graphs and their projections onto coordinate planes. The effectiveness of Graphica3D was evaluated through a survey of 37 engineering students enrolled in Further Calculus for Engineers at UiTM Cawangan Pulau Pinang. Before using the module, 40.5% of students admitted to struggling with 3D graph visualisation and sketching. After its implementation, all students agreed that the module enhanced their ability to visualise, interpret and sketch 3D graphs. The module's ease of use and interactive design make it a valuable supplement to traditional teaching methods, fostering a more visual and intuitive understanding of complex mathematical concepts.*

Keywords: *3-dimensional graphs, GeoGebra, interactive learning, multiple integrals, multivariable calculus*

1. INTRODUCTION

Multivariable calculus is a compulsory course in many degree programs in the sciences and engineering. One of the key topics in multivariable calculus is multiple integrals. Multiple integrals play a crucial role in mathematics and calculus, enabling the determination of plane areas, mass and volume calculations, moments of inertia, and surface areas of 3D objects (Milenković & Vučićević, 2024). One of the biggest challenges students encounter in learning multivariable calculus is developing the skills needed to visualise, interpret, and illustrate 3D geometrical shapes from algebraic equations. The application and practice of these skills in solving mathematical problems related to multiple integrals are crucial. Kashefi et al. (2011) reported that most students mainly struggled with interpreting and illustrating 3D graphs, which are important in determining integration limits and identifying regions of integration. Similarly, Gemechu et al. (2021) supported this finding by revealing that many students experienced difficulties associating algebraic equations with corresponding geometrical representations. This negatively impacted the students' ability to set up and solve multiple integration problems.

Generally, the traditional methods available for teaching multivariable calculus appear to have limitations and shortcomings in providing students with sufficient learning platforms to enhance their skills in interpreting, visualising, and illustrating geometric representations of algebraic equations. The traditional pencil-and-paper approach often fails to engage students in discovering and exploring geometrical concepts as effectively as technology-based methods (Sariyasa, 2017). Gemechu et al. (2021) further highlighted that traditional teaching methods tend to emphasise computational skills rather than conceptual understanding. As such, this suggests that innovative teaching strategies need to be designed to improve students' achievement by promoting visualisation and conceptual understanding, as well as encouraging the interactive learning of multivariable calculus.

Interactive tools like GeoGebra offer solutions to address the challenges faced by students and the gaps left by traditional teaching methods. GeoGebra is a powerful mathematical software that creates a flexible learning environment, allowing for the interactive exploration of mathematical equations. GeoGebra has features that permit students to manipulate mathematical variables and monitor the results immediately. This encourages students to actively experiment and explore mathematical concepts, thereby enhancing their learning outcomes (Jelatu et al., 2018). Ng and Rosli (2023) emphasised that GeoGebra not only aids students in understanding geometrical concepts but also assists educators in delivering mathematical content more clearly and effectively. Foo and Ng (2022) demonstrated that a GeoGebra-based module significantly improved students' comprehension of the topic of circles in mathematics. The study demonstrated that GeoGebra can be utilised to enhance students' understanding of abstract concepts and simplify complex ideas by providing interactive visualisation platforms.

As GeoGebra becomes a tool to support technical and interactive visual learning environments, flipbook meanwhile adds a creative touch by bringing lessons to life through visual effects and interactive storytelling. According to Hardiansyah (2016), the flipbook concept refers to a classic animation technique that involves applying a series of static images on paper to create the illusion of movement as the pages are flipped. The concept was initially used to generate animation stories without the help of advanced technologies. As technology has been growing rapidly, the concept has evolved too. This evolution results in the development of creative digital applications that incorporate animation effects into e-books. As such, flipbook is a great medium to improve the way students learn. Sari et al. (2024) suggested that flipbooks make lessons more engaging and enjoyable by displaying visual animation effects. It offers flexibility, allowing students to learn at their preferred time and location. It also supports links, images, videos, audio, and other functional supplementary materials that can be embedded into it. Saad et al. (2024) developed an educational flipbook containing step-by-step guidance, embedded videos, and other interactive materials, which were proven effective in enhancing students' interest in learning mathematics. Flipbooks also incorporate traditional and digital learning, assisting educators with a creative way to deliver lessons.

GeoGebra and flipbooks have technical, interactive and creative features. Therefore, integrating both as a learning device is one of the best combinations that can provide a promising way to inspire students to explore new knowledge and further assist them in understanding it effectively. Several studies have demonstrated the benefits of integrating both GeoGebra and flipbook in mathematics education. Azzahroh et al. (2024) demonstrated the integration of this approach to improve students' learning outcomes in quadratic functions. Their study showed that the students' mastery of the topic improved significantly after practising the integrated tools. Furthermore, Faizah et al. (2023) also developed an e-module that integrates GeoGebra and a flipbook for learning geometric transformations. They received positive feedback that their integrated module is effective and relevant as a practical solution to help students visualise abstract mathematical concepts and improve understanding. Jumroh et al. (2022) conducted research that also supported the integration of GeoGebra and flipbook as a learning device. They developed an e-module to enhance students' understanding of definite integral concepts. Their study proved that the integrated learning device benefits students in improving their comprehension of topics in definite integrals. Valid reviews from experts also supported their findings.

Based on these prior findings, this study aims to develop an educational tool, called Graphica3D, which leverages GeoGebra's powerful visualisation capabilities and the creative, multimedia-rich format of a flipbook to aid students in understanding abstract mathematical concepts taught in multivariable calculus. It is also hoped that the integrated learning tool encourages students' motivation to learn the knowledge. This approach aligns with previous studies that have shown significant improvements in mathematical learning outcomes when these tools were integrated into topics such as quadratic functions (Azzahroh et al., 2024), geometric transformations (Faizah et al., 2023), and definite integrals (Jumroh et al., 2022). Therefore, this study aims to further this foundation by focusing on the visualisation of 3D graphs, a fundamental component of multivariable calculus.

2. METHODS

The Graphica3D module was developed as an educational tool to address students' challenges in visualising and understanding 3D graphs. The key features and functionalities of an effective educational module were identified through a literature review, as well as feedback from lecturers and students. The development of the Graphica3D module consisted of three phases: design and conceptualisation, module development, and effectiveness testing.

2.1 DESIGN AND DEVELOPMENT OF THE GRAPHICA3D MODULE

Based on the gathered information, the essential features and functionalities required for the module were outlined. The module was designed to include interactive 3D graph visualisation, concise but straightforward explanatory notes on the 3D graphs, and accessibility across various devices.

The module was developed using GeoGebra, a free open-source mathematical software, to create an interactive learning environment. The GeoGebra applets were embedded in the module, enabling students to visualise standard 3D graphs in multivariable calculus, including planes, cones, cylinders, paraboloids, spheres, and hemispheres. Additionally, each 3D graph applet included a feature to project the graphs onto the three coordinate planes (xy-plane, yz-plane, and xz-plane), aiding students in understanding 2D projections of 3D surfaces. The Graphica3D module also includes notes explaining the mathematical functions of the 3D graphs. This can help students become familiar with the functions for each 3D graph.

The flow of user interaction within the Graphica3D module is structured to gradually build students' understanding of 3D graphs and their features. In the introduction, students are provided with an overview of the importance of visualising three-dimensional graphs when solving multiple integrals. Each section of the module focuses on a specific type of 3D graph, such as planes, cones, cylinders, paraboloids, spheres, and hemispheres. For each graph type, the module provides a brief description of its mathematical function, followed by an interactive GeoGebra applet. Students can manipulate the graphs to observe their shape from various perspectives by rotating, zooming, or changing the viewpoint.

Multiple mathematical functions are included for each type of graph to help students identify differences in algebraic forms and how these affect the 3D structure. Each applet also includes projection views on the xy-plane, yz-plane, and xz-plane, which help students better understand the relationships between 2D and 3D representations. Although the module is designed for sequential use, students are free to navigate through different graph types at their own pace. The flow used in the module – from explanation to hands-on manipulation – supports independent and visual learning, making abstract concepts more accessible and understandable.

To enhance accessibility, the Graphica3D module was designed as a digital flipbook, allowing students to access the material conveniently via laptops, tablets, or smartphones. The interactive applets and notes were arranged systematically to facilitate independent learning at one's own pace. To create the interactive flipbook, we utilised Heyzine Flipbooks, a free online platform that offers an intuitive and engaging interface. Figure 1 provides a preview of several pages from the Graphica3D module.

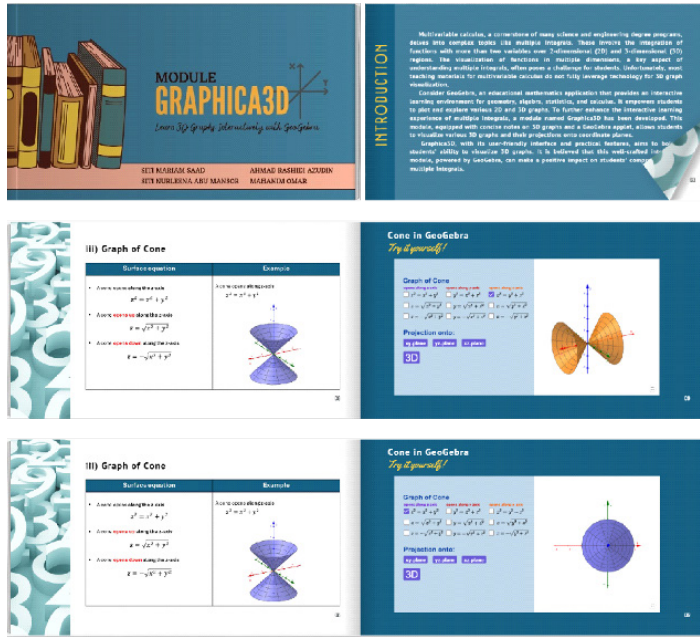


Figure 1: The Graphica3D Module

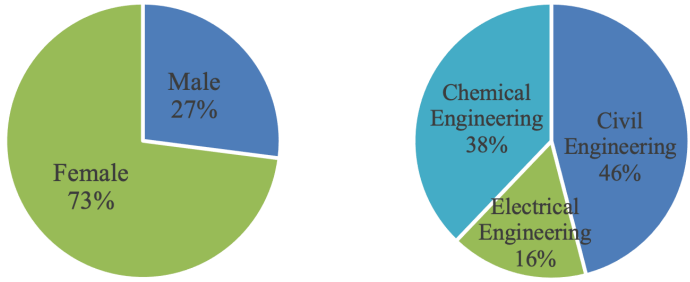
2.2 EVALUATION OF THE GRAPHICA3D MODULE

The effectiveness of the Graphica3D module in helping students visualise and sketch 3D graphs was evaluated through a survey. A total of 37 students enrolled in the Further Calculus for Engineers course at Universiti Teknologi MARA, Cawangan Pulau Pinang, participated in the study. A four-point Likert scale survey (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree) was distributed to students to gather their feedback on the usefulness of the module. The questionnaire was developed specifically for this study by the authors. The items were reviewed by two subject experts in multivariable calculus and mathematics education to ensure their clarity, relevance, and validity. Table 1 presents the questions asked in the survey.

No	Questions
1	The ability to sketch 3D graphs is important to solve multiple integrals.
1	I am skilled at sketching 3D graphs.
3	The Graphica3D module helps me learn how to sketch 3D graphs for various algebraic equations.
4	The Graphica3D module helps me in sketching 3D graphs from the given algebraic equations.
5	The Graphica3D module helps me in visualising 3D graph projections on coordinate planes.

Table 1: Assessment of Students' Experience with the Graphica3D Module

As illustrated in Figure 2, the respondents comprised 10 males (27%) and 27 females (73%). The majority were civil engineering students (17 students, 45.9%), followed by chemical engineering students (14 students, 37.8%), while the remainder were enrolled in electrical engineering.



(a) Gender (b) Programme

Figure 2: Summary of Respondents According to Gender and Programme

3. RESULTS AND DISCUSSIONS

3.1 STUDENTS' PERCEPTIONS OF 3D GRAPH SKETCHING SKILLS

The survey results reveal insights into students' perceptions and experiences with visualising and sketching 3D graphs using the Graphica3D module. As shown in Figure 3, the majority of students (70.3%) strongly agreed that having the ability to sketch 3D graphs is essential for solving problems related to multiple integrals. Regarding their skills in sketching 3D graphs, 54.1% agreed and 5.4% strongly agreed that they considered themselves skilled before being introduced to the Graphica3D module. However, 40.5% admitted to having difficulty in sketching 3D graphs, a relatively high percentage. According to Milenković et al. (2024), previous calculus courses tend to be more analytical than visual, which may explain why many students struggle to visualise and sketch graphs of two-variable functions.

The inability to visualise and sketch graphs of two-variable functions presents a significant barrier to students' understanding and problem-solving abilities in multiple integrals (Kashefi et al., 2010; Yeni et al., 2022). Solving multiple integrals extends beyond applying integration procedures correctly. Students must also identify integration domains (Alessio et al., 2022; Milenković &

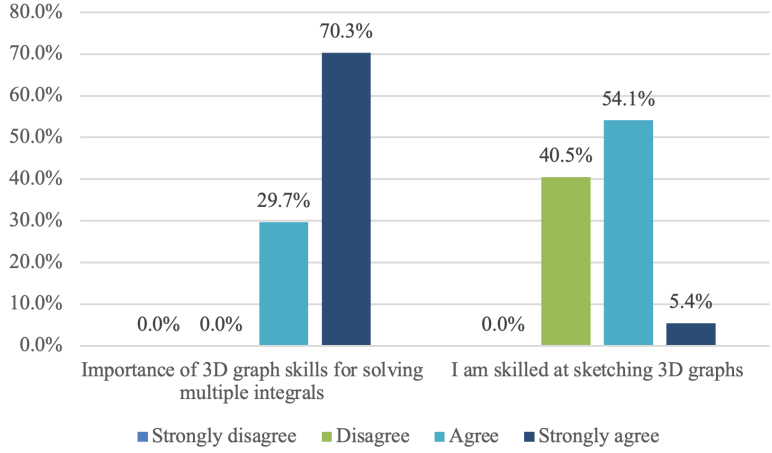


Figure 3: Students' Opinions on Sketching Skills for 3D Graphs

Vučićević, 2024). A weak understanding of graph concepts often leads to incorrect sketches of integration regions, which in turn cause difficulties in determining integration limits and solving multiple integration problems (Untarti & Kusuma, 2019; Gemechu et al., 2021).

To address this challenge, Martinez-Planell and Gaisman (2012, as cited in Gemechu et al., 2021) recommended exposing students to visual representations of functions of two variables to improve their comprehension of multiple integrals. Similarly, Milenković and Vučićević (2024) found that integrating GeoGebra into the learning environment significantly improved students' ability to solve multiple integral problems by enhancing their visualisation skills.

3.2 STUDENTS' FEEDBACK ON USING THE GRAPHICA3D MODULE 2.3

As displayed in Figure 4, all students either agreed (43.2%) or strongly agreed (56.8%) that the Graphica3D module helped them learn how to sketch 3D graphs. The combination of notes and GeoGebra applets enabled students to recognise algebraic equations and sketch the corresponding graphs—an aspect where all participants expressed agreement (45.9% agreed and 54.1% strongly agreed). This finding suggests that the interactive module effectively enhances students' understanding of 3D graph sketching.

Additionally, the module facilitated students' ability to illustrate projections of 3D graphs on different coordinate planes, with 59.5% agreeing and 40.5% strongly agreeing. The ability to visualise projections plays a crucial role in determining the limits of integration for double and triple integrals.

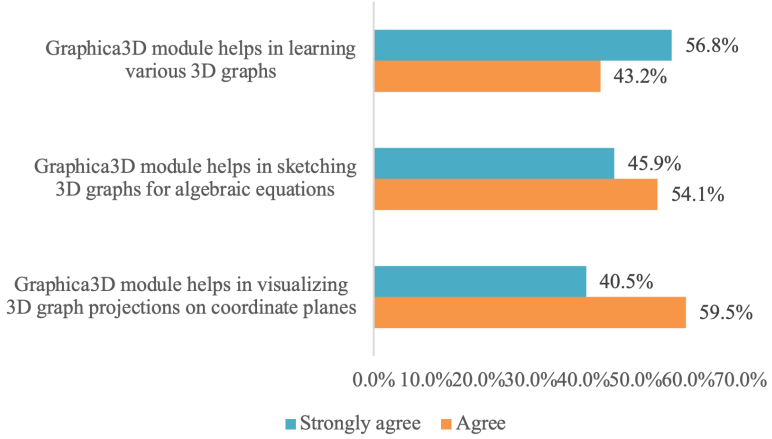


Figure 4: Students' Feedback on the Effectiveness of Graphica3D

Student feedback indicates that the Graphica3D module enhances their ability to visualise and sketch 3D graphs, ultimately strengthening their understanding of multiple integrals. This aligns with previous studies, which found that integrating GeoGebra with instructional materials aids students in learning the graphical representation of algebraic equations (Septian et al., 2021; Yeni et al., 2022).

Furthermore, Milenković et al. (2024) demonstrated that students who used GeoGebra-based applications achieved significantly better learning outcomes in multiple integral problems than those who relied on traditional teaching methods. This underscores the module's effectiveness as a supplementary learning resource, filling gaps in traditional classroom instruction by providing an interactive and visual learning experience.

With the Graphica3D module, students can independently explore various 3D graphs at their own pace. This aligns with Saputra and Fahrizal (2019), who argued that integrating GeoGebra into instructional materials empowers students with learning independence, even among those with no prior experience (de Carvalho et al., 2024).

4. CONCLUSION

This study examines the effectiveness of Graphica3D, an interactive educational module designed to enhance students' ability to visualise and understand abstract mathematical concepts in multivariable calculus. The implementation of Graphica3D among engineering students enrolled in multivariable calculus courses has yielded positive results. The findings indicate that the module improves students' ability to visualise and sketch 3D graphs, a crucial skill for understanding multiple integrals. Additionally, positive feedback suggests that the module serves as an effective supplementary learning tool. The promising outcomes of this study highlight the potential for further integration and development of Graphica3D to enhance learning experiences in multivariable calculus, particularly in the context of multiple integrals. Its interactive approach makes it a valuable supplement to traditional teaching methods, fostering a more visual and intuitive understanding of complex mathematical concepts.

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7. AUTHORS' CONTRIBUTION

Siti Mariam Saad: Writing – review and editing, Writing – original draft, Project administration, Methodology – designed and organised the research. Siti Nurleena Abu Mansor: Writing – review and editing, Methodology – developed the questionnaires, Data Analysis. Ahmad Rashidi Azudin: Writing – original draft. Mahanim Omar: Data Analysis, Writing – original draft. All authors offered valuable feedback and contributed to shaping the research, analysis, and manuscript.

8. CONFLICT OF INTEREST DECLARATION

We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We attest that all authors have made significant contributions to the work, including the validity and legitimacy of the data and its interpretation, for submission to IJELHE.

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Assessing Student Satisfaction in Business Mathematics Using Net Promoter Score

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Abstract: *Assessing student satisfaction with instructional practices is critical to fostering engagement and improving educational outcomes, particularly in quantitative subjects such as business mathematics. This study investigates the use of the Net Promoter Score (NPS) as a metric for evaluating student satisfaction with structured practice exercises in an undergraduate business mathematics course. The course included three key topics: Trade and Cash Discounts, Markup and Markdown, and Instalment Purchase, each supported by a dedicated practice exercise designed to reinforce both conceptual understanding and practical skills. To capture student satisfaction, an NPS survey was administered to 64 students after they completed the exercises, asking them to rate their likelihood of recommending the practice sessions to their peers. Responses were categorised into Promoters, Passives, and Detractors, resulting in an overall NPS score of 77, reflecting a high level of satisfaction among participants. Additional analysis compared satisfaction*

levels across the three topics, providing insights into specific areas where instructional design effectively met student needs. The findings underscore the utility of NPS as a simple yet effective tool for measuring student satisfaction in educational settings, offering valuable insights that can guide curriculum design and instructional practices. This study contributes to the field of educational assessment by demonstrating the applicability of NPS for providing rapid, interpretable feedback on targeted learning activities, particularly in courses where structured practice is essential to student success.

Keywords: *business mathematics, Net Promoter Score, online survey, practice exercises, student satisfaction*

1. INTRODUCTION

In the continuously evolving landscape of higher education, student satisfaction and engagement serve as critical indicators of instructional effectiveness and the quality of learning experiences. (Gamarra-Moreno et al., 2021). One metric that has seen increasing adoption across various domains, including education, is the Net Promoter Score (NPS), a measure initially developed to gauge customer loyalty in business contexts (Lucero, 2022). NPS has become recognised as a straightforward yet robust tool for evaluating student satisfaction, offering insights into the likelihood that students will endorse a course, activity, or educational resource to their peers (Cruz et al., 2019). This metric is particularly valuable for educators and administrators, as it provides a precise, quantitative measure of students' experiences that can inform instructional strategies and foster improvements in course design (Yudet Millones-Liza & Emperatriz Garc'ia-Salirrosas, 2021; Smithson et al., 2015).

In higher education, particularly within quantitative disciplines like business mathematics, assessing student satisfaction with specific instructional elements, such as practice exercises, presents distinct challenges. While traditional satisfaction surveys and feedback mechanisms are insightful, they often lack the comparative potency and simplicity that NPS provides (Koladycz et al., 2018). Although the Net Promoter Score (NPS) is increasingly used in educational research to evaluate general course satisfaction and online

learning experiences (Lucero, 2022; Gamarra-Moreno et al., 2021), its specific application to structured practice exercises, particularly in business mathematics, has not been directly addressed in the existing literature. A review of available studies suggests that while NPS is widely recognised across disciplines, studies focusing on its use in assessing individual instructional strategies, such as structured exercises, remain limited. This observation is consistent with recent literature reviews (Adams et al., 2022; Baehre et al., 2021; Jaramillo et al., 2023), which highlight broad applications of NPS across fields but do not report its targeted use for structured mathematical practice. This gap in the literature highlights the need for focused studies that capture student satisfaction within such courses, while also investigating how NPS can enhance our understanding of effective instructional practices in specialised and quantitative domains (Wazzan, 2019).

This study aims to fill this gap by utilising the NPS to assess student satisfaction with structured practice exercises in a business mathematics course. Through the analysis of NPS scores, this research aims to assess the extent to which these exercises align with student expectations and support learning outcomes. The objective is to apply NPS within the novel context of business mathematics practice exercises and to explore how quantitative feedback derived from NPS can guide course design and instructional strategies in this field.

This study offers both academic and practical contributions. Academically, it establishes a foundation for the use of NPS as a reliable metric for assessing instructional components in quantitative courses (Ramadhan et al., 2022). Practically, it provides educators with actionable insights into student satisfaction, offering a metric that could inform future adjustments in curriculum design. This research demonstrates the broader application of NPS beyond conventional business settings, highlighting its effectiveness as a tool for enhancing student engagement and satisfaction in educational environments.

2. LITERATURE REVIEW

In higher education, student satisfaction and engagement are crucial metrics that reflect instructional effectiveness and the overall quality of the learning environment (Cruz et al., 2019). Traditional approaches to gauging student satisfaction often rely on comprehensive surveys, Likert-scale questionnaires, and qualitative feedback forms, capturing multiple dimensions of the student experience, including course content, teaching quality, and learning outcomes (Kapi et al., 2023). While these methods provide valuable insights, they demand extensive data analysis and may yield feedback that is difficult to interpret or to apply consistently across diverse courses and instructional strategies (Wazzan, 2019; German, 2021).

The NPS, introduced by Reichheld as a customer loyalty metric in the business sector, offers an alternative by focusing on a single, pivotal question regarding the likelihood of recommending a product or service (Reichheld, 2003). When adapted to educational contexts, NPS functions as a streamlined yet robust indicator of student satisfaction with specific courses, resources, or learning activities. By encapsulating overall sentiment in a straightforward, quantifiable format, NPS provides educators with a rapid and interpretable mechanism for assessing satisfaction and identifying areas for improvement. This approach positions NPS as an effective supplement to traditional evaluation methods, particularly in contexts where immediate feedback is essential to inform instructional practices (Gamarra-Moreno et al., 2021).

The application of NPS in educational settings has gained momentum as institutions seek efficient ways to assess and enhance student experiences. Recent studies illustrate NPS's effectiveness as an indicator of student satisfaction, engagement, and perceived value in educational environments (Lucero, 2022). For instance, Lucero (2022) demonstrates that NPS can effectively capture students' commitment to recommending educational programs, aligning these recommendations with perceived learning benefits. Gamarra-Moreno et al. (2021) found a positive correlation between higher NPS scores, student retention, and positive feedback on course content, further validating NPS as a tool to measure student satisfaction.

Despite the increasing popularity of NPS in broader educational evaluations, its application in assessing discrete instructional elements, such as practice exercises in mathematics, remains relatively unexplored. Previous research has primarily focused on general course satisfaction or engagement with digital learning platforms rather than examining student responses to specific learning activities. This gap suggests a need for focused studies investigating the applicability of NPS in evaluating targeted instructional practices, such as structured exercises, particularly in quantitative disciplines where consistent practice and engagement are integral to learning (Yudet Millones-Liza & Emperatriz García-Salirrosas, 2021).

Practice exercises occupy a foundational role in mathematics education by reinforcing theoretical knowledge and cultivating essential problem-solving skills. Empirical studies highlight the benefits of regular practice in enhancing students' understanding of mathematical concepts, increasing confidence, and improving retention (Ho et al., 2021). Structured exercises enable students to apply mathematical theories to real-world situations, facilitating the transition from abstract concepts to practical applications. The cumulative nature of mathematical knowledge underscores the importance of these exercises, which support foundational comprehension and enable students to progress to more advanced topics.

While the pedagogical value of practice exercises in mathematics is well-established (Ho et al., 2021), our review of existing literature suggests that their specific impact on student satisfaction has not been widely studied. Most NPS-related research in education focuses on broader evaluations, such as course-level satisfaction or platform usability (Lucero, 2022; Gamarra-Moreno et al., 2021), rather than isolating instructional elements like structured practice exercises. Research has shown that structured practice enhances confidence and improves performance (Ramadhan et al., 2022); however, the extent to which students find such exercises satisfying or recommendable remains underexplored (Sandok, 2021). Assessing satisfaction with structured exercises using the Net Promoter Score (NPS) may yield valuable data on the impact of targeted practice on students' overall educational experiences.

The integration of NPS into mathematics education research represents an innovative approach to evaluating student satisfaction with specific instructional practices. NPS provides a simplified, quantifiable assessment of satisfaction, enhancing current evaluation tools and potentially enriching the understanding of how structured practice influences student engagement and satisfaction in quantitative courses. Further research on the application of NPS in this context could enrich pedagogical strategies and contribute to refining instructional design within mathematics and other quantitative disciplines.

3. METHODOLOGY

This study employs a structured methodology consisting of five key components: (1) Study Context and Course Design, (2) NPS Survey Design and Administration, (3) NPS Calculation and Interpretation, (4) Data Analysis and Comparative Insights, and (5) Data Privacy and Ethical Considerations, as illustrated in Figure 1.

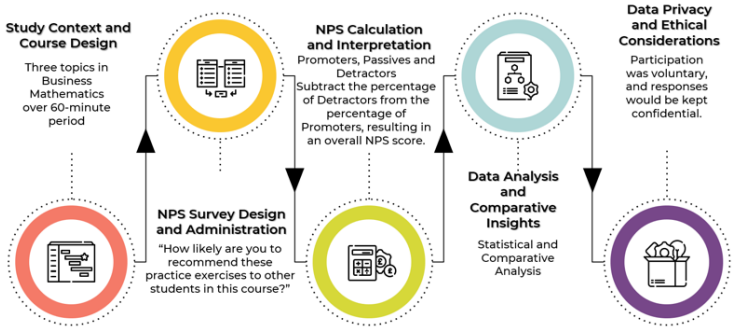

Figure 1: Overview of the five components in the research methodology for assessing student satisfaction with practice exercises in business mathematics using NPS

Each component was carefully designed to systematically assess student satisfaction with practice exercises in a business mathematics course, using the Net Promoter Score (NPS). The following sections present a detailed description of each component.

3.1 STUDY CONTEXT AND COURSE DESIGN

The first component establishes the context of the study within a business mathematics course for undergraduate students. The course curriculum included three main topics essential for practical business applications: Trade and Cash Discounts, Markup and Markdown, and Instalment Purchase. To support learning, each topic was reinforced through a dedicated practice exercise, which allowed students to apply theoretical knowledge to realistic business scenarios. Each exercise was designed to be completed within 60 minutes, providing students with an opportunity to work under time constraints as depicted in Figure 2.

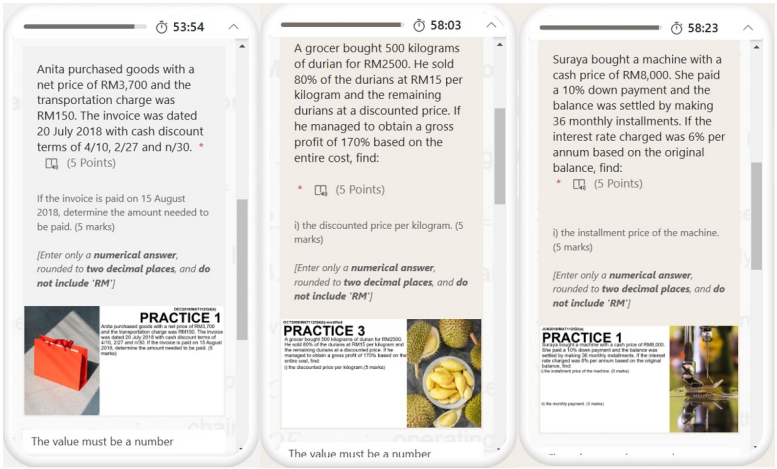

Figure 2: Examples of timed practice exercises in business mathematics delivered via Microsoft Forms in mobile view.

The practice exercises were designed to enhance students' comprehension of core mathematical principles and strengthen their problem-solving skills. By actively engaging with these exercises, students were expected to achieve better retention of the material, bridging the gap between theoretical understanding and practical application.

3.2 NPS SURVEY DESIGN AND ADMINISTRATION

In the second component, a Net Promoter Score (NPS) survey was administered to evaluate students' satisfaction with the practice exercises. The survey consisted of a single, standardised question: "How likely are you to recommend these practice exercises to other students in this course?" This question was intended to capture the overall sentiment and likelihood of recommendation, serving as a key indicator of student satisfaction.

The practice exercises and survey were distributed through Microsoft Forms, an online platform accessible via both mobile devices and computers. This flexibility allowed students to complete the exercises and survey on their preferred device, ensuring ease of access and convenience. The survey was administered immediately after the final practice exercise to 64 students, enabling students to provide feedback based on their recent experiences. Administering the survey at this time ensured that students' feedback was based on their recent experiences with the exercises, providing an accurate reflection of their satisfaction levels.

3.3 NPS CALCULATION AND INTERPRETATION

The third component focused on calculating and interpreting the NPS based on student responses. Following the standard NPS methodology (Reichheld, 2003), responses were categorised as follows:

- Promoters: Students who rated 9-10, indicating a high likelihood of recommending the exercises.
- Passives: Students who rated 7-8, indicating moderate satisfaction without strong enthusiasm.
- Detractors: Students who rated 0-6, indicating dissatisfaction or indifference.

The NPS was calculated by subtracting the percentage of Detractors from the percentage of Promoters, resulting in an overall NPS score for the practice exercises. A higher NPS score indicates a greater level of student satisfaction and willingness to recommend the exercises, providing an interpretable measure of overall sentiment within the class.

3.4 DATA ANALYSIS AND COMPARATIVE INSIGHTS

In the fourth component, data analysis was conducted to derive comparative insights into student satisfaction across three topics: Trade and Cash Discounts, Markup and Markdown, and Instalment Purchase. The analysis focused on the following key areas:

- Statistical Analysis: Calculation of the average scores, distribution of responses, and percentage of Promoters, Passives, and Detractors for each topic.
- Comparative Analysis: Comparison of NPS scores across topics to determine if any specific exercise contributed more significantly to student satisfaction or dissatisfaction.
- Qualitative Feedback: Optional open-ended responses, where students were invited to share specific feedback on their experiences with each exercise. This qualitative feedback was used to contextualise the NPS results, helping to identify aspects of the exercises that particularly resonated with or challenged students.

3.5 DATA PRIVACY AND ETHICAL CONSIDERATIONS

The fifth and final component focused on data privacy and ethical considerations. The survey was conducted anonymously, with students being assured that their participation was voluntary and that responses would remain confidential. All participants were informed that the purpose of the survey was to improve instructional practices and contribute to academic research.

4. RESULTS

The survey assessed student satisfaction with practice questions in Business Mathematics, specifically their likelihood of recommending the questions using the Net Promoter Score (NPS) system. A total of 64 students participated in the survey.

4.1 NPS ANALYSIS

The NPS categorises respondents into three groups based on their likelihood of recommending:

- Promoters (scores of 9-10): These are students who are highly satisfied with the practice questions and are enthusiastic about recommending them to peers. They view the questions as beneficial and engaging, contributing positively to their learning experience.
- Passives (scores of 7-8): Passives are students who are moderately satisfied with the questions. While they see value in the practice material, they are not as enthusiastic as promoters and are unlikely to promote the questions actively.
- Detractors (scores of 0-6): Detractors are students who are less satisfied with the practice questions. They may feel that the questions do not meet their needs or expectations and are unlikely to recommend them. Notably, there were no detractors in this survey.

In this survey of 64 students:

- Promoters (scores of 9-10): 49 students
- Passives (scores of 7-8): 15 students
- Detractors (scores of 0-6): 0 students

The Net Promoter Score, calculated as the percentage of promoters minus the percentage of detractors, is 76.56%. This score is significantly high, indicating strong student satisfaction and a willingness to recommend the practice questions. Most students rated the questions as either 9 or 10, showing strong support for the material.

4.2 COMPARISON WITH NPS BENCHMARKS IN EDUCATION AND BUSINESS

An NPS of 76.56% is notably high when compared to typical benchmarks in both education and business contexts. In the educational sector, scores around 30-40% are generally satisfactory, with anything above 50% considered excellent. For course satisfaction surveys at universities, scores between 20% and 50% are considered standard, depending on the course's engagement and difficulty. This survey's NPS surpasses these typical ranges, indicating a higher-than-average level of student satisfaction. Research has shown that structured improvement processes can significantly enhance student satisfaction. For instance, a study at the College of Pharmacy, Umm Al-Qura University, employed the DMAIC methodology to address various areas of dissatisfaction, including poor catering services and inadequate academic support. The implementation of an improvement plan resulted in an 11.9% increase in the NPS, demonstrating the effectiveness of targeted interventions in enhancing student satisfaction (Jastania et al., 2017). Similarly, the use of the Net Promoter Score in a virtual learning environment during the COVID-19 pandemic revealed high levels of student satisfaction. In courses such as Data Structures, Artificial Intelligence, and Emerging Technologies, the NPS exceeded 75%, which is significantly higher than the average satisfaction level of 71% in educational and training contexts. This indicates that well-structured online learning strategies can lead to exceptional student satisfaction (Gamarra-Moreno et al., 2021). Furthermore, the impact of university accreditation on student satisfaction was examined using the Net Promoter Score (NPS) as a metric. The research showed a significant increase in student satisfaction following the implementation of improvement plans under the SINEACE accreditation model. This underscores the positive effect of accreditation processes on perceived educational quality and student satisfaction.

In business contexts, companies often view an NPS above 50% as indicative of intense customer satisfaction. Leading brands such as Apple and Netflix frequently achieve scores in the 60-70% range. Achieving a score of 77% or higher in this survey places these practice questions on par with top consumer brands, underscoring their effectiveness and value from a student perspective. The Net Promoter Score (NPS) is a widely adopted metric used to gauge customer loyalty and satisfaction. It has been extensively applied

in various industries, including the hotel sector, where it is often integrated into annual budget planning and management evaluations (Baquero, 2022). The NPS is also employed to predict sales growth, with studies confirming its effectiveness in tracking overall brand health and future sales growth, despite some methodological concerns raised by academics (Baehre, 2022). Research has shown that while NPS is positively correlated with customer loyalty, satisfaction, and financial performance, other metrics such as Customer Experience Quality (CEQ) may surpass NPS in these areas, suggesting a synergistic relationship between the two metrics (Bennett & Molisani, 2020). Additionally, studies have indicated that NPS is neither superior nor inferior to other customer satisfaction metrics in predicting company growth rates, highlighting the importance of using a combination of metrics for a comprehensive assessment (Van Doorn et al., 2013).

In conclusion, achieving an NPS close to 77% is a significant accomplishment, placing these practice questions on par with top consumer brands like Apple and Netflix. This high score underscores the effectiveness and value of the practice questions from a student perspective, aligning with the broader understanding of NPS as a key indicator of customer satisfaction and loyalty.

4.3 FEEDBACK ON PRACTICE QUESTIONS

Most respondents (50) did not report any major complaints, with common responses like “no” or “tiada.” A few students provided specific feedback, including requests for answer keys to facilitate self-review for adjustments to decimal precision in some questions.

Many students praised the questions for their effectiveness in preparing for the test. Responses highlighted the challenging nature of the questions and their utility in revision, with one student remarking, “The questions are challenging and good for test preparation.”

Overall, the high NPS score and positive feedback indicate that the practice questions were valuable for students, particularly in enhancing test readiness and mathematical proficiency. This score, well above typical benchmarks in education and comparable to top business standards, underscores the positive impact these materials have on student learning.

5. DISCUSSION

The NPS of 76.56% achieved in this survey indicates an exceptionally high level of student satisfaction with the Business Mathematics practice questions. An NPS score above 50% is generally regarded as a positive indicator, with a score above 70% considered outstanding in both educational and business contexts. This high NPS score indicates that students found the practice questions both valuable and practical, which positively contributed to their academic performance and test readiness. The composition of responses further emphasises the strong satisfaction level: out of the 64 respondents, a large majority were Promoters (scoring 9-10), while there were no Detractors (scoring 0-6).

The large proportion of Promoters in this survey suggests that the practice questions align well with students' expectations and academic needs. Promoters are typically those who find the resources not only helpful but also critical to their learning, often perceiving a direct benefit to their performance. Students who rated the questions as highly likely felt that they effectively supported their preparation for exams, contributing to improved confidence and a deeper understanding of the material. Feedback from promoters emphasised that the questions were "challenging" and "useful for revision," indicating that they were perceived as high-quality materials that fostered both engagement and knowledge retention.

The absence of Detractors is particularly notable, as it suggests a lack of significant dissatisfaction among the students. There are several possible explanations for this. First, the practice questions were well-aligned with the course objectives and student skill levels, ensuring that even students who might typically be more critical found value in the questions. Additionally, students who felt supported in their learning journey by the questions may have had a generally positive perception of the material, which in turn reduced the likelihood of negative feedback. The open feedback section revealed minimal complaints, with many students stating there were "no errors" or "no issues" with the questions. This suggests that any potential areas for dissatisfaction were effectively addressed in the design and structure of the materials.

In educational settings, achieving an NPS score comparable to that of high-performing consumer brands—such as Apple and Netflix, which typically

score in the 60-70% range — is rare. Such a high score in an academic context underscores the quality and relevance of the practice questions. It may also reflect an instructional strategy that supports active learning, whereby students engage in practice to reinforce their understanding. This result highlights the use of practice questions as a potentially powerful tool in enhancing student learning and satisfaction, which may contribute to better academic outcomes.

5.1 LIMITATIONS

While the high NPS score provides a positive measure of student satisfaction, several limitations should be considered. One limitation is the lack of qualitative feedback in the form of in-depth comments, which could offer richer insights into students' specific preferences and perceptions regarding the practice questions. Although some students provided brief feedback, more detailed qualitative data would enable a deeper understanding of what students found most valuable, as well as any nuanced areas for improvement.

Additionally, the survey did not include performance data to correlate with satisfaction scores. Having data on students' actual performance, such as test scores before and after using the practice questions, would enable an analysis of whether higher satisfaction is associated with improved academic outcomes. This correlation could help validate the impact of the practice questions on knowledge retention and exam preparedness. Future research could address these limitations by incorporating mixed methods (both quantitative and qualitative approaches) and collecting performance data to provide a more comprehensive understanding of the effectiveness of the practice questions.

5.2 IMPLICATIONS FOR FUTURE PRACTICE

The high NPS score and positive feedback suggest that these practice questions could serve as a model for developing similar resources in other courses. Emphasising challenging yet relevant questions, as well as providing resources that closely align with course content and testing formats, may foster a similar level of student engagement and satisfaction. Additionally, incorporating student feedback to improve and adapt the materials continually could help maintain high satisfaction levels over time, potentially increasing both retention and academic performance in Business Mathematics, as well as in other related subjects.

6. CONCLUSION

This study revealed a high Net Promoter Score (NPS) of 77%, indicating intense student satisfaction with the Business Mathematics practice questions. The high proportion of Promoters and the absence of Detractors suggest that students found the questions highly effective and relevant to their learning needs. This positive feedback underscores the value of NPS as a reliable metric for evaluating student satisfaction in educational contexts, providing actionable insights for instructors and curriculum developers.

The findings carry practical implications for educational practice. Educators could consider incorporating regular NPS surveys to gauge student satisfaction with course materials and instructional methods. By systematically tracking NPS scores, instructors can pinpoint areas for improvement and refine their materials to enhance student engagement and learning outcomes. Additionally, NPS surveys can serve as a valuable tool for gathering continuous feedback, enabling educators to respond to students' evolving needs and expectations. Future research could build on these findings by exploring the relationship between NPS scores and actual student performance metrics, such as exam or assignment scores, better to understand the impact of satisfaction on academic achievement. Further studies may also apply NPS to various course types and educational contexts, examining how course content and delivery styles impact satisfaction. Such research could provide deeper insights into the factors contributing to student engagement and learning effectiveness in diverse educational settings.

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9. AUTHORS' CONTRIBUTION

Azyan Yusra Kapi @ Kahbi contributed to the conceptualisation and design of the study, developed the research methodology, and led the data analysis. She also made significant contributions to the drafting and editing of the manuscript. Azrina Suhaimi was involved in data collection and management, assisted with data analysis, and contributed to the interpretation of the results. She also reviewed and edited the manuscript for intellectual content and clarity. Harshida Hasmy conducted the literature review, provided critical insights into the theoretical framework, and contributed to the development of the discussion section. She also played a role in revising the manuscript to ensure coherence and academic rigour.

Mohamad Faizal Ab Jabal assisted with the research methodology, helped with data visualisation and presentation, and provided feedback on the manuscript's structure. He also contributed to the final proofreading and approval of the manuscript.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

10. CONFLICT OF INTEREST DECLARATION

The authors hereby certify that they have no conflicts of interest in the subject matter or materials discussed in this manuscript. There are no financial, personal, or professional affiliations or relationships that could be perceived as influencing the research, analysis, or interpretation presented. This declaration is made to affirm the authors' commitment to the integrity and objectivity of the research process, ensuring that the findings and conclusions of this study are presented impartially and without bias.

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Global Disruption: Unveiling the Educational Metamorphosis Triggered by COVID-19

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Abstract: *The COVID-19 pandemic disrupted educational systems across more than 155 nations, affecting billions of students. This unprecedented crisis has accelerated the adoption of online learning, challenging traditional teaching methods and reshaping education in a matter of days. The transition to digital platforms revealed enhanced content retention and quicker learning curves among students in online environments. This study examines the integration of adaptive learning technologies with traditional methods, demonstrating their potential to create personalised and effective educational experiences. A key concern is whether these changes will persist beyond the pandemic. To address this, the study explores the long-term viability of digital adaptations and their potential to transform educational paradigms. This research provides insights into the pandemic's impact on education and offers a roadmap for future practices. It highlights state-of-the-art technological applications that could redefine learning, ensuring education systems are better equipped to prepare for future disruptions.*

Keywords: *Open and Distance Learning, Artificial Intelligence, Education, Online Learning, COVID-19*

1. INTRODUCTION

In December 2019, the world witnessed the emergence of COVID-19, caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), with its first cases reported in China. By March 11, 2020, the World Health Organisation (WHO) officially declared COVID-19 a global pandemic, ushering in a series of unprecedented challenges worldwide. To mitigate the spread of the virus, nations enforced stringent measures such as social distancing, lockdowns, and curfews, which profoundly impacted societal structures, including education. Traditional classroom settings were abruptly rendered inaccessible, compelling educators, students, and institutions to seek alternative solutions for knowledge dissemination (Spiteri et al., 2020; Vargas-Alarcón et al., 2022).

This disruption catalysed a paradigm shift in education, transitioning from conventional in-person instruction to digital learning platforms almost overnight. Policymakers and educators rapidly adopted innovative strategies to ensure the continuity of learning (Sintema, 2020). The pandemic accelerated the integration of digital technologies such as Artificial Intelligence (AI) and Machine Learning (ML) into educational systems, enabling personalised learning, real-time progress tracking, and the creation of adaptive learning environments. These changes redefined the roles of educators and students, highlighting the potential of technology to transform education beyond crisis management (Dhawan, 2020).

This study is a conceptual paper that explores the impact of COVID-19 on higher education systems through theoretical perspectives and a synthesis of existing literature. The data for this paper were collected through peer-reviewed journal articles. The selection criteria included relevance to post-pandemic educational transformations, accessibility, and data credibility. By examining how technology-driven solutions have been leveraged, this research provides a roadmap for integrating digital learning tools and strategies into future educational practices, ensuring resilience and adaptability in the face of disruptions. Figure 1 illustrates the integration of digital tools and methodologies in modern education. It highlights key components, including virtual instructors, collaborative learning environments, and course delivery systems. Additionally, it emphasises the use of online tutorials and help tools for independent learning and data analysis methods to enhance course design,

cooperative exercises, and personalised learning experiences. These elements collectively aim to improve the adaptability and efficiency of education in a digital era.

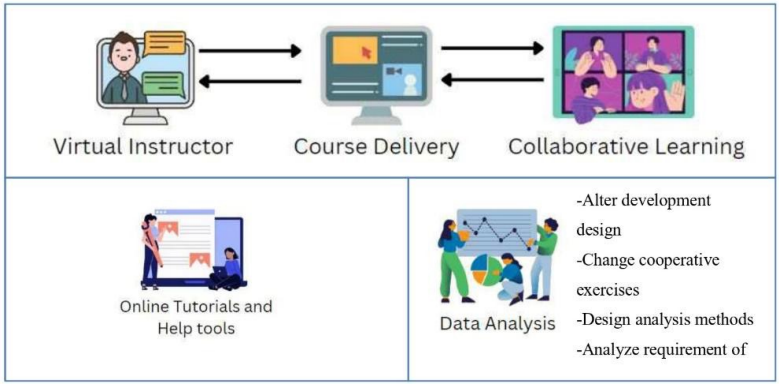

Figure 1: Online Learning Methodology

This methodology encompasses a diverse array of digital resources, interactive tools, and collaborative platforms that extend beyond physical boundaries. As we learn more about e-learning, it becomes clear that this represents a paradigm shift, promoting a more connected and technologically advanced educational experience rather than merely a departure from traditional techniques. Furthermore, the pandemic's widespread adoption of highly popular online courses and open educational resources has increased the opportunity for high-quality education by bridging the gap between various socioeconomic levels and geographic regions. E-learning, which offers students a diverse and engaging platform for knowledge acquisition, is a testament to the evolving landscape of education in a world where digital connectivity is increasingly prevalent (Aboagye et al., 2020).

In the aftermath of the COVID-19 pandemic's impact on online teaching and training, this research highlights several challenges, including communication barriers, inadequate home study environments, equity concerns, and achieving educational excellence in postsecondary education. It presents the cutting-edge concept of digital equity audits, which methodically identify and address inequalities in students' access to technology and digital resources. It highlights shortcomings in online learning, including issues with virtual classrooms,

teachers' limited access to online training, and a lack of expertise in internet-based instruction. The report also identifies creative ways to boost student motivation and engagement, such as incorporating gamification into online learning environments.

This paper also examines the impact of the COVID-19 pandemic on global educational practices, highlighting both challenges and opportunities for academic and digital growth during the pandemic. Amid the complex web of difficulties, the study also suggests a path forward for making headway under the particular conditions created by the COVID-19 pandemic. A common framework for emergency remote teaching will be developed as part of this roadmap, which can be customised to fit different educational environments and guarantee readiness for unforeseen events in the future. This investigation reveals the complexities of educational constraints while also offering a forward-looking perspective that highlights the possibility of learning progress and improvement despite the obstacles faced (Lizcano et al., 2019). Adaptive learning technologies, which employ algorithms to tailor each student's educational experience and better meet their unique learning needs, were a revolutionary technique used during this shift. A paradigm shift was brought about by the transition from traditional in-person instruction to digital platforms, creating an incredibly dynamic learning environment. Despite the initial learning curve, instructors and students found themselves fully engaged in an exceptionally fruitful learning environment.

2. TRANSFORMATION OF EDUCATION: ONLINE PLATFORMS

In response to the COVID-19 pandemic, governments enforced social distancing orders and shutdowns, resulting in the closure of international educational institutions. In reaction to this significant shift in the educational landscape, educators transformed their pedagogical approaches by incorporating an extensive array of digital resources into their lessons. The solution to this unanticipated worldwide catastrophe was online learning, virtual classrooms, and continuous training, which addressed issues faced by both teachers and students. The quick creation and implementation of virtual labs and simulation tools, which preserved the integrity of experiential learning while enabling science and engineering students to perform experiments and practical tasks

remotely, was another novel feature. This transformation of education led to the implementation of emergency training methods, made possible by several online platforms, which require institutions and teachers to be flexible and adaptable (Pokhrel & Chhetri, 2021).

Additionally, a creative way to enhance openness and confidence in digital education is to utilise blockchain technology to manage and verify student credentials and academic records securely. This study explains how educators have responded to pressing issues while also showcasing their inventiveness and resiliency in the face of adversity. Online learning environments like BYJU are providing their courses for free due to high demand. The company's Chief Operating Officer, Mrinal Mohit, reports that the availability of free live classes has resulted in a 200% increase in prospective users of the BYJU Think and Learning application. In addition to increasing their user base, this calculated move provided the platform with valuable data about learning preferences and habits, which enabled them to improve and optimise their tailored learning algorithms. Tencent Education has seen an increase in use concurrently with the Chinese government's directive in mid-February 2022 for a quarter of a billion holistic learners to continue their education online (Rizvi & Nabi, 2021).

Having grown its membership to over 730,000 students, roughly 81% of all prekindergarten students, the Tencent Prekindergarten Virtual Academy in Wuhan has become a significant online academic movement. Tencent implemented AI-driven teaching assistants to handle this unprecedented increase, providing students with immediate help and feedback while maintaining a high level of instruction. This phenomenon not only highlights the flexibility of educational platforms but also underscores the importance of adapting to changes in educational requirements and trends worldwide (Baxter et al., 2022). Additionally, these platforms leveraged cutting-edge data analytics to rapidly identify learning gaps and implement targeted interventions, ultimately enhancing educational outcomes throughout the crisis. Many organisations are expanding their capacities to become all-inclusive centres for learners and teachers. Lark, which was initially created to manage rapid expansion for the Singapore-based firm ByteDance, is a great example. Lark currently offers a range of services, including nearly infinite meeting time, automated translation, real-time co-editing of research projects, and intelligent scheduling coordination, to educators and students. It created a creative integration when they included an AI-driven engagement

tracker that tracks student involvement and provides teachers with feedback, thereby improving the interactive nature of online instruction. Lark increased its technological capabilities and worldwide server capacity in response to the increasing demand, guaranteeing dependable connectivity, which is especially important in times of crisis. Alibaba DingTalk, a platform for remote learning, is also expected to experience a similar upsurge. The CEO of DingTalk, Chen Hang, disclosed their response as they broke the record for the fastest capacity expansion by successfully deploying over 100,000 additional cloud servers in just two hours, utilising Alibaba Cloud. DingTalk unveiled a real-time classroom analytics dashboard to further assist instructors (Xiao et al., 2023). This dashboard empowers teachers with dynamic control over their teaching by providing them with data on student performance and engagement. The enrollment procedure for online courses is illustrated in Figure 2.

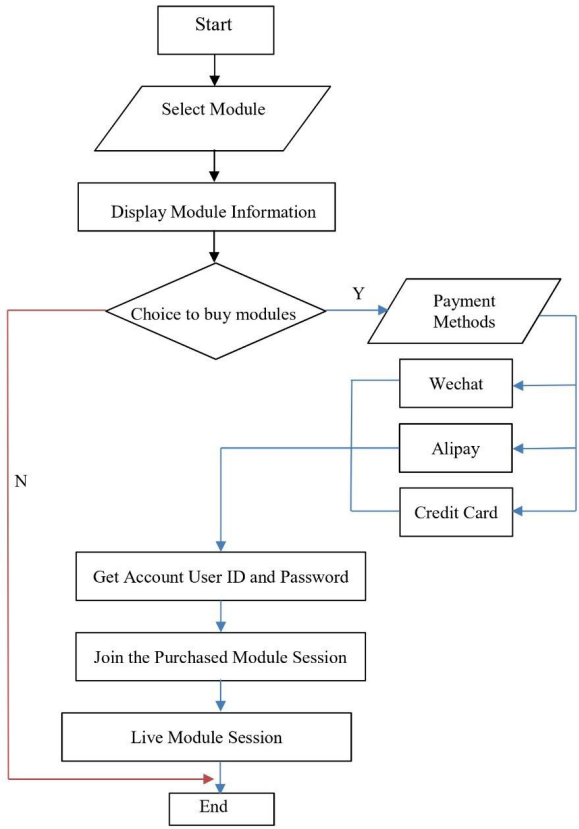

Figure 2: The Flowchart of Online Learning Enrollment

This proactive strategy not only demonstrates adaptability but also emphasises how important technology is in quickly scaling up educational resources to satisfy previously unheard-of demand. Both platforms have also included virtual counselling services and mental health tools, recognising the importance of supporting teachers' and students' well-being during these challenging times. Innovative collaborations are being formed among several public schools. The goal of this partnership is to provide public school broadcasts on various networks, appealing to a wide age range and offering multiple digital alternatives. The incorporation of interactive elements into broadcasts, which enable students to participate in real-time surveys and quizzes, is a unique characteristic of this collaboration that enhances interaction and engagement. Prominent media organisations, such as the BBC, are also supporting virtual education, as evidenced by programs like Bitesize Daily. It was introduced on April 20 and offers 14 weeks of course material coaching to youth in the UK (Anthony et al., 2020). Athletes such as Sergio Aguero of Manchester City promote it. The curriculum incorporates augmented reality features into lectures to provide a rich educational environment that bridges the gap between virtual and physical learning settings. The preparation of educators and learners throughout this shift to new educational paradigms must be appropriately assessed and supported. Teachers now have access to a cutting-edge training program that focuses on building resilience and digital pedagogical skills, preparing them for the shift to online learning. While students with a growth mindset quickly adapt to the latest teaching techniques, individuals with a fixed mindset may find it challenging to adjust (Adipat et al., 2021).

AI-powered technologies are revolutionising education by enabling personalised learning pathways that cater to individual student needs, offering tailored instruction to accommodate diverse learning paces and styles. Tools such as adaptive learning platforms, intelligent tutoring systems, and recommendation engines dynamically adjust content and pace based on a student's performance and interests. This shift underscores that education cannot rely on a one-size-fits-all approach; instead, diverse strategies must be employed to address the varying needs of learners across different themes and grade levels (Udeogalanya, 2022). Moreover, online learning has significantly enhanced accessibility for individuals with physical limitations by minimising mobility barriers. Advanced technologies such as speech recognition software, eye-tracking systems, and text-to-speech converters are being integrated into virtual platforms to create inclusive learning environments (Basilaia

& Kvavadze, 2020). These approaches are not only helpful for gaining information but also for developing essential skills such as critical thinking, problem-solving, and self-directed learning. In addition, facilitated peer-to-peer interactions in virtual environments have been demonstrated in recent research to significantly improve communication and cooperation skills within the flipped classroom paradigm. The technology environment that facilitates remote learning is extensive and varied. Smooth virtual communications are made possible by popular video conferencing technologies like Google Hangouts Meet, Cisco, Slack, Zoom, and WebEx. Such innovations not only empower students with disabilities but also cultivate essential digital skills in a rapidly evolving educational landscape.

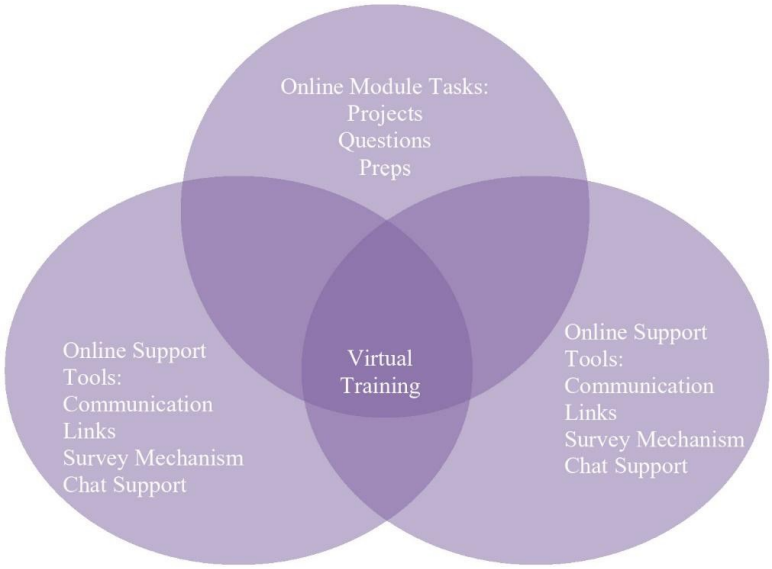

Figure 3: The Virtual Learning Environment

As illustrated in Figure 3, the growing adoption of such technologies emphasises the need for flexibility and adaptability in shaping the future of education. Virtual classrooms are becoming increasingly inclusive and accessible due to recent platform innovations, such as AI-driven real-time transcription and translation services. Furthermore, learning management systems that are cloud-based and adaptable, like Elias, Moodle, BigBlueButton, and Skype, provide instructors and students with an extensive toolbox.

These systems incorporate innovative features, including AI-powered analytics that monitor student performance and engagement, providing teachers with valuable insights to inform their teaching strategies. Furthermore, the incorporation of virtual and augmented reality (VR/AR) capabilities into these platforms is transforming experiential learning by enabling students to participate in previously unthinkable immersive simulations and virtual field excursions. These platforms not only enhance accessibility as technology advances, but they also help students acquire critical skills in an ever-evolving educational environment.

3. UNVEILING OBSTACLES: CHALLENGES IN ONLINE TRAINING AND LEARNING

Handling the wide world of online training and education presents more difficulties than just connecting to and using resources. With numerous alternatives available, students and teachers often struggle to select the most valuable and relevant resources. The process can be enhanced by recent advancements in artificial intelligence and machine learning algorithms, which provide customised suggestions for educational materials and tools tailored to each user's unique learning preferences and needs. Moreover, the fluid nature of digital platforms may lead to challenges in adapting to new interfaces and developing new technologies. To address this, the adoption of adaptable user interfaces that change according to patterns of human interaction can significantly enhance the user experience by providing simple navigation and valuable features. A multidimensional strategy is necessary to address these issues, including user-friendly interface designs, comprehensive training programs, and ongoing support systems to enhance the overall quality of the online learning environment. Cutting-edge training programs with gamification components have demonstrated potential in raising retention and engagement,

improving the efficacy and enjoyment of the learning process. Understanding and addressing these challenges is essential to creating an online learning environment that is both more efficient and more accessible as the digital world develops. Furthermore, the implementation of resilient feedback mechanisms that enable users to promptly express concerns and propose enhancements might result in the ongoing improvement of virtual learning environments.

3.1 CHALLENGES TACKLED BY INSTRUCTORS IN THE REALM OF ONLINE TEACHING

Most tutors faced a challenging learning curve in the rapid transition to online learning while trying to stay current with the latest developments. When transferring traditional in-person courses to virtual classrooms, teachers found it easier to use pre-made teaching materials rather than starting from scratch. However, as teachers adjusted their classes to account for technical complexities, problems surfaced. Some cutting-edge platforms have addressed these issues by introducing AI-driven lesson planning tools that can automatically convert paper lesson plans into interactive online formats, significantly reducing the technical burden on teachers (Worthington & Levasseur, 2015). The requirements of online instruction proved too much for the instruments that had worked effectively for them in traditional settings, underscoring the necessity for more technological expertise in the rapidly changing field of digital education. Specialised training programs in digital pedagogy and the integration of new technology into teaching methods have been developed in response to this. These programs, which offer certificates and micro-credentials, provide teachers with specialised skills to enhance their ability to teach online. This dynamic movement highlights the importance of educators being adaptable and underscores the need for ongoing professional development to navigate the complexities of online education effectively. Additionally, peer-to-peer learning and the exchange of best practices among educators are facilitated by collaborative platforms that are emerging. This promotes the development of a supportive community and ongoing advancements in digital teaching approaches (Rapanta et al., 2020). With the shift from conventional teaching techniques that heavily relied on PowerPoint presentations, educators are facing the challenge of providing students with insufficient slideshows to understand the material independently. The requirement for internet services to maintain connectivity may pose additional difficulties, especially when handling potentially slow broadband connections, as shown in Figure 4.

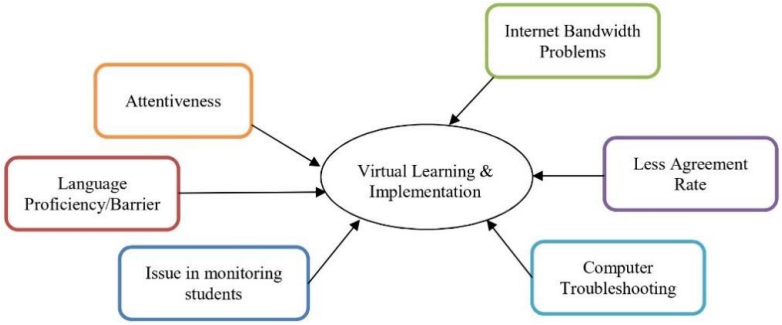

Figure 4: Challenges in Online Training and Learning

This dilemma calls for the investigation of novel tools and development techniques to produce comprehensive educational resources. To close this gap, creative solutions are being created, such as interactive e-books and multimedia-rich content platforms, which will enable students to have more engaging and self-paced learning experiences (Cullinan et al., 2021). It is possible that previously available technology tools, such as computers and the internet, were offered by educational institutions for use in instruction and learning. However, these days, teachers have to rely on their home resources, which might not always be efficient or easily accessible. This change raises several problems, one of which is that teachers' personal computers may not have the most recent upgrades installed to support new features and handle large file sizes related to course materials. Virtual Desktop Infrastructures (VDI) and cloud-based solutions are becoming essential tools to address these issues, allowing educators to access powerful computer resources and updated software without requiring expensive gear at home. Effective online education depends critically on instructors being able to adapt to this new environment and having access to updated technology. Additionally, organisations are starting to implement digital literacy initiatives and provide remote technical assistance to help teachers overcome technological difficulties and enhance their ability to deliver high-quality instruction remotely.

This is especially evident when households simultaneously engage in online activities for both work and leisure. Faculty personnel may encounter restrictions regarding resources necessary for creating courses, communicating with students, and exchanging knowledge, such as cloud-based solutions, video

conferencing software, and screen recording apps. Due to access limitations and brief trial periods, educators should be cautious of free services and demo software, as many credible tools require membership payments. To improve the quality of online education without increasing expenses, some universities are now exploring partnerships with digital businesses to offer staff and students free or heavily discounted access to premium learning resources (Mody & Gontjes, 2022). To ensure the uninterrupted operation of online education in the event of unforeseen circumstances, educators must make a long-term commitment to training and become proficient in Information and Communication Technologies (ICT). In addition, novel approaches such as mesh network technology are being explored to enhance connectivity in regions with inadequate internet infrastructure, ensuring that every student can engage efficiently in online learning (Tadesse & Muluye, 2020). Teachers must contend with the challenges that come with connectivity and access, while also preparing for the ongoing need to adapt to new digital tools and resources as technology continues to evolve. Furthermore, efforts are being made to integrate artificial intelligence into educational platforms to provide personalised learning experiences. This would enable more effective catering to the individual needs of students and promote an inclusive learning environment.

Some academic staff members have started using Zoom, but only for the 40-minute free trial version. When courses were ending just before the scheduled lecture periods, this constraint became apparent. Furthermore, the fact that Zoom broadcasts require high-speed internet presents a challenge for students who might not have access to such connectivity. Real-time education introduces an additional level of complexity, as some students may behave or speak in ways that contradict social etiquette conventions. This puts further strain on teachers, who are already juggling other responsibilities outside of the classroom. Innovative approaches, such as asynchronous learning models, where students view recorded lectures at their convenience, are being used to mitigate these difficulties. This method provides students in different time zones or with varied timetables with flexibility, while also reducing the strain on real-time internet connectivity (Basar et al., 2021). The changing online tool landscape and the requirement for inclusive and respectful online conduct become critical components to address for an efficient and fair learning environment as educators navigate the challenges of virtual education. To help educators manage conduct in online classrooms, preserve social etiquette, and lessen the additional load on teachers, new software advancements in AI-driven

moderation tools are also being launched. These technologies offer a more regulated and polite virtual learning environment by automatically identifying and responding to unwanted conduct.

3.2 CHALLENGES TACKLED BY INSTRUCTORS IN THE REALM OF ONLINE TEACHING

Educational systems need to acknowledge that students from low-income families and those residing in rural areas often face challenges in accessing reliable online and multimedia resources, such as virtual meetings and other digital tools. This highlights the importance of teachers considering the diverse technological aptitudes and internet access levels of their students when they enrol in an online course. To address these issues and close the digital divide, creative projects such as mobile learning systems are being implemented. By utilising widely available smartphones, mobile learning eliminates the need for expensive computer equipment and traditional internet connectivity, offering interactive learning experiences and instructional content (Edelhauser & Lupu-Dima, 2021). Because they lack access to reliable technology or the internet, some students struggle to participate in online learning, highlighting socioeconomic differences both within and across countries. According to the International Student Assessment Program (ISAP), only 34% of Indonesian students have access to a computer for educational purposes, compared to 95% in nations like Austria, Switzerland, and Norway. This highlights the nation's significant digital divide. On the other hand, new developments in satellite internet technology hold the potential to transform rural internet access altogether, providing high-speed connectivity to marginalised groups and levelling the playing field for students everywhere (Goudeau et al., 2021). Addressing these gaps is crucial for creating inclusive and equitable learning environments internationally, as education continues to shift online.

In the United States, a clear difference exists between wealthy and less wealthy households: only 25% of children from less affluent homes report having access to a computer at age 15, whereas almost all 15-year-olds from wealthier families report having one. Although several educational institutions, such as those in New South Wales, Australia, have provided pupils in need with technical equipment, worries about the ongoing epidemic potentially widening the technology divide still exist. Creative strategies are being explored to alleviate this problem, such as community-driven technology sharing initiatives, in

which wealthy households donate gently used equipment to underprivileged pupils, guaranteeing fair access to educational materials (Nufus et al., 2023). In the past, comprehension was improved for students in physical classrooms by keeping eye contact with teachers, reading their body language, and analysing their attitude. Furthermore, students' learning experiences have been greatly aided by the confidence they gained from knowing that teachers were always ready to explain any confusing topics. Fostering a fair and equitable education system becomes increasingly dependent on bridging technology gaps and maintaining the fundamental elements of conventional learning as educational dynamics continue to evolve.

However, educators were forced to choose between synchronous learning and real-time remote learning due to several technological obstacles, including issues with internet speeds, connectivity, and other problems. As an alternative, students can participate in asynchronous lectures, where they view a previously recorded lecture sent to them via email. The disadvantage is that the session may not meet the intended standards of excellence if it is the instructor's first attempt at conducting one. Among the many additional challenges that instructors face, one of the most notable is the quality of the streaming audio in online session recordings. The pursuit of efficient synchronous and asynchronous learning techniques becomes increasingly crucial as the educational landscape evolves into new modalities, necessitating ongoing improvement and technological breakthroughs to ensure the best possible virtual learning environment.

Thus, the primary obstacles related to e-learning are financial limitations, flexibility, accessibility, learning approaches, the significance of lifelong learning, and curriculum design (Godber & Atkins, 2021). Innovative approaches to address these issues are being developed, such as personalised adaptive learning algorithms and gamified learning platforms, to accommodate a range of learning preferences and styles and promote more successful and engaging online learning (Bhamani et al., 2020). For students taking online courses, personality development and participation in outdoor extracurricular activities are becoming increasingly important, underscoring the need for a comprehensive education that extends beyond traditional academic disciplines. In response to concerns about parental guidance, joint efforts between academic institutions and community organisations are being undertaken to provide resources and support for parents and students, ensuring a supportive learning environment even in homes where one or both parents work.

To overcome these obstacles, physical workstations must be designed that take into account the various aspects affecting successful online education and accommodate a range of learning styles. Emerging innovations in e-learning, such as peer-to-peer learning networks and virtual mentoring programs, are transforming the landscape of online education, fostering social engagement and collaboration among students in virtual settings (King et al., 2022). To build a strong and welcoming online learning environment that fosters intellectual, emotional, and social growth in the digital age, a comprehensive strategy that incorporates both technological and socioemotional factors is essential.

4. IMPLICATIONS ARISING FROM ONLINE LEARNING AND EVALUATION

As online learners experience reduced contact time and encounter fewer interactions with instructors to address challenges in knowledge acquisition, it is anticipated that the quality of students' academic performance will diminish in both 12-month assessments and class examinations. The traditional method of conducting proctored assessments was deemed impractical during the COVID-19 outbreak due to the risk of infection transmission. This led to the adoption of online examinations, introducing a significant amount of trial and error, ambiguity and heightened frustration stemming from misunderstandings among instructors, students, and guardians (Murphy & Wyness, 2020). As the educational landscape grapples with these shifts, the repercussions on assessment methodologies and student performance underscore the need for innovative and effective strategies in the realm of online learning. Various strategies are employed to conduct online tests, taking into consideration the comfort level, expertise threshold and synchronisation of both teachers and students. Due to the extensive student population, standardised methods for detecting violations have yet to be universally implemented across many institutions and schools. Interestingly, amidst the disruptions caused by the lockdown and the shift to online learning, some students have experienced unexpected benefits. For instance, in Norway, a decision was made for every Grade 10 learner to receive a high school diploma (Maurin & McNally, 2008). Similarly, a French study highlighted that the 1968 youth demonstrations' choice to deviate from traditional examination procedures had a significant and lasting impact on the affected cohorts in terms of their labour supply (Ali & Dmour, 2021). These nuanced approaches and unanticipated outcomes underscore

the complexity and varied repercussions of online testing methodologies. If you have more than one paragraph, please insert a line space between the paragraphs. Do not insert any spaces before and after the paragraph. Please insert a line spacing after each paragraph, before the next section.

Online exam platforms present both advantages and drawbacks. The benefits include increased efficiency, reduced time, cost savings and a decrease in paperwork. However, a notable drawback is the heightened susceptibility to cheating, which requires a careful approach in designing evaluations to address this issue. It is essential to create assessments that cannot be easily solved by referencing textbooks or online sources. While essay questions can be incorporated, they present challenges in terms of grading, as they require meticulous evaluation by examiners. The challenge becomes more pronounced when dealing with practical curriculum components that necessitate face-to-face interactions, such as laboratories, demonstrations, and workshops. These hands-on experiences are crucial for learners and their absence poses a significant obstacle to qualification. As educational assessments continue to evolve, finding the right balance between the advantages and challenges of online exam platforms becomes imperative for ensuring fair and effective evaluation processes. Online evaluation methods have evolved to cater to the digital landscape. Educationalists are leveraging a variety of valuation tools, including online quizzes, interactive projects and virtual exams. This transfer has prompted a reassessment of traditional grading procedures, with a growing emphasis on assessing not just memorisation but also critical thinking, problem-solving, and digital literacy. Teachers are adapting to the need for clear and timely communication, providing detailed feedback to students through digital channels (Sapriati et al., 2023).

Learners may sometimes resort to using equipment for in-house experiments or accessing virtual laboratories, but this necessitates careful planning and preparation, making it challenging to accomplish within tight deadlines. Withholding specific coursework from students is feasible, especially if it is not essential for their major and does not adversely impact their ability to pass. However, in cases where practical experience is integral to their specialisation, a mechanism should be in place for learners to complete such work once the crisis has abated and conditions are conducive. This flexible method of approaching practical learning emphasises the need to provide students with opportunities to gain essential real-world expertise in their chosen disciplines,

while acknowledging the limitations imposed by unanticipated events. The challenges of maintaining a sense of community in online learning environments are faced by both educators and learners. Videoconferencing technologies and platforms for collaboration have become indispensable for promoting contact and engagement. While access to and customised educational opportunities are two advantages of online learning, there are drawbacks as well, such as the requirement for fair access to technological advances and the potential for an increase in academic fraud. Currently, ongoing collaboration between educators and learners is essential to address these implications and refine the online learning and evaluation landscape for a more effective and inclusive educational experience (Braßler & Schultze, 2021).

4.1 IMPLICATIONS ON OPPORTUNITIES AND THE EFFICIENCY OF ONLINE LEARNING

Given the concerns raised by some individuals who anticipate unfavourable user experiences and a hindrance to sustainable development due to the abrupt transition to web-based learning without sufficient preparation, training, and readiness, there is an opposing belief that a novel hybrid instructional approach could emerge, offering substantial advantages. Wang Tao, Vice President of Tencent Cloud and Tencent Education, envisions a continued acceleration of information technology integration in educational settings. He predicts that distance learning will evolve into an integral component of learning environments, emphasising the ongoing transformation and potential long-term benefits in education (Braßler & Schultze, 2021). As the educational landscape adapts, these differing perspectives underscore the ongoing debate surrounding the future of online learning and its potential to revolutionise traditional educational paradigms.

Several universities have successfully undergone transformative measures. For example, Zhejiang University swiftly implemented DingTalk ZJU, enabling a seamless transition to providing over 5,000 classes online within just two weeks. Notably, Imperial College London introduced a highly popular program on Coursera in 2020 focused on coronavirus research (Blinkoff et al., 2023). This program has garnered widespread acclaim for its benefits. Dr. Amjad, a faculty member at the University of Jordan utilising Lark for instruction, attests, “It has revolutionised my teaching approach. Particularly during this pandemic, it allows me to engage with my students efficiently through

group chats, video conferences, polling, and content sharing" (Bailey et al., 2020). These success stories highlight the adaptability and effectiveness of innovative tools and approaches in the face of challenges, offering a glimpse into the evolving landscape of higher education, as illustrated in Figure 5. More notably than ever, the bond between teachers and parents has been strengthened, especially as parents play a more active role in supporting their children's academic and economic development during homeschooling. The global shift to digital platforms for learning and teaching, including Zoom, Google Classroom, virtual learning environments and various social and group platforms such as WhatsApp, Telegram Messenger and WeChat, represents a unique era in education (Bustamante et al., 2022). This shared experience among instructors, parents and learners creates unprecedented opportunities for collaboration, the development of innovative solutions and a shared enthusiasm for learning from one another and exploring novel approaches. In the evolving landscape of education, the integration of digital platforms not only facilitates learning but also fosters a collaborative and dynamic educational ecosystem.

A survey in the United States indicates that learners often retain 25–60% more knowledge when engaged in online learning compared to 8–10% in a traditional classroom setting. The flexibility of studying at one's own pace, whether through re-reading, skimming, or swiftly navigating subjects, contributes to increased retention (Hollister et al., 2022). Furthermore, e-learning requires 40–60% less time to comprehend than conventional classroom instruction, primarily because learners can access materials online (Chi, 2009). Dowson Tong, President of Smart Industries Group, emphasises the need for a coordinated effort to establish a framework that transcends merely replicating a physical classroom through video capabilities. He emphasises the importance of utilising a variety of tools, features, and awareness approaches that promote integration, personalisation, and competence (Claessens et al., 2013). These insights underscore the effectiveness and efficiency of online learning methodologies, highlighting the need for a strategic approach to enhance the overall learning experience. Recognising that children primarily rely on basic senses for learning, Mrinal Mohit from BYJU emphasises the importance of utilising technology to make education engaging and effective. Drawing from experience, Mohit notes that incorporating gamification has proven to enhance participation and foster a heightened enthusiasm for learning, particularly among young learners. This approach surpasses traditional methods, fostering a genuine fascination with the learning process (Crouch et al., 2018). The

incorporation of captivating components into education has the power to revolutionise the learning process as technology advances, drawing students' attention and commitment in fresh and creative ways.

Following the epidemic, the effectiveness of online learning in this modern era is highlighted by its capacity to provide individualised and adaptable learning experiences. From the convenience of their residences, learners can access a wide range of programs and materials, customising their education to fit their schedules and preferences. The online learning environment has been enhanced by collaborative tools, immersive technology, and AI-centred learning systems, which offer dynamic and captivating educational possibilities. The adaptability of online learning has also been instrumental in addressing various learning styles and accommodating diverse student needs. While challenges such as the digital divide and the importance of social interaction persist, the overwhelming trend in 2023 is the recognition of online learning as a resilient, scalable and effective educational model. The experiences of adapting to online education during the pandemic have spurred continued innovation, fostering a dynamic educational environment that prioritises accessibility, personalised learning and the seamless integration of technology into the fabric of modern education (Deslauriers et al., 2019).

5. CONCLUSION

The COVID-19 pandemic's aftermath has sparked a radical change in the field of education. Following extensive disruptions, the effectiveness of the conventional educational paradigm in fostering 21st-century skills has come under scrutiny. While the pandemic thrust online learning into the spotlight, revealing both advantages and challenges, numerous countries embraced this paradigm shift, expanding the use of online education. This study examines the collaborative efforts of instructors and students in exploring effective strategies amid ongoing pandemic challenges. The analysis reveals that the willingness of learners to engage in additional e-learning depends on effective teaching methodologies, time management proficiency, and the adaptability of online platforms like BYJU's, DingTalk ZJU, and others. Factors influencing less frequent e-learning include communication challenges, unreliable internet connectivity and unfavourable living conditions. Learners who view online training as a time-saving alternative and maintain focus stand to

benefit the most. Critical conclusions suggest the need to enhance teaching methods, prioritise effective communication, and create designated spaces for online learners on campuses. Educating parents about their children's virtual classroom needs is crucial, ensuring a conducive domestic learning environment. As institutions grapple with the collective lessons learned, an opportunity arises to deliver online instruction more effectively, particularly in emergencies. Advanced technologies, such as artificial intelligence-driven platforms and virtual reality tools, can further enhance the quality of online education. The vision for 2024 reflects a paradigm shift, with the widespread adoption of digital methodologies and the integration of hybrid models to enhance flexibility. While the benefits of online learning are evident, challenges persist, including issues of digital equity and the challenge of replicating social interactions online. In conclusion, post-COVID-19 online learning has become integral, shaping the future of education through the ongoing refinement of digital tools and a nuanced understanding of its benefits and challenges. The evolving landscape positions online learning as a dynamic force in education, redefining how knowledge is acquired and shared.

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8. AUTHORS' CONTRIBUTION

Mr. Abdul Basit designed the study framework, coordinated the research activities, and led the writing of the manuscript. Prof.Dr. Jasni Mohamad Zain provided strategic guidance, reviewed the methodology, and contributed to

refining the manuscript. Miss Hafiza Zoya Mojahid conducted data collection, analysis, and visualisation. Dr. Abdul Kadir Jumaat contributed to the validation of findings and ensured the alignment of the research with the study objectives. Dr. Nur'Izzati Hamdan reviewed and enhanced the statistical approaches, contributing to the interpretation of the results. All authors provided critical feedback, shaped the research direction, and approved the final manuscript version.

9. CONFLICT OF INTEREST DECLARATION

We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research/manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to IJELHE.

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Evaluating the Impact of CIDOS in Enhancing Digital Literacy and Learning Outcomes among Community College Students: A Focus on Accessibility and Usability

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Abstract: *The study examines the impact of the Curriculum Information Document Online System (CIDOS) on digital literacy and learning outcomes among students at Selayang Community College, Malaysia. A mixed-methods approach combined quantitative data from 200 student surveys with qualitative insights from 15 in-depth interviews. Using the Technology Acceptance Model, the research found that perceived usefulness and student engagement were significant predictors of learning outcomes. In contrast, ease of use was not a significant predictor of learning outcomes. Challenges such as inconsistent internet access and varying digital literacy levels were identified, but they did not significantly hinder academic performance. The study emphasises the importance of content relevance and engagement features over technical simplicity in driving effective digital learning. Recommendations include system stability, expanding digital literacy programs, and improving internet accessibility.*

Keywords: *Curriculum Information Document Online System (CIDOS), Learning Management System (LMS), Technology Acceptance Model (TAM), Digital Learning (DL)*

1. INTRODUCTION

Educational practices are redefined as traditional teaching and learning methods are adapted to present-day digital platforms. In academic settings, digital literacy is key, particularly at the college level. Integrating technology in education, primarily via Learning Management Systems (LMS), underscores the strong emphasis needed on digital literacy for academics. UNESCO's (2021) research indicates that drawbacks to digital literacy are often exacerbated by socio-economic factors, uneven access to technological resources, and patchy internet connectivity, which can render live communication impossible between students and the platform.

In Malaysia, the Curriculum Information Document Online System (CIDOS) is a tool designed to support online and blended learning in polytechnics and community colleges. Initially developed for the delivery of curricula and blended learning for Polytechnic students, CIDOS has evolved into a multifunctional tool that aims to increase peer collaboration, knowledge exchange, and hands-on digital skills building (Yahya, Hussin, Abdullah, 2024; Hasnan Mohin, 2021). CIDOS, which was initiated in 2023, is a Web-based tool to promote digital learning experiences throughout the Malaysian Community College system.

Based on the Technology Acceptance Model (TAM), this research examines how CIDOS influences students' technological confidence and classroom success. Despite the growing reliance on CIDOS in Malaysian Community Colleges, there is a noticeable lack of empirical research assessing its real-world effectiveness, particularly concerning its usability, accessibility, and impact on digital literacy and learning outcomes. Most existing studies focus on Polytechnic institutions, with minimal attention given to Community Colleges, where students may face unique socio-economic and technological challenges.

In Malaysia's Community Colleges, CIDOS was introduced to enhance digital learning experiences. Despite its implementation, the acceptance of using CIDOS for teaching and learning faces challenges related to inconsistent internet connectivity, inadequate user training, and complex interface design. Most current studies have focused on Polytechnics. Yong et al. (2022) and Hasnan and Mohin (2021) highlight these systemic barriers; however, limited research exists on how these issues affect students' digital literacy and learning outcomes in Community Colleges.

Although CIDOS was introduced to enhance the digital learning experiences of various communities, including those in campus-based schools and students from lower-income backgrounds, its implementation has encountered challenges such as inconsistent internet access, insufficient staff training prior to the project launch, and a complex interface design that yields unexpected results. In short, there is still little research to verify how these systematic obstacles affect students' digital literacy and their study achievements in Community Colleges.

This study aims to bridge the gap by exploring the specific challenges faced by Selayang Community College students to identify strategies to improve CIDOS' usability and accessibility. The findings will provide ideas for improving CIDOS to serve better its objective of supporting effective digital learning and fulfilling the goal of providing individuals from all backgrounds within the Malaysian Community College System with an equal opportunity to be educated through virtual classrooms.

2. LITERATURE REVIEW

2.1 LEARNING MANAGEMENT SYSTEM (LMS) EVOLUTION AND CIDOS IN MALAYSIAN HIGHER EDUCATION

The Learning Management System (LMS) has evolved to support modern learning and content creation. It enables a combination of teaching and learning methods, including blended learning, tools for resource sharing, and real-time collaborative resources (Jansen et al., 2020). In Malaysia, CIDOS (Curriculum and Instructional Design Online System) is the Learning Management System (LMS) of the Department of Polytechnic and Community College Education (DPCCE), specifically designed for use in Technical and Vocational Education and Training (TVET) institutions, also known as community colleges. Unlike Moodle or Canvas, CIDOS supports the integration of curricula and the management of learning materials (Hasnan & Mohin, 2021). However, its implementation phase presents several obstacles, including inconsistencies in internet access and maladaptation (Yahya et al., 2024). CIDOS makes course delivery efficient for educators, but its success ultimately depends on overcoming barriers related to accessibility and usability.

2.2 DIGITAL LITERACY AND LEARNING OUTCOMES

Digital literacy (DL) is the capacity to navigate, evaluate, and create digital content, which directly impacts students' academic performance. In a previous study, Ying et al. (2022) found a positive relationship between the frequency of CIDOS usage and the better digital literacy (DL) skills of Malaysian community college students, especially in online collaboration and information retrieval. However, DL benefits are not uniform: learners with prior experience in technology outperformed their colleagues by 25% in course completion rates. Garcia et al. (2023) highlighted the role of mentorship in driving behaviour, demonstrating that DL training increased assignment submission rates by 40%. Most studies overlook the impact of DL on long-term educational outcomes, certifications, and employability. This study addresses this gap by linking CIDOS engagement to measurable learning outcomes such as grades and skill acquisition.

2.3 COMPARATIVE STUDIES AND ALTERNATIVE PLATFORMS

Rodriguez et al. (2022) and Tan et al. (2023) found that Canvas is superior in terms of interaction design and third-party tool integration for Learning Management System (LMS) platforms. However, due to its ease of integration with Office applications, Teams is the preferred choice. The two studies highlight the vital role that user training and technical support can play in enabling the successful adoption of the LMS, emphasising the need for LMS systems with greater functionality.

Meanwhile, compared to Moodle and Google Classroom, Hasnan and Mohin (2021) stated that CIDOS, while aligning effectively with curriculum objectives and organising course resources, lacked a user-friendly design and real-time communication functions. According to Yong et al. (2022), usability issues and a lack of interactive features impeded the adoption of CIDOS in Malaysian Polytechnics, suggesting that design and functionality improvements are essential.

2.4 BRIDGING THE GAP BETWEEN USABILITY AND DESIGN WITH TAM

Usability profoundly shapes student involvement within LMS platforms. TAM hypothesises that perceived ease of use (PEOU) and perceived usefulness (PU) determine technology adoption (Davis, 1989). Studies analysing CIDOS reveal mixed results: while its curriculum-oriented organisation advances PU, poor interface and constrained interactivity limit PEOU (Yong et al., 2022). For instance, Razali and Shahbodin (2014) found that CIDOS's complex navigation discouraged nearly one-third of learners from participating in online discussions. These findings suggest CIDOS can improve critical thinking and problem-solving skills, particularly in virtual learning environments. This aligns with Islam et al. (2023), who argue that virtual learning promotes creativity and flexibility, especially in higher education settings.

Despite these observations, the studies lack actionable recommendations for improving CIDOS's design or functionality. Moreover, existing research on CIDOS primarily focuses on technical aspects rather than its educational impact. For instance, while Anggraeni et al. (2023) emphasise the importance of immediate feedback in LMS, there is insufficient exploration of how CIDOS's feedback mechanisms influence student learning outcomes. Furthermore, perceptions of CIDOS's usefulness and ease of use vary among user groups (Navin & Sulaiman, 2021; Yong et al., 2022). In contrast, platforms similar to Canvas prioritise straightforward design and third-party integration, enhancing PEOU and PU (Rodriguez et al., 2022). Training courses can mitigate these issues; Garcia et al. (2023) demonstrated that structured digital literacy preparation amplified LMS involvement by 60%. This analysis applies the Technology Acceptance Model (TAM) to assess how a usability overhaul and instructional initiatives in CIDOS could enhance acceptance.

3. METHODOLOGY

This research adopts a blended approach, integrating statistical analysis with narrative insights to assess how effectively CIDOS bridges digital literacy gaps among students at Selayang Community College. Framed within

the Technology Acceptance Model (TAM), the study prioritises four core dimensions: ease of use, perceived usefulness, accessibility, and impact on learning outcomes. It strives to paint a complete picture of how CIDOS shapes students' academic journeys by weaving together numerical data and interviews.

The research population for this study was the CIDOS users enrolled at Selayang Community College. To ensure credibility, 200 students were surveyed to capture broad trends, while 15 participated in interviews to share their experiences. This study used stratified sampling, ensuring diverse representation across academic programmes and levels.

For the quantitative phase, a structured survey was deployed, using a 5-point rating scale (1 = Strongly Disagree to 5 = Strongly Agree) to measure perceptions of CIDOS's practicality, relevance, accessibility, and influence on learning. Content validation of the survey instrument was conducted through a systematic expert review process involving two senior lecturers in educational technology, each with extensive experience in digital learning environments and instructional design.

Following the expert validation, a pilot test was administered to 20 students from Selayang Community College who were not part of the final study cohort. The pilot's objective was to evaluate the instrument's reliability, internal consistency, and comprehensibility from the students' perspective. Responses were analysed for reliability using preliminary Cronbach's Alpha, and cognitive debriefing was employed to gather participant reflections on the clarity and interpretability of the items. Based on this feedback, revisions were made to ambiguous questions, and formatting adjustments were introduced to improve the user experience prior to the full-scale survey rollout.

To ensure the reliability of the questionnaire, the researcher employed the Cronbach's Alpha method to assess internal consistency. The total reliability for all items was determined to be 0.975 (Table 1), showing high internal consistency.

Cronbach's Alpha N of Items	Cronbach's Alpha N of Items
.975	25

Table 1: Overall Reliability Statistics for the Questionnaire

These results suggest that the survey items are highly reliable and consistent in measuring the intended constructs. Each section of the survey also demonstrated high reliability, with values exceeding 0.90, reinforcing the consistency of the responses.

The qualitative stage involved semi-structured interviews with 15 purposefully selected students to capture in-depth perspectives on their experiences with CIDOS. It explored the challenges students faced using the platform, identified possible improvements that could be made, and gathered reflections on the impact of CIDOS on their learning outcomes. Thematic analysis was employed as the analytical framework, following Braun and Clarke's (2006) six-phase approach: familiarisation with the data, initial coding, theme generation, theme review, definition and naming of themes, and report production. Coding was performed inductively to allow patterns to emerge from the data, while also being informed deductively by the Technology Acceptance Model (TAM) constructs. Three overarching themes were identified: (1) Navigational Accessibility and Interface Design, (2) Learner Autonomy and Motivation, and (3) Infrastructure and Device Limitations. These themes provided nuanced insights that complemented the quantitative findings and helped contextualise statistical associations with authentic student narratives. These themes offered rich contextual insights that complemented and substantiated the quantitative findings (Garcia, Lopez, & Martinez, 2023; Islam et al., 2023).

The data were processed using SPSS (version 29) to examine the influence of CIDOS (Community College Digital Learning System) on improving digital literacy and academic outcomes among community college students, with an emphasis on accessibility and usability. The results are presented in the following sections.

4. RESULT

4.1 HOW DO COMMUNITY COLLEGE STUDENTS PERCEIVE THE USABILITY AND ACCESSIBILITY OF CIDOS?

The findings indicate that community college students perceive CIDOS as a user-friendly and accessible platform. Perceived Ease of Use had a mean score of 3.659, while Perceived Usefulness recorded a mean of 3.714. These values suggest that most students found the system relatively easy to navigate and beneficial for learning activities. The instrument's internal consistency was strong, with Cronbach's Alpha of 0.941 for Ease of Use and 0.969 for Usefulness, supporting the reliability of these constructs.

Internet accessibility results showed that 56% of students had consistent access when using CIDOS, and 52% primarily accessed the system via smartphones, underscoring its cross-device usability. However, 37% noted that their internet access was only occasionally reliable, indicating that connectivity remains a barrier for some students.

Qualitative insights further reinforce these findings. Students commonly cited the following features as beneficial:

a. Ease of use (e.g., "Mudah untuk difahami" / "Easy to understand")
b. Access to structured learning materials
c. Convenient revision tools (e.g., "Senang melihat nota dalam CIDOS untuk ulang kaji" / "Easy to review notes in CIDOS")

Quantitative correlation analysis showed strong, statistically significant relationships between students' perceptions and their learning outcomes:

Variables	Correlation Coefficient (r)	Significance (p)
Perceived Ease of Use	0.778	$p < 0.001$
Perceived Usefulness	0.894	$p < 0.001$
Engagement	0.889	$p < 0.001$
Challenges	0.419	$p < 0.001$

Table 2: Pearson Correlations with Learning Outcome (N = 200)

These results suggest that students who perceive CIDOS as useful and engaging report better learning outcomes. Notably, the effect of Perceived Usefulness (r = 0.894) is stronger than that of Perceived Ease of Use, aligning with the notion that content relevance outweighs technical simplicity in learning environments.

4.2 TO WHAT EXTENT DOES CIDOS CONTRIBUTE TO DEVELOPING DIGITAL LITERACY SKILLS AMONG STUDENTS?

The data reveal that CIDOS plays a significant role in developing digital literacy skills among students. According to the Digital Literacy Level variable, 49.5% of students identified as beginners, 40% as intermediate, and 10.5% as advanced users. However, a one-way ANOVA revealed no statistically significant differences in Perceived Ease of Use, Perceived Usefulness, Engagement, Learning Outcomes, or Challenges across the different digital literacy groups (Beginner, Intermediate, Advanced). This suggests that the platform is inclusive and accessible, regardless of students' prior digital proficiency.

Variables	Beginner (n=99)	Intermediate (n=80)	Advanced (n=21)	Total Mean
Perceived Ease of Use	3.59	3.68	3.89	3.659
Perceived Usefulness	3.65	3.74	3.90	3.714
Engagement	3.63	3.65	3.70	3.644
Learning Outcome	3.64	3.57	3.77	3.629
Challenges	3.09	3.30	3.51	3.207

Table 3: Descriptive Means by Digital Literacy Level

Moreover, the high average scores for Engagement (mean = 3.644) and Learning Outcomes (mean = 3.629) indicate that CIDOS enhances digital literacy and supports students in applying these skills to their academic activities. The system's design caters to a broad range of digital competencies, making it an effective tool for developing practical digital skills across proficiency levels.

Qualitative data also supported these findings. Students who self-identified as beginners expressed that CIDOS was easy to learn and navigate. This positive feedback across all digital literacy groups suggests that the platform is adaptable and responsive to a broad spectrum of user needs.

4.3 WHAT IS THE RELATIONSHIP BETWEEN CIDOS USAGE AND STUDENT ENGAGEMENT IN LEARNING ACTIVITIES?

The correlation analysis revealed a strong positive relationship between CIDOS usage and student engagement. Specifically, Perceived Usefulness and Engagement showed a correlation coefficient of $r = 0.911$ ($p < 0.01$), indicating that students who found CIDOS to be useful and well-designed were significantly more engaged in their learning activities.

The regression analysis reinforced this observation. Engagement emerged as a significant predictor of learning outcomes, with a standardised beta coefficient (β) of 0.446 and $p < 0.001$, confirming its crucial role in enhancing educational performance through active digital participation.

Relationship Tested	Pearson r	Significance (p)	Regression β	p-values
Engagement ↔ Learning Outcome	0.911	< 0.01	0.446	< 0.001
Usefulness ↔ Engagement	0.911	< 0.01	-	-
Ease of Use↔ Engagement	0.823	< 0.01	-	-

Table 4: Correlation and Regression Summary – Engagement and Learning Outcomes

The high engagement scores (mean = 3.644) suggest that CIDOS effectively captures students' interest and motivates them to participate in learning activities. The platform's interactive features and accessibility likely contribute to this high level of engagement, making it a valuable tool for fostering active learning.

4.4 WHAT CHALLENGES DO STUDENTS FACE WHEN USING CIDOS TO BRIDGE DIGITAL LITERACY GAPS?

Despite the overall positive perceptions of CIDOS, students reported several challenges in using the platform. The Challenges section (Section F) yielded a mean score of 3.207, suggesting that students experience moderate difficulties interacting with the system.

The most frequently cited challenges included:

a. Occasional internet access issues (with 37% reporting the internet as only "sometimes available"),
b. More advanced digital skills are needed, particularly among students identifying as beginners (49.5%),
c. An interface navigation difficulty.

During interviews, over 50% of students highlighted internet connectivity disruptions as the most common issue (e.g., "Kadang kala gangguan internet" / "Occasional internet disruptions"). Other qualitative responses emphasised:

a. Technical issues (e.g., system lag, slow loading times)
b. Limited access to digital devices
c. Navigation difficulties for first-time users

To quantify these perceptions, a correlation analysis revealed a moderate but significant relationship between Challenges and Learning Outcomes ($r = 0.419$, $p < 0.01$), indicating that difficulties do not critically obstruct students' ability to achieve learning goals.

Relationship Tested	Pearson (r)	Significance (p)
Challenges ↔ Learning Outcome	0.419	$p < 0.01$
Challenges ↔ Engagement	0.395	$p < 0.01$
Challenges ↔ Perceived Usefulness	0.349	$p < 0.01$

Table 5: Correlation Between Challenges and Other Constructs

The correlation analysis also revealed a moderate positive relationship between Challenges and Learning Outcomes ($r = 0.419$, $p < 0.01$), indicating that challenges do not significantly hinder students' ability to achieve positive learning outcomes. However, addressing these challenges, such as improving internet access and providing additional digital literacy training, could further enhance the effectiveness of CIDOS.

4.5 DOES CIDOS USAGE SIGNIFICANTLY IMPROVE STUDENTS' LEARNING OUTCOMES?

The findings confirm that the use of CIDOS significantly improves students' learning outcomes. The Learning Outcome construct had a mean score of 3.629, indicating that most students experienced positive academic benefits when using the platform.

A strong positive correlation was observed between CIDOS usage and Learning Outcome ($r = 0.894$, $p < 0.01$), highlighting the system's effectiveness in enhancing academic performance. These outcomes support the claim that CIDOS strengthens digital literacy and learning engagement among community college students.

The regression analysis revealed that Perceived Usefulness and Engagement were significant predictors of Learning Outcomes, collectively accounting for 83.2% of the variance ($R^2 = 0.832$). This reinforces the platform's role as a strategic educational tool.

Predictor	Standardised β	Significance (p)	R^2	Adjusted R^2
Perceived Usefulness	0.504	< 0.001	0.832	0.830
Engagement	0.446	< 0.001		
Ease of Use	-0.019	0.745 (n.s.)		

Note: $R^2 = 0.832$, $F(3,196) = 323.96$, $p < 0.001$

Table 6: Regression Summary – Predictors of Learning Outcome

Qualitative responses also aligned with these results. Approximately 70% of students reported that CIDOS prepared them well for future academic or professional demands. Key comments included:

a. "Ya, kerana nota dalam CIDOS boleh digunakan sebagai rujukan masa hadapan." ("Yes, because the notes in CIDOS can be used as future references.")
b. "I can do the work easily without stress and understand better."
c. "Yes, because CIDOS is a platform that encourages independent learning."

These results suggest that CIDOS enhances digital literacy and improves student learning outcomes, particularly when learners perceive the platform as useful and engaging.

In summary, the findings indicate that CIDOS is perceived as a usable and accessible platform that effectively enhances digital literacy and learning outcomes among community college students. While some challenges exist, such as occasional internet access issues and varying levels of digital literacy, these do not significantly hinder the system's effectiveness. The strong relationship between CIDOS usage, student engagement, and learning outcomes highlights the platform's potential as a valuable tool for supporting student success in a digital learning environment. Future efforts to address the identified challenges could further enhance the impact of CIDOS on student learning and the development of digital literacy.

5. DISCUSSION

The findings of this study highlight the primary role of CIDOS in promoting digital literacy and improving learning outcomes among Selayang Community College students. The discussion below situates these results by integrating quantitative and qualitative insights within the broader context of existing literature and theoretical models, particularly the Technology Acceptance Model (TAM).

5.1 SYNTHESISING KEY QUANTITATIVE FINDINGS WITH PRIOR RESEARCH

The quantitative results illustrate strong positive correlations between CIDOS usage and both student Engagement ($r = 0.911$, $p < 0.01$) and Perceived Usefulness ($r = 0.894$, $p < 0.01$). Furthermore, regression analysis reveals that Perceived Usefulness ($\beta = 0.504$, $p < 0.001$) and Engagement ($\beta = 0.446$, $p < 0.001$) significantly predict Learning Outcomes, whereas Perceived Ease of Use does not ($\beta = –0.019$, $p = 0.745$). These outcomes resonate with the established tenets of TAM (Davis, 1989), which identify Perceived Usefulness as a core determinant of Behavioural Intention and, by extension, system usage.

TAM Construct	Correlation with Learning Outcome (r)	B Coefficient	Significance (p)
Perceived Usefulness	0.894	0.504	< 0.001
Engagement	0.911	0.446	< 0.001
Ease of Use	0.778	-0.019	0.745 (n.s.)

Table 7: Summary of Correlation and Regression with TAM Constructs

Despite the strong correlation between Ease of Use and Learning Outcomes ($r = 0.778$, $p < 0.01$), the regression analysis revealed a non-significant effect ($\beta = –0.019$, $p = 0.745$). The non-significant effect of Ease of Use on Learning Outcomes differs from many TAM-based studies that propose ease of use as equally influential (Yong et al., 2022).

One possible reason is that, while usability remains important, students may place greater emphasis on the practicality and relevance of CIDOS content, particularly under time constraints or when course performance is at stake. This suggests that for community college learners, the perceived relevance of online resources may overshadow minor navigation or interface limitations, and practical value may outweigh usability when evaluating the effectiveness of a digital learning platform.

From a comparative standpoint, these results align with research showing that well-structured LMS platforms significantly enhance engagement and performance (Tan et al., 2023). Hasnan and Mohin (2021) noted that properly aligned curriculum-based content can mitigate usability issues. In the current study, although some respondents reported moderate design complexities, the system's strong alignment with course objectives and convenient features appear to overshadow interface shortcomings, reinforcing its perceived usefulness.

5.2 ENGAGEMENT AND DIGITAL LITERACY: CONVERGENCE WITH LITERATURE

Another key finding is the strong association between high levels of student engagement (mean = 3.644) and robust learning outcomes (mean = 3.629). In CIDOS, interactive features such as discussion boards, quizzes, downloadable notes, structured modules, and self-paced review tools foster repeated student interaction with course materials. These platform elements sustain students' motivation and engagement, encouraging them to revisit and master content over time.

Past research confirms that such LMS features are essential for engagement in digital learning environments (Garcia et al., 2023). When learners frequently access and interact with materials through discussion boards, quizzes, or collaborative activities, engagement increases, leading to improved knowledge retention and digital skill development (Rodriguez et al., 2022). CIDOS appears to replicate this pattern, leveraging its content structure to encourage repeated exposure, enhance digital proficiency and support deeper learning.

Digital Literacy Level	Engagement Mean	Learning Outcome Mean
Beginner (n=99)	3.63	3.64
Intermediate (n=80)	3.65	3.57
Advanced (n=21)	3.70	3.77
Total (n=200)	**3.64**	**3.63**

Table 8: Engagement and Learning Outcomes by Digital Literacy Level

These results also reveal that over 49.5% of the participants identified as beginners in digital literacy. Despite this, their learning outcomes were comparable to those of intermediate and advanced users. This supports findings from Ying et al. (2022), who reported that LMS platforms can effectively scaffold digital skills among novice users. It also highlights the importance of platform design that accommodates diverse digital proficiencies—a conclusion echoed in Malaysian-based research (Yahya, Hussin, & Abdullah, 2024).

CIDOS's ability to align content with course goals and reduce interface complexity allows beginner users to engage confidently. The platform's relevance and structure serve as scaffolding to bridge knowledge gaps, empowering students to grow their digital competence without being overwhelmed by unfamiliar tools.

5.3 CONTRASTING EASE OF USE AND PERCEIVED USEFULNESS

According to the Technology Acceptance Model (TAM), Perceived Ease of Use and Perceived Usefulness are essential predictors of user acceptance and educational effectiveness (Davis, 1989). In LMS research, interface simplicity is often emphasised as a key factor influencing user satisfaction and platform adoption (Razali & Shahbodin, 2014). Systems that are intuitive and easy to navigate are believed to lower user resistance and promote continuous usage.

However, findings from the current study contrast with this conventional view. While Perceived Ease of Use received a relatively favourable mean score (3.659) and correlated significantly with Learning Outcomes ($r = 0.778$, $p < 0.01$), it did not emerge as a significant predictor in the regression model ($\beta = –0.019$, $p = 0.745$). In contrast, Perceived Usefulness showed both a strong correlation ($r = 0.894$) and a substantial predictive effect ($\beta = 0.504$, $p < 0.001$) on student learning outcomes.

Variables	Mean	Correlation (r)	B Coefficient	Significance (p)
Perceived Ease of Use	3.659	0.778	-0.019	0.745 (n.s.)
Perceived Usefulness	3.714	0.894	0.504	< 0.001

Table 9: Comparison of Ease of Use vs. Usefulness

This result supports Hasnan and Mohin's (2021) finding that curriculum alignment and content relevance can outweigh superficial design preferences. In the context of community college students, the utility and alignment of content with academic goals may override the need for perfect usability. Students facing time constraints and heavy workloads may tolerate interface complexity if the content helps them achieve their educational objectives.

The study suggests that usefulness trumps simplicity—a content-rich, assessment-aligned LMS like CIDOS can foster meaningful engagement and academic performance, even if its interface is only moderately intuitive.

5.4 PERSISTENT CHALLENGES AND THEIR LIMITED IMPACT

Despite the system's overall strengths, students did highlight persistent internet connectivity challenges—37% reported that the internet was only sometimes available. Additionally, nearly half of the participants indicated limited access to digital devices as a recurring obstacle. These challenges reflect broader infrastructural issues in Malaysia's rural and semi-urban settings, as highlighted by UNESCO (2021) and the World Bank (2021).

However, the moderate correlation between these challenges and learning outcomes ($r = 0.419$, $p < 0.01$) suggests that while connectivity constraints pose an inconvenience, they do not substantially derail academic performance for most students—particularly those who have found workarounds, such as downloading materials for offline study or using college-provided internet facilities at scheduled times. This resilience may be explained by students' adaptive strategies, such as downloading materials for offline access, completing work during scheduled internet availability, or utilising campus-provided Wi-Fi facilities.

Moreover, students may overcome these barriers due to several mitigating factors:

a. Intrinsic motivation to succeed, particularly among working learners, is a challenge when balancing multiple responsibilities.

b. Campus-based support systems include access to computer labs, technical help desks, and peer assistance networks.
c. Cultural emphasis on educational achievement, especially within communities where formal qualifications are highly valued.

These factors likely buffer the impact of digital access limitations, allowing students to maintain academic progress even under suboptimal technological conditions.

Nevertheless, the ongoing reports of technical disruptions, slow loading times, or occasional platform lags underscore the need for more robust system stability and institutional support. Continuous improvement in this area—possibly through campus Wi-Fi upgrades, mobile-friendly design enhancements, or partnerships with telecommunication providers—remains vital. This perspective is strongly echoed in previous work by Aljaraideh et al. (2023), who highlight that even minor technical barriers can accumulate over time to disengage users, especially for students already coping with time or skill constraints.

In summary, while challenges persist, students' adaptive behaviours, external support structures, and internal motivation help them navigate and overcome barriers, ensuring that CIDOS continues to support learning outcomes effectively.

5.5 ALIGNMENT WITH THEORETICAL PERSPECTIVES AND FUTURE DIRECTIONS

Research by Jansen et al. (2020) and Singh and Thurman (2023) highlights the growing importance of Learning Management Systems (LMS) in higher education, particularly in facilitating content distribution, evaluation, and interaction between instructors and learners. The positive reception and impact of CIDOS on learning outcomes align well with TAM's proposition that technology adoption is contingent on the system's perceived value and alignment with users' tasks (Davis, 1989). The present study diverges from some earlier research (Yong et al., 2022) in its finding that perceived ease of use did not significantly impact learning outcomes. This discrepancy highlights the importance of context, namely, that in community college environments where academic goals can overshadow minor usability hurdles, perceived usefulness

and engagement become the foremost drivers of success. Additionally, the system's ability to cater to multiple digital literacy levels addresses calls in the literature for inclusive Learning Management System (LMS) design (Chen et al., 2022).

The findings have several practical implications:

a. For LMS Designers: Systems should prioritise curriculum alignment, practical utility, and assessment relevance over excessive emphasis on visual or interface simplicity. Features such as downloadable content, offline accessibility, and scaffolded feedback mechanisms can enhance engagement even when usability is moderate.
b. For Community College Policy: Policymakers should invest in connectivity infrastructure, student digital literacy programs, and institutional support mechanisms (e.g., help desks, training modules). These provisions would buffer technological limitations and promote equitable access across socio-economic segments.

In the future, researchers could incorporate longitudinal analyses into their investigations to determine whether these results persist over multiple semesters or program cycles. Investigating longer-term educational attainment and employability (Garcia et al., 2023) would also be beneficial, as it addresses gaps in prior investigations. In addition, cross-LMS studies comparing CIDOS with other systems, such as Moodle or Canvas, would shed further light on its strengths and weaknesses in comparison to other Learning Management Systems (LMSs). Such studies will likely lead to improved platform design and university-level practice grounded in evidence.

In sum, the research adds to the body of evidence that a context-aligned LMS – linked to specific course objectives, featuring engaging aspects, and viewed as helpful for academic grades – can bring strong learning outcomes from students, even in situations where the ease of use is only rated as moderate and not exceptionally high. CIDOS is revealed as a powerful tool for enhancing digital literacy and learning. This evidence supports earlier research (Yahya et al., 2024; Hasnan & Mohin, 2021) on LMS adoption in Malaysia's higher education institutions, extending the topic in this context. By referring to existing empirical studies and situating the observations

within theoretical frameworks (such as the Technology Acceptance Model), this discussion emphasises the need to improve connectivity, user training, and technical support in a manner sensitive to local conditions. CIDOS stands out as a functional and inclusive digital platform that promotes digital literacy development and learning performance among Malaysia's diverse and heterogeneous community college populations.

6. CONCLUSION

The results showed that CIDOS was perceived as a highly usable and accessible intervention that could successfully build up digital literacy skills and enhance learning outcomes. Findings show students had high engagement with the platform, and correlations indicated strong positive relationships between CIDOS ease of use, perceived usefulness, engagement, and learning outcomes.

While there are challenges, such as occasional difficulties in accessing the internet and students' different levels of digital literacy, these have not made CIDOS less effective as a bridge to digital literacy, as it helps students achieve their academic goals. Designed to support students of varying digital literacy levels, the platform provides interactive and engaging learning opportunities for all students.

Nevertheless, it also highlights several shortcomings, including addressing internet connectivity issues, enhancing system stability, and providing more interactive and engaging content. This could further optimise CIDOS and solidify its place as a valuable digital learning tool for community colleges.

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9. AUTHORS' CONTRIBUTION

Wan Syukriah Wan Mohamad conceptualised the study, identified the research focus, and designed the methodological framework. Malathi A/P Palanisamy collected the data and facilitated the focus group discussions. Idayati Piduman contributed to the analysis and interpretation of the findings. All authors reviewed and provided critical feedback on the research process, contributed to the data analysis, and participated in the writing and revision of the manuscript.

10. CONFLICT OF INTEREST DECLARATION

We hereby certify that the article is the original work of the authors and co-authors. It has not been previously published and is not under consideration for publication elsewhere. This research has not been submitted for publication, in whole or in part, in any other journal or outlet. We affirm that all Authors have contributed significantly to the conception, execution, and interpretation of the research, and take full responsibility for the validity and integrity of the data and its findings.

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Enhancing Language Learning Through Gamification in Linguistically Diverse Classrooms

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Abstract: *The effectiveness of Trithasa as a multilingual educational card game in supporting vocabulary acquisition and learner engagement among ESL learners is the focal point of this study. In response to the increasing need for multilingual competence in globalised settings, it explores how gamification can foster motivation, cross-cultural awareness, and language confidence. Rooted in Vygotsky's Zone of Proximal Development, a survey-based approach was conducted with 38 undergraduates who used Trithasa over a one-month period. The game, which features English, Arabic, and Mandarin vocabulary supported by audio via QR codes, encourages interactive and self-directed learning. Findings revealed high levels of learner satisfaction and engagement, particularly in English and Arabic language development, while the impact on Mandarin was comparatively lower. Participants also reported improved cognitive and problem-solving abilities, as well as increased cultural awareness and confidence in multilingualism. However, some respondents found the cognitive demands of the game overwhelming, thus highlighting the need for a more balanced design. Overall, gamification for multilingual language learning has its potential for refinement to optimise cognitive load and inclusivity. Future studies could contribute to the growing body of research on gamification in language education by applying the Application in other linguistically diverse classrooms.*

Keywords: *Language Games, Language Learning, Multilingual Classrooms, Multilingual Students*

1. INTRODUCTION

Multilingualism is essential due to the increasing prevalence of international employment and social interaction (Duarte et. al., 2023). Educational advancements have sparked a renewed interest in learning foreign languages. Gamification in education is crucial in language teaching and learning. It is the process of incorporating gaming elements, such as learning, progression, and competition, into non-gaming contexts by utilising a reward structure (Thurairasu, 2022). This process increases learners' engagement, inspires them to act, enhances their academic achievement, and facilitates language learning effectively .

Trithasa Cards are designed to enhance language skills and promote Multilingualism is supported by allowing players to speak in three languages: English, Arabic, and Mandarin. Each card has a QR code that allows players to listen to the pronunciation of the words. Trithasa promotes language learning in a fun and interactive way. It encourages players to use and practice the three languages, building their vocabulary and confidence in multilingual communication

In linguistically diverse classrooms, educators often struggle to engage the students effectively and foster language skills across varying proficiency levels. Traditional language learning methods may not adequately support interactive, communicative, or multimodal learning approaches, especially in multilingual environments where students benefit from diverse, flexible, and adaptive tools. Specifically, Trithasa aims to address these challenges by providing an engaging, structured, and collaborative approach to language learning.

Therefore, the present study implemented Trithasa (as exemplified in Figure 1), which is an educational language card game designed to enhance multilingual vocabulary learning among ESL learners. Trithasa integrates cognitive and social learning principles with engaging mechanics, including turn-based

play, immediate feedback, and peer interaction. It also creates a dynamic and enjoyable learning experience. The study aimed to assess the effectiveness of Trithasa in improving learners' vocabulary retention, motivation, and cross-linguistic awareness. This study aims to examine the effectiveness of using Trithasa language games as a pedagogical tool to support multilingual vocabulary acquisition in the ESL classroom.

Figure 1: Pictures of Trithasa cards

2. LITERATURE REVIEW

Many scholars have observed that gamification has positive effects on cognitive learning results. Topushipambao (2022) indicated that gamification can reduce educational gaps, improve language proficiency, and enhance learning environments. Shen et al. (2024) investigated the impact of integrating gamification on learners' language learning performance and the motivational role of learners as a mediating factor. Additionally, Salimei and Zangeneh (2022) demonstrated that students' acquisition of English vocabulary as a second language was enhanced by gamification. Thiagarajah et al. (2022) investigated how learners perceive the use of gamification tools to enhance their vocabulary and how learners' vocabulary scores differ when gamification is employed to replace traditional teaching methods. Vocabulary and grammar of the languages were the most frequently examined basic language abilities (Tsai & Tsai, 2018; Althaqafi & Saleh, 2022; Salimei & Zangeneh, 2022; Manokaran et al., 2023). Furthermore, applications such as Duolingo and virtual reality are also used to explore foreign languages through gamified platforms (Thiagarajah et al., 2022; Shortt et al., 2023; Shen et al., 2024).

Since learning a new language is a cognitively demanding and prolonged process, sustaining learners' motivation is critical to achieving long-term success. Motivation in language learning is widely recognised as a key factor influencing learners' engagement and achievement (Dornyei & Ushioda, 2011). In recent years, gamification has emerged as an innovative pedagogical approach that incorporates game-like elements, such as points, levels, challenges, and feedback, into non-game contexts to increase motivation and promote active participation. Numerous studies, such as those by Munday (2016) and Hung (2017), have demonstrated the positive effects of gamified learning environments on vocabulary acquisition, learner autonomy, and retention.

Beyond enhancing motivation and engagement, gamification in language learning offers several pedagogical advantages that contribute to more in-depth and sustained learning outcomes. One notable benefit is the promotion of learner autonomy. Gamified environments often encourage self-directed learning through clear goal-setting, progress tracking, and immediate feedback mechanisms. According to Su and Cheng (2015), such features empower learners to take ownership of their learning journey, fostering independence and perseverance in language acquisition.

Additionally, gamification supports differentiated learning by catering to diverse learner needs and proficiency levels. Through adaptive challenges and modular content progression, gamified tools can individualise the pace and complexity of tasks, making learning more accessible and inclusive. This approach aligns with Vygotsky's Zone of Proximal Development, where learners benefit most from tasks that are slightly above their current level of competence when supported appropriately (Vygotsky, 1978). In multilingual settings, this adaptability is particularly valuable for addressing linguistic diversity and varied background knowledge.

Gamification also enhances cognitive development, particularly in areas such as memory, problem-solving, and critical thinking. For instance, memory-based tasks within gamified platforms strengthen vocabulary recall through repetition and retrieval practice while strategy-based mechanics develop analytical and decision-making skills. Studies, such as those by Ibanez and Delgado-Kloos (2018), have affirmed that well-designed gamified interventions stimulate both lower-order and higher-order thinking skills.

Moreover, gamification fosters a collaborative learning culture. Many gamified language learning tools incorporate social elements, such as peer competition, team-based challenges, or cooperative quests, which foster a sense of community and promote communicative competence. This social interaction supports the development of speaking and listening skills in authentic contexts, aligning with the principles of communicative language teaching (CLT). According to Plass, Homer, and Kinzer (2015), these social dynamics also enhance learners' affective engagement, reducing anxiety and increasing willingness to communicate in the target language.

Finally, gamification provides rich data for formative assessment (Shute & Ventura, 2013). The digital nature of many gamified platforms enables real-time monitoring of learner performance, allowing instructors to identify learning gaps and tailor instruction accordingly. This continuous assessment cycle contributes to a more responsive and evidence-based teaching approach.

3. METHODOLOGY

Based on Vygotsky's Zone of Proximal Development Theory, this study employed a survey-based approach adapted from Althaqafi and Saleh (2022) and Thurairasu (2022) to evaluate the effectiveness and enjoyment of the Trithasa language learning game. The survey was administered to 38 undergraduate students at a local university. They played and engaged with Trithasa for over a month, both in class and at home or in their hostels. This enabled a comprehensive assessment of the game's impact in various learning environments. Figure 2 illustrates the research framework.

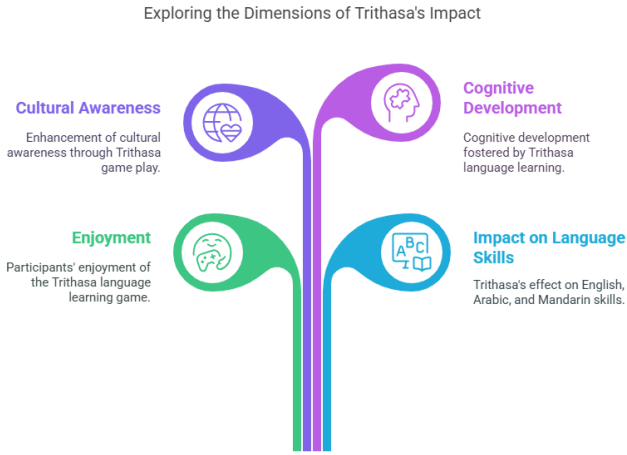

Figure 2: Research framework

Figure 3: Pilot Study (video of students playing Trithasa)

Figure 3 represents a video of Trihasa pilot study which has been conducted with the help of undergraduates' students in a local Malaysia university. Based on the feedback of the pilot study, the survey was structured into three sections. Section 1 was respondents' background. This section collected demographic and background information of the participants, including their age, gender, language proficiency, and previous experience with language learning games. This data helped contextualise the findings and provided insights into how different respondent characteristics might influence their perceptions of Trithasa. Section 2 discussed perceptions of implementing Trithasa. It consisted of 10 questions aimed at gauging participants' perceptions of Trithasa. The questions focused on various aspects such as the game's enjoyment, its impact on language skills (English, Arabic, and Mandarin), cultural awareness, and cognitive development. Section 3 embarks on challenges of implementing Trithasa. It also contained 10 questions designed to identify any challenges or difficulties participants faced while using Trithasa. Questions addressed issues such as cognitive demands, balancing competitive and learning aspects, and any technical or usability problems encountered during gameplay. Participants were asked to rate their level of agreement with statements about the game on a 5-points Likert scale. The data collected from the survey was analyzed to determine the overall effectiveness of Trithasa in enhancing language learning and to identify any areas requiring refinement. The results from this study contribute to understanding the potential of gamification in language education and its broader implications for educational practices.

4. FINDINGS AND DISCUSSION

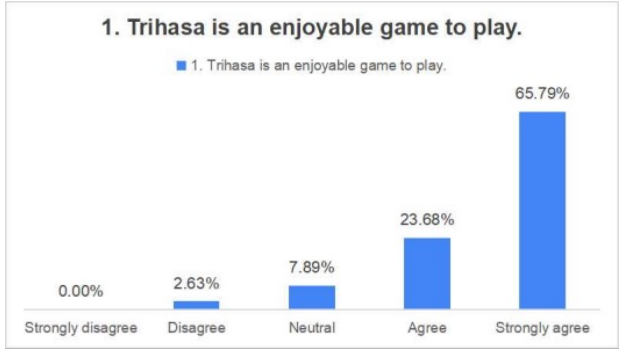

Figure 4: Trithasa is an enjoyable game

In Figure 4, the majority of respondents (65.79%) strongly agreed that Trithasa was an enjoyable game, indicating a high level of satisfaction and engagement among the participants. Another 23.68% agreed with this statement, bringing the total positive response to nearly 90%. This suggested that the game was generally well-received and considered fun by most participants. Only 7.89% of participants remained neutral, while a mere 2.63% disagreed, indicating that dissatisfaction with the game's enjoyment was minimal. Trithasa had successfully created an enjoyable gaming experience for the participants.

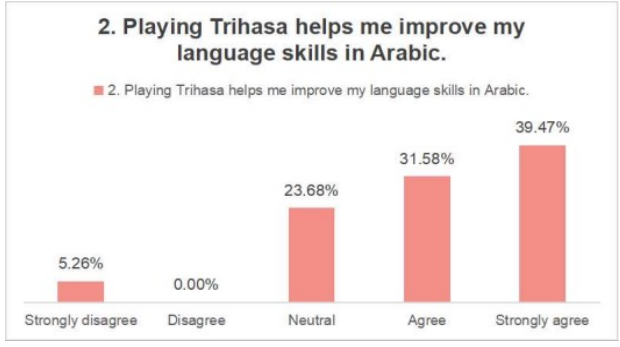

Figure 5: Playing Trithasa helps me to improve my language skills in Arabic

Figure 5 reveals a mixed but generally positive response regarding the effectiveness of Trithasa in improving Arabic language skills. A significant portion of the participants (39.47% strongly agreed and 31.58% agreed) that gaming aided in their Arabic language development. However, 23.68% of respondents remained neutral, suggesting that gamification may not have an equally positive impact on all participants. A small percentage (5.26%) strongly disagreed, which indicated that for a minority, the game did not significantly contribute to their Arabic language skills. Although Trithasa had a positive impact on Arabic language learning for many, its effectiveness may vary among individuals.

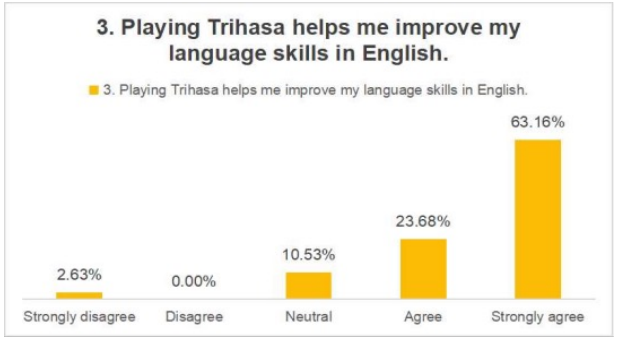

Figure 6: Playing Trithasa helps me to improve my language skills in English

A strong positive correlation was observed in Figure 6 between playing Trithasa and the improvement of English language skills among the respondents. A substantial 63.16% of participants strongly agreed that the game enhanced their English abilities, with an additional 23.68% agreeing. Nearly 87% of respondents recognised the game's value in improving their English. The neutral response was relatively low at 10.53% which reflected that most participants experienced noticeable benefits. Only 2.63% of the participants strongly disagreed, which highlighted that dissatisfaction in this area was rare. Gamification was effective in supporting English language learning.

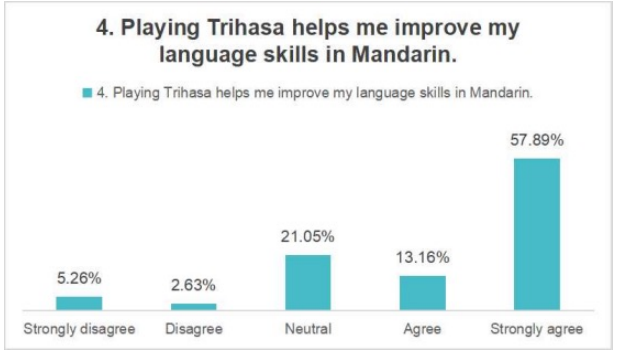

Figure 7: Playing Trithasa helps me to improve my language skills in Mandarin

The impact of Trithasa on Mandarin language skills was largely positive, with 57.89% of respondents strongly agreeing that the game aided in their Mandarin language skills, as reflected in Figure 7. An additional 13.16% agreed, which reflected a consensus on the game's usefulness in this area. However, there was a noticeable neutrality (21.05%), indicating that some participants may not have experienced significant benefits from the game in terms of Mandarin. A small percentage (7.89%) of respondents either disagreed or strongly disagreed, suggesting that the game's effectiveness in improving Mandarin skills may not be as consistent as it is for other languages. While gamification is beneficial for many participants, its impact on Mandarin learning may require additional support or refinement to benefit the learners consistently.

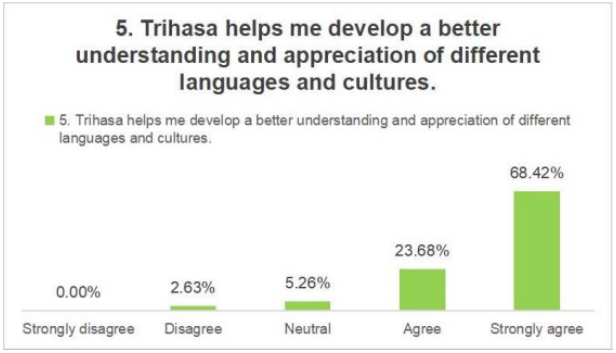

Figure 8: Trithasa helps me develop a better understanding and appreciation of different languages and cultures

Figure 8 reveals that 68.42% respondents strongly agreed that Trithasa enhanced their understanding and appreciation of different languages and cultures, which effectively fostered cultural awareness. An additional 23.68% of the respondents agreed, which brought the total positive response to over 90%. It suggested that the game was highly successful in promoting cross-cultural understanding among the participants. Only a small percentage (5.26%) of respondents were neutral. Only 2.63% disagreed that nearly all participants recognised the game's contribution to cultural appreciation. It reflected that gaming played a significant role in broadening the participants' cultural horizons.

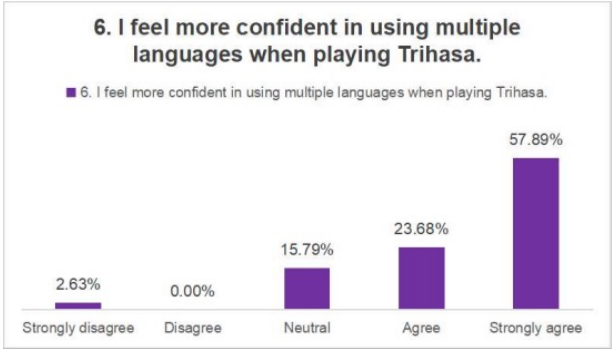

Figure 9: I feel more confident in using multiple languages when playing Trithasa

Figure 9 illustrates that Trithasa had a substantial positive impact on participants' confidence in using multiple languages, with 57.89% of respondents strongly agreeing and 23.68% agreeing with this statement. The game effectively built linguistic confidence in the majority of participants. However, 15.79% of respondents remained neutral, which might indicate that the confidence boost was not universal or that some participants were already confident in their language use. Only a small fraction (2.63%) strongly disagreed. It showed generally that gamification succeeded in fostering multilingual confidence.

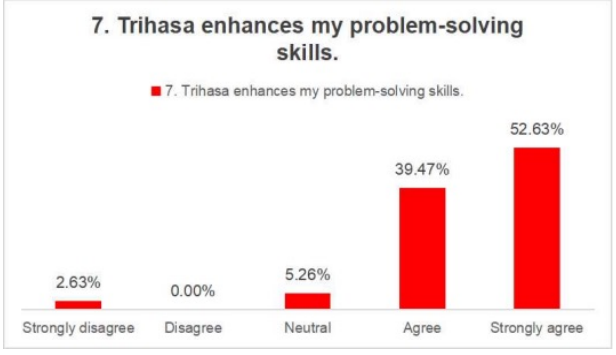

Figure 10: Trithasa enhances my problem-solving skills

The respondents (52.63%) strongly agreed that Trithasa improved their problem-solving skills, with an additional 39.47% agreeing, as shown in Figure 10. The game was widely perceived as beneficial in developing cognitive and analytical abilities. Only 5.26% of participants were neutral, and 2.63% strongly disagreed, which suggested that almost all participants recognised the game's potential to improve their problem-solving skills. A strong correlation between playing games and enhanced problem-solving capabilities make it an effective tool for cognitive development.

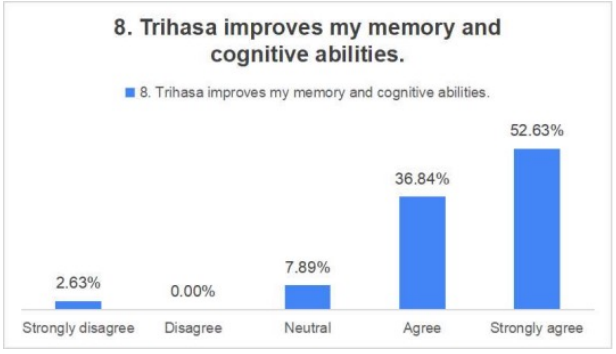

Figure 11: Trithasa improves my memory and cognitive abilities

In Figure 11, Trithasa had a substantial positive impact on memory and cognitive abilities, with 52.63% of participants strongly agreeing and 36.84% agreeing that the game was beneficial. It suggested that the game effectively supported cognitive functions for most participants. A small percentage (7.89%) remained neutral, and only 2.63% strongly disagreed, which reflected that the game's cognitive benefits were minimal. Gamification was effective for improving memory and cognitive abilities among participants.

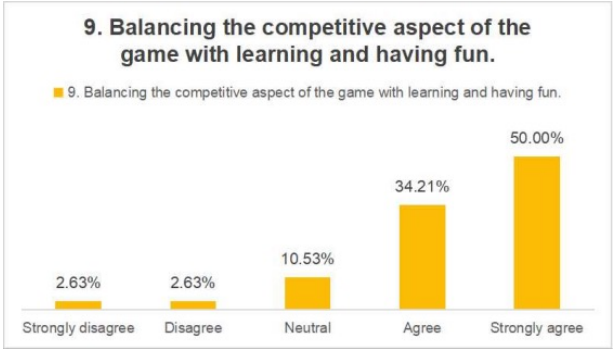

Figure 12: Balancing the competitive aspect of the game with learning and having fun

In Figure 12, 50% of the respondents strongly agreed that Trithasa successfully balanced the competitive aspects of the game with learning and fun. Another 34.21% agreed, which suggested that the game effectively integrated these elements for most participants. However, 10.53% of participants were neutral, and a small percentage (5.26%) either disagreed or strongly disagreed. While the game is generally well-balanced, some participants may find it challenging to manage the competitive aspects with the learning and enjoyment components.

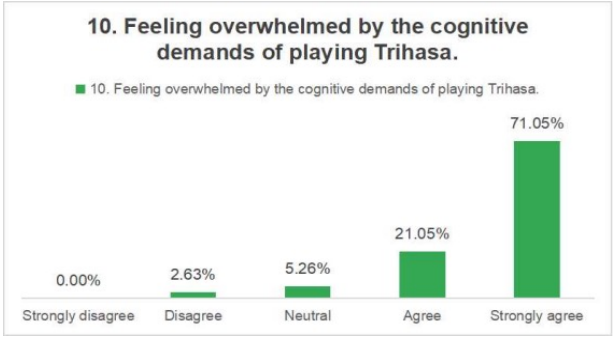

Figure 13: Feeling overwhelmed by the cognitive demands of playing Trithasa

A significant majority of participants (71.05%) strongly agreed that they were overwhelmed by the cognitive demands of playing Trithasa, as denoted in Figure 13. An additional 21.05% agreed, indicating that nearly all respondents experienced some level of cognitive strain while playing the game. Only a small percentage (5.26%) were neutral, and 2.63% disagreed, which reflected that the cognitive challenges posed by the game were not widely recognised among the participants. Although gamification was engaging, it may also present significant cognitive demands that could be addressed to make the game more accessible and enjoyable for all participants.

The findings revealed an overall positive reception towards the use of gamification in multilingual vocabulary learning, with the majority of respondents reporting high levels of satisfaction and engagement. Most participants strongly agreed that the gamified approach was enjoyable, which reflected its capacity to sustain learner interest and motivation. Gamification was generally well-received and effectively fostered active participation among learners.

However, the effectiveness of gamification in enhancing language skills varied across the three target languages. For Arabic, a considerable proportion of participants acknowledged the game's contribution to their language development. In comparison, the impact on English language acquisition was more uniformly positive. Conversely, the effect of gamification on Mandarin learning was comparatively limited, which indicated lower perceived gains in vocabulary and proficiency. These discrepancies suggest that language-specific factors may influence the pedagogical effectiveness of game-based learning. It was also perceived as highly beneficial in promoting intercultural understanding. A strong majority of participants agreed that the game facilitated greater awareness and appreciation of different languages and cultures, which highlights its role in fostering cross-cultural competence. While learners generally reported increased multilingual confidence, the findings also point to areas for refinement, particularly in designing tasks that are both cognitively stimulating and accessible.

Gamification was acknowledged for enhancing cognitive and problem-solving abilities, particularly in relation to memory retention and task management. Nevertheless, a subset of participants reported feeling overwhelmed by the cognitive load associated with certain game elements. While gamification can support higher-order thinking skills, it may also introduce cognitive challenges that need to be carefully managed to ensure inclusivity and learner comfort.

5. CONCLUSION

The decisive role of gamification in language learning, as demonstrated by Trithasa's success in engaging participants and enhancing their language skills, is undeniable. The integration of fun and interactive elements has been demonstrated to be an effective tool in enhancing linguistic abilities, promoting cultural awareness, and developing cognitive skills. The positive reception of Trithasa reflects the potential of gamified learning to make language acquisition more accessible and enjoyable, particularly in multilingual contexts. On a global scale, gamification represents a transformative approach to education by offering a dynamic alternative to traditional methods. As educational systems increasingly embrace technology, games like Trithasa can play a crucial role in bridging cultural and linguistic gaps, which make learning more engaging and effective for diverse learners worldwide. With continued refinement, gamified learning tools can have a significant and lasting impact on global education by promoting language proficiency, fostering cross-cultural understanding, and enhancing cognitive development.

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8. AUTHORS' CONTRIBUTION

All authors offered valuable feedback and contributed to shaping the research, analysis, and manuscript.

9. CONFLICT OF INTEREST DECLARATION

We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research/manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to IJELHE.

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Evaluation of Knowledge, Attitude, and Preventive Practices of Dengue among the Malaysian Population Using a Video-Aided Tool

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Abstract: *Dengue, a mosquito-borne viral disease transmitted primarily by Aedes aegypti, continues to be a significant global health threat, including Malaysia. Various programs have been implemented to reduce the population's susceptibility to dengue and curb its spread. This study aims to evaluate the knowledge, attitude, and preventive practices (KAP) related to dengue among the Malaysian population and assess the efficacy of a video-aided tool in disseminating dengue information. A cross-sectional study with random sampling was conducted from March to May 2024 involving 438 respondents. A self-administered questionnaire was distributed using the Google Forms platform. The video was utilised during the interphase of the test to implement the pre-and post-test approach. The scores were assessed based on previous studies using Bloom's cutoff point criteria. SPSS version 28.0 was used to analyse the data. Analysis of the respondents' sociodemographic data revealed*

that female respondents possess higher knowledge levels than males ($\chi 2$ = 11.26, $p < 0.001$). Pearson's correlation analysis showed a positive relationship between age and attitude toward dengue prevention ($r = 0.298$, $p < 0.001$). There was a significant positive correlation between knowledge and preventive practices ($r = 0.354$, $p<0.001$), knowledge and attitude scores ($r = 0.633$, $p<0.001$), and attitude and preventive practices scores ($r = 0.307$, $p<0.001$). The paired T-test analyses suggested that the video-aided tool significantly enhanced the KAP scores of the respondents ($p<0.05$). Hence, this study demonstrated the effective use of video as a knowledge transfer instrument to improve the KAP of the Malaysian population towards dengue.

Keywords: *Knowledge, Attitude, Preventive Practices, Dengue, Video*

1. INTRODUCTION

Dengue is a mosquito-borne viral disease transmitted through the bites of female Aedes aegypti mosquitoes. Dengue is considered the most prevalent viral disease transmitted by mosquitoes (Mashudi et al., 2022). According to Palmal et al., the number of documented dengue cases reported to the World Health Organisation (WHO) increased sixfold, rising from 505,430 in 2000 to 3,312,040 in 2015 (Palmal et al., 2023). Dengue cases have been comprehensively documented in Malaysia, a Southeast Asian country, since 1902 (Salim et al., 2021). In addition, dengue fever is regarded as the second most significant vector-borne disease in the world, surpassed only by malaria in terms of both incidence and mortality rates (Jing & Wang, 2019).

Depending on the severity of the infection, dengue can range from a moderate febrile illness to a life-threatening condition, or it may have no symptoms at all (Ministry of Health Malaysia, 2015). Based on Chen et al., dengue symptoms, when present, typically include headache, muscle pain, self-limiting fever, and a rash that lasts for five to seven days, accompanied by a decrease in white blood cells and platelets (Chen et al., 2023). However, nearly 300 million of the 390 million cases of DENV infections that occur each year have no apparent symptoms of illness (Selvarajoo et al., 2020). Due to the non-existence of specific medications or antiviral drugs to treat dengue, controlling mosquito populations has become a vital public health concern. The development of

effective treatments and vaccines within a short timeframe poses significant challenges, primarily due to the high costs, prolonged establishment periods, and drawbacks associated with vaccine development (Subramaniam et al., 2021).

Despite numerous initiatives undertaken in Malaysia to eradicate dengue, the prevalence of dengue remains high. The number of dengue cases and fatalities in 2019 surpassed those recorded in 2018 by a substantial margin, despite remarkable efforts by the health sector to manage the outbreak (Jayawickreme et al., 2021). Zaheer et al. stated that major obstacles in the dengue endemic involve the widespread misconception among local people regarding the causes and spread of dengue fever. This leaves a negative perspective of the disease among the public (Zaheer et al., 2022). Additionally, the efficacy and acceptability of conventional health education, such as posters and leaflets, in disseminating information regarding dengue may be insufficiently compelling and influential, hence leading to inadequate knowledge retention. Based on Hasanica et al., students perceive PowerPoint presentations and audio-visual resources as more favourable techniques for acquiring knowledge compared to printed materials and leaflets (Hasanica et al., 2020). Moreover, conventional methods can be costly due to production and distribution, particularly for extensive distribution purposes. According to Usman et al., dengue prevention and management rely on health education efforts (Usman et al., 2019). Nevertheless, increasing Malaysians' knowledge, attitudes, and behaviours around mosquito-borne diseases necessitate inclusive participation and well-structured educational initiatives (Khairi et al., 2021).

2. PROBLEM STATEMENT

In an era driven by digital advancements, sole reliance on conventional methods such as posters may impose constraints on the extent of dissemination as well as the level of people's involvement. This highlights the importance of visually engaging tools for disseminating accurate information about dengue and encourages the public to adopt preventive measures daily. The incorporation of short videos is favoured for their convenience, popularity, engagement, and flexibility. Additionally, research highlights the potential of videos in enhancing individuals' understanding of health topics, promoting behavioural change, boosting confidence, and providing numerous other benefits.

3. OBJECTIVE

This study aims to explore the use of video as an effective tool in improving knowledge, attitude, and preventive practices (KAP) regarding dengue among the Malaysian population. The pre- and post-scores of the KAP were compared using descriptive and inferential statistical analyses.

4. MATERIALS AND METHODS

This study received approval from the Research Ethics Committee of Universiti Teknologi MARA (UiTM) (REC (PH)/UG/1192024 (MR)) on January 29, 2024. Respondents were required to provide consent electronically via a Google Form before the study commenced. The participation of the respondents was voluntary. The sample size required for this research was calculated using a Raosoft sample size calculator with a 95% confidence level, a 5% margin of error, and a 50% response rate. A total of 438 respondents participated in the study. The study design for this research was a cross-sectional study with random sampling. A pre-and post-test approach was conducted, and respondents were given a questionnaire via a Google Forms link. The random sampling was conducted from March to May 2024. The research was structured to gather information from respondents via bilingual questionnaires in English and Malay.

The questionnaire consisted of four sections, requiring respondents to answer queries both before and after watching an intervention video. Section A comprised seven questions that requested sociodemographic information from the respondents. Section B consisted of five questions that were adapted and self-constructed from Selvarajoo et al. (2020) based on the topic of knowledge about dengue. Section B was evaluated using three options: yes, no, and do not know. One point was awarded for each 'No' answer, and zero points were given for either 'Yes' or 'Do not know' responses. Section B had a maximum score of 5 points. The score of knowledge was graded as follows: good (5), fair (3-4), and poor (0-2) (Aung et al., 2023).

Section C contained five statements associated with attitudes toward dengue (Mustapha et al., 2023). Section D included five statements about dengue preventive practices (Mustapha et al., 2023; Ramli et al., 2022). Sections

C and D were evaluated using a 5-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree). The rating scales were graded based on Bloom's cut-off point criteria as good (80% to 100%), moderate (60% to 79%), and poor (less than 60%). Prior to statistical analysis, a preliminary test was conducted to confirm the reliability of the data using Cronbach's alpha. The content validation was conducted and reviewed by three experts from the Faculty of Pharmacy, including lecturers.

The statistical analysis of the data for this research was conducted using the Statistical Package for Social Sciences (SPSS), version 28.0. The sociodemographic data of the respondents were analysed using descriptive statistics, and the findings were presented in terms of frequency and percentages. Inferential statistical tests, such as the chi-square test, paired t-test, and correlation analyses, were conducted to identify differences and associations between variables. A p-value <0.05 was considered the cut-off level for statistical significance.

5. RESULTS

A total of 438 respondents participated in this study. Table 1 summarises the socio-economic characteristics of the study sample gathered in Malaysia. The demographic profile of the respondents revealed a higher representation of females, comprising more than half of the sample (60.3%), compared to males. The age range of the respondents was between 18 and 69 years, with a mean age of 31 years. Two-fifths of the respondents (40.9%) resided in urban areas, while the remaining were from rural and suburban regions. For income, almost one-fourth of the respondents (23.5%) reported a monthly income ranging from RM1001 to RM3500. The educational background of the respondents varied, with a substantial majority holding bachelor's degrees (71.7%), while a smaller proportion reported secondary education qualifications. A notable percentage earned between RM 1001 and RM 3500 monthly (23.5%), while a smaller fraction reported incomes of more than RM 10,000 per month.

Variable	Description	n (%)
Gender	Female	264 (60.3)
	Male	174 (39.7)
Age group (years old)	18-29	255 (58.2)
	30-45	99 (22.6)
	46-60	79(18.0)
	61 and above	5 (1.2)
Highest education level	Secondary Education	18(4.1)
	Certificate or Diploma	74 (16.9)
	Bachelor's degree	314 (71.7)
	Postgraduate degree	32 (7.3)
Area of living	Urban	179 (40.9)
	Sub-urban	138 (31.5)
	Rural	121 (27.6)
Monthly family income (RM)	< RM 1000	80 (18.3)
	RM 1001- RM 3500	103 (23.5)
	RM 3501 - RM5000	75 (17.1)
	RM 5001 – RM 7500	68 (15.5)
	RM 7501 – RM 10000	64 (14.6)
	> RM 10000	48 (11.0)

Table 1: Sociodemographic characteristics of the study population in Malaysia

The distribution of the respondents across 14 states in Malaysia is presented in Fig. 1. Nearly one-fourth (23.3%) of the respondents came from Kelantan. In contrast, the fewest respondents were from Perlis (1%).

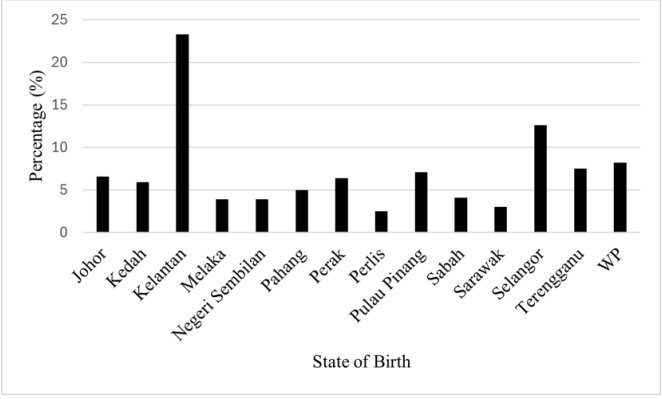

Fig 1. Number of study population according to the state of birth

Table 2 illustrates the relationship between gender and knowledge responses on dengue among the respondents. The Chi-square analysis demonstrated statistically significant differences in knowledge between males and females for every statement. Notably, females exhibit greater levels of knowledge than males. Only half of the respondents (55.71%) were able to respond correctly (i.e., answer 'No') to the question about the prevalence of asymptomatic and symptomatic dengue infections. Almost three-fourths (73.52%) of the population were aware of dengue transmission from infected mothers to the baby ($p < 0.05$). The question regarding the presence of one dengue serotype was answered correctly by most respondents (71.7%), with 31% being males and 40.6% being females ($p = 0.015$). Moreover, more than half of the respondents reported the absence of specific antiviral medication (with a gender difference of 6.48%). In addition, more than two-thirds (69.2%) were aware that NSAIDs should not be given to dengue patients.

Items	Options	Male n (%)	Female n (%)	Total n (%)	χ^2	p-value
The symptomatic dengue infection occurs more frequently than the asymptomatic dengue infection	Yes / I do not know	60 (13.7)	134(30.6)	194 (44.3)	11.26[a]	<0.001***
	No	114 (26.0)	130 (29.7)	244 (55.7)		
Dengue cannot be transmitted from the infected mother to the baby	Yes / I do not know	35 (8.0)	81 (18.5)	116 (26.5)	6.02[a]	0.014**
	No	139 (31.7)	183 (41.8)	322 (73.5)		
The dengue virus is present in one serotype only (DENV-1)	Yes / I do not know	38 (8.7)	86 (19.6)	124 (28.3)	5.96[a]	0.015**
	No	136 (31.0)	178 (40.6)	314 (71.7)		
Nonsteroidal Anti-Inflammatory drugs (NSAIDs) such as aspirin and ibuprofen can be given to a dengue patient	Yes / I do not know	37 (8.4)	98 (22.4)	135 (30.8)	12.37[a]	<0.001***
	No	137 (31.3)	166 (37.9)	303 (69.2)		
There is a specific antiviral medication available to treat dengue	Yes / I do not know	33 (7.5)	95 (21.7)	128 (29.2)	14.69[a]	<0.001***
	No	141 (32.2)	169 (38.6)	310 (70.8)		

[Based] on the Chi-Square Test
***Statistically significant at p-value < 0.001
**Statistically significant at p-value < 0.05
*Statistically significant at p-value < 0.01

Table 2: Association between gender and knowledge of the respondents towards dengue statements

The attitudes toward dengue prevention among the Malaysian population were also investigated. The percentage of respondents' answers on pre- and post-scores is illustrated in Figs. 2 and 3.

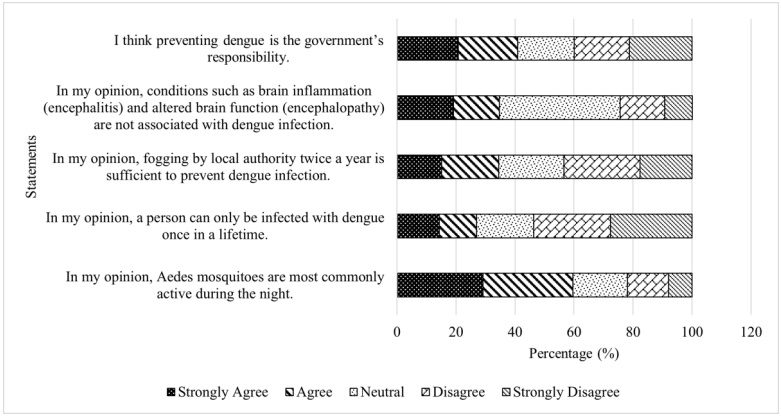

Fig 2: Pre-score percentages of attitudes toward dengue prevention among target respondents

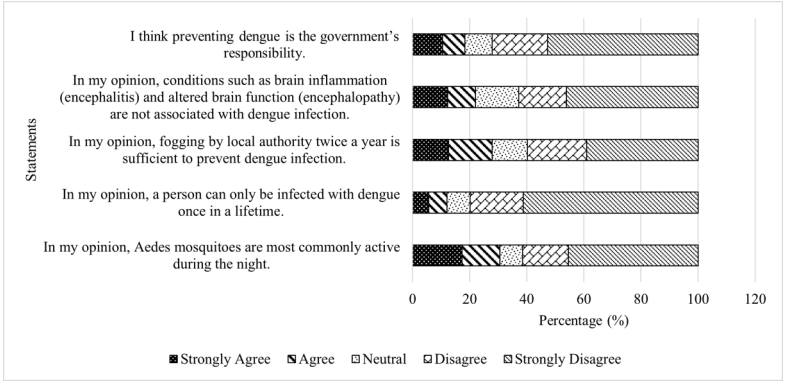

Fig 3: Post-score percentages of attitudes toward dengue prevention among target respondents

About 20.8% of the respondents strongly agreed that preventing dengue is the government's responsibility. However, the attitude changes after the video intervention, with 52.7% of them strongly disagreeing with the statement. It shows that all, including individuals, should share the responsibility for dengue prevention. Some of the respondents (27%) believed that dengue infection can only occur once in a lifetime. However, a significant increase in the percentage

of disagreement with this statement (79.9%) was observed following the video intervention. Indeed, dengue infection can occur in individuals more than once in a lifetime. This highlights the effectiveness of the video in changing the respondents' attitudes.

A one-way analysis of variance (ANOVA) test was conducted to investigate occupational differences in attitude toward dengue prevention. The results indicate a statistically significant difference in attitude toward dengue prevention across occupational categories. This suggests that there are notable differences in attitude scores among individuals in various professions. Post hoc analysis of attitudes toward dengue prevention in students, self-employed individuals, employed individuals, and retired individuals revealed significant results with $p < 0.001$. Nevertheless, there were no differences in attitude toward dengue prevention between unemployed individuals and housewives, with p-values of 0.589 and 0.074, respectively.

Table 3 presents the frequency distribution of respondents' practices regarding dengue prevention. A total of 420 respondents (95.9%) either agreed or strongly agreed that periodic emptying or proper storage of containers is needed to prevent water accumulation, thus preventing dengue. Approximately only 19% of respondents disagreed or strongly disagreed that keeping the doors or windows open during fogging activities can help eliminate mosquitoes. Most of the respondents were aware of the use of temephos to eliminate mosquito larvae. The respondents were also informed about the importance of regularly cleaning the refrigerator and following reliable information sources to prevent and effectively eliminate dengue.

	n (%)				
Practices	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Periodic emptying or proper storage of containers to prevent water accumulation.	353 (80.6)	67 (15.3)	14 (3.2)	0 (0)	4 (0.9)
Keeping the doors or windows open during fogging activities can help reduce the number of mosquitoes.	318 (72.6)	71 (16.2)	28 (6.4)	9 (2.1)	12 (2.7)
The use of temephos (e.g., Abate®) could eliminate mosquito larvae.	320 (73.1)	81 (18.5)	31 (7.1)	3 (0.7)	3 (0.7)
Cleaning the refrigerator tray at least once a week can be effective in reducing breeding sites of mosquitoes.	333 (76.0)	75 (17.1)	21 (4.8)	5 (1.1)	4 (0.9)
Follow trusted sources of information such as the World Health Organisation (WHO) or local health authorities to obtain updates on dengue.	345 (78.8)	72 (16.4)	15 (3.4)	2 (0.5)	4 (0.9)

Table 3: Post-evaluation frequency of respondents' practices toward dengue prevention

Furthermore, Pearson's correlation analysis revealed a significant difference between KAP, as shown in Table 4 ($p < 0.001$). The moderate correlation between knowledge and attitudes ($r = 0.633$) implies a moderate relationship between the knowledge levels of the participants and their attitudes toward dengue prevention. Conversely, there was only a weak correlation between knowledge and preventive practices, as well as between attitudes and preventive practices.

Variables	Pearson's correlation, r	p-value
Knowledge & Preventive Practices	0.354	<0.001*
Knowledge & Attitude	0.633	<0.001*
Attitude & Preventive Practices	0.307	<0.001*

Based on Pearson's Correlation

*Statistically significant at p-value <0.001

Table 4: Association between Dengue Knowledge, Attitude, and Preventive Practices

The paired t-test results analysis indicated significant improvements in the mean scores of knowledge, attitude, and preventive practices following the video intervention ($p<0.001$) (Table 5). Notably, the mean knowledge scores increased substantially from 1.06 to 3.41, signifying that most respondents had inadequate knowledge regarding dengue (0-2 range) prior to the video intervention. In addition, the video intervention exposure contributed to a significant increase in the mean knowledge score to 3.41, which is classified as fair knowledge (3-4 range).

A total of five statements were used to evaluate the respondents' attitudes. The total maximum score for attitude is 25. The mean attitude score for all respondents was 14.72 ± 4.47 in the pre-test evaluation (poor attitude). In contrast, the mean score improved to 20.11 ± 5.86 (indicating a good attitude) after the video intervention in the post-test evaluation. In addition, the mean practice score of post-evaluation was 23.29 ± 2.93 out of a maximum score of 25. The results indicate a notable improvement in practice among the respondents following the video intervention.

Criteria	Mean ± SD		t	p-value
	Before intervention	After intervention		
Knowledge	1.06 ± 1.33	3.41 ± 1.88	-22.65	<0.001*
Attitude	14.72 ± 4.47	20.11 ± 5.86	-13.75	<0.001*
Preventive Practices	20.64 ± 3.41	23.29 ± 2.93	-13.86	<0.001*

Based on the Paired T-Test
*Statistically significant at p-value <0.001

Table 5: Effect of Video-Aided Tool on Dengue Prevention

6. DISCUSSION

Considering the rising number of dengue cases, educational initiatives such as the utilisation of video-aided tools are essential to educate individuals with the necessary knowledge on dengue-related information, enabling them to implement preventive measures effectively. This finding aligns with a study conducted by Dede et al. in 2023, which demonstrated an improvement in students' knowledge scores following the utilisation of a visualisation approach in health education (Dede et al., 2023). Our findings found that females were more knowledgeable about dengue treatment, transmission, and prevalence than males. In accordance with our findings, another study also concluded that females possess greater knowledge of dengue symptoms and prevention compared to males (Elson et al., 2020). The findings showed that most female respondents exhibited a strong correlation with a higher level of dengue understanding compared to males. Generally, the differences in social roles or health information-seeking behaviours influence the knowledge level of the individual. To support this, a 2018 study by Kumaran et al. revealed that 63% of women are more likely to be able to identify three or more dengue symptoms compared to males. This suggests that women's role as caregivers equips them with a higher level of knowledge about dengue (Kumaran et al., 2018).

In general, many of the respondents were aware of the vertical transmission of dengue from pregnant mothers to their babies. Individuals can reduce the risk of congenital infections by preventing mother-to-child transmission through a thorough understanding of the vertical transmission of dengue. Selvarajoo et al. (2020) emphasised the importance of raising awareness about the dangers of dengue infection during pregnancy among parents and future parents (Selvarajoo et al., 2020). The study revealed that half of the respondents were aware of the possibilities of dengue vertical transmission.

Coinciding with other studies, most of the respondents acknowledged the contraindications of NSAIDs during dengue infection. The finding is consistent with current treatment guidelines that recommend avoiding these drugs due to the risk of bleeding complications in dengue infection (Koonisetty et al., 2021; Soni et al., 2023). According to the WHO, in 2024, the treatment of dengue infection mainly focuses on treating pain symptoms (Dengue & Severe Dengue, 2023). This aligns with the findings obtained, highlighting the public's acknowledgement of the absence of antiviral medication for dengue treatment. Hence, the knowledge possessed by respondents highlights the importance of preventive measures in avoiding the risk of dengue transmission. This can be overcome by raising community awareness via educational programs. As mentioned by Ahbirami & Zuharah in 2020, dengue health education has been proven to assist student in enhancing their practice level towards dengue prevention by 21% (Ahbirami & Zuharah, 2020).

The study suggested misconceptions about the recurrence of dengue infection. Many mistakenly believed that dengue can occur only once. This is in contrast to a 2024 study that demonstrates awareness of the possibility of dengue infection more than once (Soo et al., 2024). As stated by Khairun et al. in 2024, the presence of four dengue serotypes can make an individual susceptible to dengue up to four times (Khairun et al., 2023). Moreover, there was a lack of understanding of the behavioural patterns and host-seeking activities of the mosquitoes. The video-aided tool effectively improved its role in disseminating accurate information to the respondents.

The majority of the respondents were well-informed about the use of temephos (Abate) as a larvicide. Temephos demonstrated efficacy in controlling mosquito larvae, leading to a significant reduction in larval populations in the treated areas (Sivabalakrishnan et al., 2023). However, the refusal of respondents to use temephos as a dengue preventive practice is due to ignorance of its correct use or a presumption that temephos is a hazardous substance (Wan Rosli et al., 2019). This issue can be addressed by conducting a campaign specifically designed to provide precise information on the safety of temephos when used as directed. As suggested by Satriawan et al. in 2019, the recommended method for applying temephos is to use 1 gram of temephos per 10 litres of water in a container every month. The study also found the residual larvicidal impact of temephos may last for over a month, depending on water turnover rate and salinity, making this treatment beneficial (Satriawan et al., 2019). Practices

related to opening the window and door during fogging demonstrate a notable increase among respondents. This is consistent with the recommendation given by the WHO to keep windows and doors open when the fogging machine is present in their vicinity to eradicate mosquitoes that are present inside the house.

Attitude and employment position were found to be positively correlated in several studies conducted in Saudi Arabia and Malaysia (Selvarajoo et al., 2020; Hamed, 2024). Consistent with this research, we found a significant difference in dengue attitude scores across different occupational categories. This implies that exposure to dengue information varies across different occupations. Those who are working have more opportunities to learn about dengue through their jobs or social networks, which helps them comprehend the disease and possess a more positive attitude. This finding aligns with Selvarajoo et al. (2020), who assert that working individuals have higher levels of involvement in health programs and educational activities (Selvarajoo et al., 2020). The findings found that self-employed, employed, and retired individuals tend to acquire more positive attitudes than students, housewives, and unemployed individuals. Education level is identified as a contributing factor to high knowledge and attitude among respondents. Individuals with higher education levels tend to possess more knowledge and a more positive attitude. This can be supported by Haniff et al. (2023), who revealed that highly educated parents possess a favourable attitude toward dengue prevention (Haniff et al., 2023). Thus, this underscores the role of educational approaches and campaigns in improving dengue awareness, specifically among low-educated groups.

Research findings revealed a correlation between KAP of dengue, which is consistent with a previous finding from 2023 that identified the correlation between all three KAP domains (Elia-Amira et al., 2023). In this study, the moderate positive correlation between knowledge and attitude highlights the significance of education in determining an individual's attitudes toward dengue prevention. According to Wan Rosli et al. (2018), positive attitudes and cautious preventive behaviour are promoted by possessing sufficient knowledge about dengue (Wan Rosli et al., 2019). This result aligns with several recent studies that have focused on the strong relationship between knowledge and attitude (Mustapha et al., 2023; Ramli et al., 2022; Ahbirami & Zuharah, 2020). Meanwhile, the minimal correlation between knowledge-preventive practices was consistent with the findings of other publications

(Mustapha et al., 2023; Ahbirami & Zuharah, 2020). This implies that a high level of knowledge is not always translated into effective preventive behaviour. However, prior studies have also reported no significant correlation between knowledge-preventive practice and knowledge-attitude (Ramli et al., 2022; Zamri et al., 2020). Additionally, the insignificant correlation between preventive practices and attitude suggests that improvements in preventive behaviour are not a direct result of a positive attitude. Nonetheless, promoting positive attitudes is essential for the effective implementation of preventive behaviours. Aligning with the Health Belief Model, it proposes that individuals tend to engage in health-promoting behaviours if they perceive the threat of the disease and believe in the effectiveness of preventive measures (Mustapha et al., 2023; Ahbirami & Zuharah, 2020; Elia-Amira et al., 2023). In contrast, no significant correlation was observed between attitude and preventive practices in other studies (Ahbirami & Zuharah, 2020; Khairun et al., 2023; Wan Rosli et al., 2019; Zamri et al., 2020).

Video-aided technologies have proven to be effective methods for educating the public on various health issues. This finding is supported by Ghozali (2023), who reported significant improvement results for respondents in the intervention group, suggesting that the video has potential as an effective tool for encouraging patients to reflect on their health issues and self-management abilities (Ghozali, 2023). The research findings suggest that the use of video can significantly enhance the knowledge, attitudes, and preventive practices related to dengue among the Malaysian population. The increase in mean scores of knowledge, attitude, and preventive practices following the video intervention can support this. Specifically, knowledge is categorised as poor, fair, and reasonable, with scores of 0-2, 3-4, and 5, respectively. Respondents demonstrated improvements in knowledge categories, transitioning from poor to fair knowledge. Hence, emphasises the effectiveness of video in disseminating vital information regarding dengue. The well-organised and engaging structure of the video enhances comprehension and retention of the content. Based on Hebert et al., the addition of visual elements, such as infographics or animations, to illustrate the concept being conveyed enables video to become an effective knowledge transfer tool (Hébert et al., 2020). In addition, the efficacy of the intervention in reaching a broad audience is enhanced by the accessibility and simplicity of disseminating videos, which contributes to the consistency of the educational initiative. This finding is substantiated by research conducted in 2022, which highlights the efficacy

of video in enhancing respondents' understanding compared to pamphlets (Md Iderus et al., 2023). Similarly, in comparison to digital alternatives, the dissemination of written guidelines is relatively ineffective in enhancing the performance of health professionals (Dagenais et al., 2021). Meanwhile, a 2023 study by Deshpande et al. emphasises the important role of video in educational initiatives (Deshpande et al., 2023). Therefore, videos can influence attitudes and practices by illustrating real-world consequences and encouraging proactive behaviour, which the text-based approach failed to achieve effectively.

7. LIMITATIONS OF THE STUDY

Despite its benefits, this study has several limitations. A bias towards females, students, and individuals from Kelantan is evident in the sample, which may potentially impact the generalizability of the results. Furthermore, participants experience hesitation and suspicion regarding data privacy due to the use of Google Forms for data collection, which could potentially affect the authenticity of their responses. Additionally, elderly individuals, who were over 61 years old, were often unfamiliar with Google Forms. They were underrepresented, resulting in a minimal response from this critical demographic, which could offer valuable insights into the KAP on dengue. Lastly, to ensure a more thorough assessment of KAP, it is recommended for future research to include participants from diverse racial backgrounds.

8. CONCLUSION

An evaluation of KAP on dengue among the Malaysian population revealed a significant knowledge difference between males and females. The utilisation of a video-aided tool successfully enhanced Malaysian KAP, demonstrating its effectiveness as one of the most effective educational approaches. This study also provides the current association between all KAP domains. Particularly, older people presented with a better attitude toward dengue prevention. Therefore, the need for early education of dengue-related information is critically important to minimise the transmission of dengue. Targeted education

should be more focused on the younger generation, as well as males, to equip them with good KAP. For instance, community-based programs such as seminars and interactive sessions designed explicitly for the targeted population should be organised frequently. This can contribute to a reduction in dengue occurrences. Hence, this study recommends the implementation of video as an educational approach to disseminate and enhance dengue awareness and practices nationwide.

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11. AUTHORS' CONTRIBUTION

Siti Nooraishah designed and organised the studies. Nur Anis' Yazmin conducted the survey and prepared the data. John Shia contributed to the analysis of the results. Siti Syairah assisted with the writing of the manuscript. All authors offered valuable feedback and contributed to shaping the research, analysis, and manuscript.

12. CONFLICT OF INTEREST DECLARATION

We certify that the article is the Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research/manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to IJELHE.

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The Impact of Perceived Usefulness of Mobile Learning on Skills Development: The Mediating Role of Cognitive Load in JPPH, Kota Bharu

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Abstract: *This pilot study explores the influence of the perceived usefulness of mobile learning on skills development among government servants in the Valuation and Property Services Department (JPPH) in Kota Bharu, with cognitive load examined as a mediating variable. As mobile learning tools become increasingly integral to professional development in the public sector, understanding how employees perceive their usefulness can provide insights into the effectiveness of these tools for skill acquisition. Perceived usefulness, defined as the degree to which users believe that mobile learning improves their job performance, is posited to influence skills development directly and indirectly through cognitive load. Cognitive load, or the mental effort required to process new information, may either facilitate or inhibit learning effectiveness depending on its level. Thirty department staff members participated in this pilot study to evaluate the extent to which perceived usefulness influences skill development and how cognitive load impacts this relationship. The study's findings aim to inform future training approaches*

that utilise mobile learning for efficient and accessible skills development, ultimately enhancing departmental performance in property valuation and management.

Keywords: *Perceived usefulness of mobile learning, Cognitive load, Skills development*

1. INTRODUCTION

The role of mobile learning in the workplace has undergone rapid evolution, transforming traditional methods of training and professional development. In sectors such as property valuation and asset management, continuous skills development is essential for employees to remain proficient in valuation techniques, data analysis, and regulatory compliance. Mobile learning provides an accessible and flexible approach to training, enabling employees to engage in learning activities from virtually anywhere and at any time (Akdim et al., 2022). This approach is particularly valuable in government sectors where logistical constraints may limit opportunities for in-person training. In Malaysia, the Valuation and Property Services Department is a key agency responsible for property assessment, land valuation, and the management of public assets (Arif et al., 2021). For staff in this department, maintaining up-to-date skills is crucial to ensure fair and accurate valuations and efficient property management, which in turn supports the financial stability and economic growth of the region.

Perceived usefulness, defined as the extent to which a learner believes that using mobile learning will enhance their job performance, is a critical factor in the adoption and effectiveness of mobile learning tools (Al-Adwan et al., 2023). When employees perceive that mobile learning resources are valuable and beneficial for their work, they are more likely to engage with the content and apply newly acquired skills in practice (Katayeva, 2023). In the context of the Valuation and Property Services Department, perceived usefulness is particularly relevant, as staff are expected to continuously develop competencies in valuation techniques, market trends, and policy updates. However, despite the potential benefits of mobile learning, there is limited research examining how government servants, specifically those in property valuation roles, perceive its usefulness and how these perceptions influence skill development. Given that government servants may have varying levels

of familiarity and comfort with digital tools, perceived usefulness may vary significantly, impacting how effectively mobile learning tools contribute to skill acquisition (Tamsah et al., 2020).

Skills development is an essential outcome of any professional training initiative. In the Valuation and Property Services Department, skilful performance is vital for tasks such as property assessments, data interpretation, and regulatory compliance. Accurate valuation and assessment require a combination of technical expertise, up-to-date knowledge, and analytical skills. The potential for mobile learning to enhance these competencies makes it an attractive option for departments seeking efficient, scalable training solutions (Mutambara & Bayaga, 2021). However, simply adopting mobile learning may not automatically lead to skill development; perceived usefulness, cognitive demands, and learning design all contribute to how effectively mobile learning can foster professional growth. Understanding these factors is crucial for optimising mobile learning for skill acquisition in the public sector.

Cognitive load, the mental effort required to process information, plays a crucial role in learning outcomes. It can act as a double-edged sword. At the same time, a moderate cognitive load is necessary for engaging with new content; excessive cognitive load can hinder learning by overwhelming the learner's mental capacity (Xu et al., 2021). In mobile learning, cognitive load may be affected by factors such as screen size, content format, navigation, and interactivity. When cognitive load is managed effectively, it can facilitate skill acquisition by allowing learners to focus on relevant information without becoming overwhelmed. However, if mobile learning tools present an excessive cognitive load, it could decrease the perceived usefulness of the tools and impede the learning process, ultimately affecting skills development. Thus, cognitive load may mediate the relationship between perceived usefulness and skills development, influencing whether mobile learning tools fulfil their intended purpose.

In the context of the Valuation and Property Services Department, employees are often required to learn complex valuation techniques and regulatory procedures, which demand a significant amount of cognitive resources. If mobile learning content is perceived as applicable but creates an overwhelming cognitive load, it may detract from the learning experience and limit skill acquisition. On the other hand, if cognitive load is optimised, employees may find mobile learning

tools to be both valuable and practical, thereby promoting skill development and improvement. Understanding how cognitive load mediates the relationship between perceived usefulness and skills development can provide valuable insights into designing mobile learning tools that meet the specific needs of government servants in valuation and property management roles.

This pilot study is significant for the Valuation and Property Services Department as it seeks to improve training methods and encourage skills development through the integration of mobile learning. By examining perceived usefulness, cognitive load, and their impact on skills acquisition, this study addresses a gap in research related to digital learning in the public sector. As the Malaysian government emphasises digital transformation, insights from this pilot study may help shape future training initiatives, ensuring that government employees are equipped with relevant, up-to-date skills for effective property management. Furthermore, the findings from this study could inform the design of mobile learning resources to reduce cognitive load, enhance usability, and improve employee engagement with training content.

1.1 OBJECTIVES OF THE STUDY

This pilot study aims to achieve three key objectives:

1. To assess the relationship between the perceived usefulness of mobile learning and skills development among staff in the Valuation and Property Services Department.
2. To examine cognitive load as a potential mediator in the relationship between perceived usefulness and skills development.
3. To provide preliminary insights into the design and deployment of mobile learning tools tailored to the needs of government servants in property valuation and management roles.

1.2 PROBLEM STATEMENT

The Valuation and Property Services Department in Kota Bharu plays a pivotal role in assessing, valuing, and managing public assets, which is crucial to ensuring the efficient functioning of the real estate market and contributing to the national economy. For staff in this department, maintaining up-to-date

knowledge and continually enhancing their professional skills is essential for performing tasks such as property valuation, market analysis, and regulatory compliance. However, traditional methods of training and development may not be sufficient to meet the evolving demands of the sector, particularly given the rapid changes in valuation techniques, market dynamics, and the increasing reliance on digital tools (Tamsah et al., 2020).

Mobile learning has emerged as a potential solution to address these challenges by providing accessible, flexible, and scalable training opportunities. With mobile devices offering the ability to learn anytime and anywhere, mobile learning can accommodate the busy schedules of government servants and reduce logistical constraints associated with traditional training methods (Frosch, 2023). However, according to Papadakis (2021), the adoption and effectiveness of mobile learning tools are often influenced by users' perceptions of their usefulness. If employees perceive mobile learning as valuable and relevant to their job performance, they are more likely to engage with it, leading to better skill development outcomes.

Despite the promise of mobile learning, its impact on skills development in the public sector, particularly within specialised roles such as property valuation, remains underexplored. While mobile learning can facilitate skill acquisition, the relationship between employees' perceptions of its usefulness and the development of relevant skills remains unclear. Additionally, the role of cognitive load—the mental effort required to process information—has not been thoroughly examined in the context of mobile learning. Excessive cognitive load can hinder learning by overwhelming the learner's mental capacity, while optimal cognitive load can enhance focus and skill development (Wang et al., 2024).

For government servants in the Valuation and Property Services Department, the challenge is twofold: first, determining whether mobile learning is perceived as helpful in enhancing job-related skills; and second, understanding how cognitive load affects the relationship between perceived usefulness and skills development (Tzafilkou et al., 2021). If mobile learning tools create excessive cognitive load, they may undermine perceived usefulness and hinder effective skill development (Han et al., 2021). Conversely, if cognitive load is well-managed, mobile learning could lead to better skill acquisition and higher performance.

Thus, the problem this study addresses is the lack of understanding regarding how the perceived usefulness of mobile learning influences skills development among government servants in the Valuation and Property Services Department, with cognitive load acting as a potential mediator. This research gap limits the ability to design and implement effective mobile learning programs that meet the department's training needs. By examining these relationships, this study seeks to provide insights that will inform the design of mobile learning tools that are both engaging and effective in improving skills in the public sector.

2. LITERATURE REVIEW

This literature review examines the key concepts related to the perceived usefulness of mobile learning, skills development, and cognitive load. It explores existing research that addresses these variables, particularly in the context of government servants and professional training in specialised fields, such as property valuation. The review highlights the theoretical frameworks and empirical studies that inform the relationships among these constructs.

2.1 PERCEIVED USEFULNESS OF MOBILE LEARNING

Mobile learning, also known as mLearning, refers to the use of mobile devices, such as smartphones and tablets, for educational purposes. It is increasingly viewed as a flexible and efficient learning tool that enables employees to access learning resources at any time and from anywhere (To & Trinh, 2021). According to Al-Bashayreh et al. (2022), mobile learning enables learners to access content and resources on demand, providing a personalised and context-driven learning experience. In the context of government servants in specialised fields, such as property valuation, the ability to engage in mobile learning provides an opportunity for continuous professional development while overcoming the logistical challenges associated with traditional learning methods.

The Technology Acceptance Model (TAM), developed by Davis (1989), is a widely used framework for understanding the acceptance and use of technology. According to the Technology Acceptance Model (TAM), two key factors influence the adoption of technology: perceived usefulness and

perceived ease of use. Perceived usefulness refers to the degree to which a person believes that using a particular technology will enhance their job performance (Al-Rahmi et al., 2021). In the context of mobile learning, perceived usefulness plays a crucial role in motivating learners to engage with mobile learning platforms. A study by Wilson et al. (2021) highlights that individuals are more likely to adopt a technology if they perceive it as helpful in improving their work performance, a notion particularly relevant in a professional setting such as property valuation.

In the Valuation and Property Services Department, where staff roles involve complex tasks such as property assessment and market analysis, the perceived usefulness of mobile learning is crucial to its effectiveness. Research by Alhumaid et al. (2021) suggests that employees in technical roles, such as property valuation, are more likely to engage with mobile learning tools if they perceive clear value in enhancing their professional skills and staying current with the latest market trends and regulatory changes.

2.2 SKILLS DEVELOPMENT IN THE PUBLIC SECTOR

Skills development refers to the process of acquiring or enhancing skills, knowledge, and competencies that enable an individual to perform tasks more effectively. In the public sector, particularly within specialised departments such as the Valuation and Property Services Department, ongoing skills development is crucial to ensure employees remain proficient in their respective areas of expertise. For instance, government servants responsible for property valuation must stay current with property market trends, new valuation methods, and legal regulations, all of which are subject to change.

Emon and Chowdhury (2023) emphasise that skills development should align with organisational goals and the specific competencies required by employees in their respective roles. For government employees, mobile learning offers an efficient means of upskilling, eliminating the need for time-consuming and costly traditional training programs. Zhang et al. (2021) argue that mobile learning facilitates the continuous development of technical skills and knowledge, making it particularly relevant in fields where changes are frequent and the demand for up-to-date knowledge is high.

In the context of property valuation, mobile learning can offer interactive learning opportunities, real-time access to resources, and the flexibility to learn at one's own pace. These attributes make mobile learning a potentially powerful tool for improving skills development among government servants who need to stay proficient in an evolving field.

2.3 COGNITIVE LOAD

Cognitive load theory, proposed by Sweller (2020), is based on the idea that human cognitive resources are limited and that instructional methods should avoid overloading these resources to enhance learning. Cognitive load refers to the mental effort required to process and understand new information, and it is divided into three types:

i. Intrinsic Load: The inherent difficulty of the material being learned.
ii. Extraneous Load: The load created by the way information is presented to learners.
iii. Germane Load: The mental effort invested in creating schemas and deeper understanding.

Mobile learning, while flexible and accessible, can potentially impose a significant cognitive load on learners, especially if the content is complex or poorly designed. Albus et al. (2021) argue that the design of mobile learning tools should aim to optimise cognitive load, ensuring that learners are not overwhelmed by extraneous load while still engaging with the material at a deep cognitive level.

In the case of property valuation, tasks such as understanding market dynamics, analysing property data, and applying legal frameworks require significant cognitive resources. If the mobile learning content is not designed effectively, it could overwhelm learners and hinder their ability to retain and apply new knowledge (Costley et al., 2021). Al-Hamad et al. (2021) found that when cognitive load is not properly managed, it can have a negative impact on learning outcomes. However, when cognitive load is optimised, mobile learning can facilitate more effective skills development by ensuring that learners are not distracted by irrelevant information or overwhelmed by excessive complexity.

2.4 THE ROLE OF COGNITIVE LOAD AS A MEDIATOR

The interaction between perceived usefulness and skills development is influenced by cognitive load, which acts as a mediating variable in the learning process. According to Huang et al. (2020), learners' perceptions of the usefulness of a learning tool may be moderated by the cognitive load they experience. Suppose learners perceive mobile learning as applicable but find the cognitive load too high. In that case, they may be less likely to engage with the learning content, thus limiting the effectiveness of the learning tool in promoting skills development.

In the context of government servants in the Valuation and Property Services Department, excessive cognitive load may reduce the effectiveness of mobile learning in developing necessary skills. On the other hand, if cognitive load is appropriately managed, perceived usefulness can positively influence skills development. Skulmowski and Xu (2022) emphasise that instructional materials designed to reduce extraneous cognitive load while fostering germane load can enhance learning outcomes. By optimising the design of mobile learning tools to manage cognitive load, it is possible to create a more engaging and practical learning experience that supports the development of relevant skills for property valuation and management.

3. METHODOLOGY

This section outlines the research methodology employed in the pilot study, which was conducted to evaluate the relationship between perceived usefulness of mobile learning (independent variable), skills development (dependent variable), and cognitive load (mediating variable) among government servants in the Valuation and Property Services Department in Kota Bharu. The pilot study involved a sample of 30 respondents. It was designed to test the feasibility, reliability, and validity of the research framework and instruments before proceeding to a larger-scale study.

3.1 INSTRUMENTATION

To assess the key constructs, a structured questionnaire was developed based on validated scales from existing literature. The instrument consisted of three primary sections, each measuring one of the study variables: Perceived Usefulness of Mobile Learning, Skills Development, and Cognitive Load. Each section utilised a 5-point Likert scale to consistently and accurately capture participants' perceptions.

Perceived Usefulness of Mobile Learning
This section was adapted from Davis's (1989) Technology Acceptance Model (TAM), which is widely used in evaluating the adoption of technology. The items were designed to measure the extent to which participants believed mobile learning improved their job performance.

- *Sample Items:*
    i. "Mobile learning helps me perform my job more effectively."
    ii. "Using mobile learning improves my job performance."
    iii. "Mobile learning provides me with access to information that I need for my job."
- *Scale:* 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree)

Skills Development
This section is derived from studies on workplace learning and skills acquisition (e.g., McGrath, 2022), with a particular focus on technical competencies in the property valuation field. The items aimed to measure the extent to which mobile learning contributed to participants' professional growth.

- *Sample Items:*
    i. "Mobile learning has helped me improve my knowledge of property valuation."
    ii. "Mobile learning has contributed to my ability to apply property valuation techniques."
    iii. "The use of mobile learning has improved my understanding of current market trends and regulations."
- *Scale:* 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree)

Cognitive Load

Items in this section were adapted from cognitive load theory, particularly the work of Paas and Van Merriënboer (1994). This construct aimed to measure the mental effort participants expended while engaging with mobile learning content.

- *Sample Items:*
  i. "I find the mobile learning tasks mentally demanding."
  ii. "The mobile learning materials require much mental effort."
  iii. "I find it hard to focus on the learning content due to its complexity."
- *Scale:* 5-point Likert scale (1 = Not at all to 5 = Very Much)

3.2 DATA COLLECTION PROCEDURE

Following the development of the instrument, the questionnaire was distributed to 30 selected government servants via Google Forms. Participants were briefed on the study's objectives, the confidentiality of their responses, and the voluntary nature of their participation. A one-week window was provided for completion, ensuring respondents had sufficient time to reflect on each item.

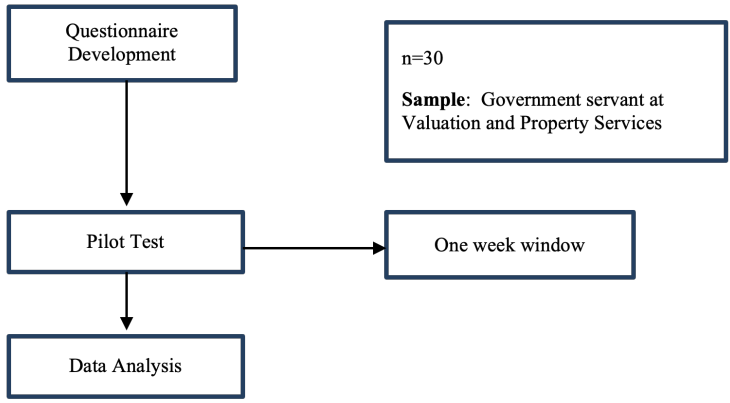

Figure 1: Data Collection Process

3.3 RELIABILITY ANALYSIS

To determine the internal consistency of the instrument, reliability testing was conducted using Cronbach's Alpha for each construct. As shown in Table 1, all scales exceeded the minimum acceptable threshold of 0.70, indicating that the items were consistent in measuring their respective constructs.

Construct	Number of Items	Cronbach's Alpha
Perceived Usefulness	5	0.86
Skills Development	5	0.81
Cognitive Load	4	0.74

Table 1: Reliability Test Results

The Perceived Usefulness scale demonstrated excellent reliability (α = 0.86), indicating that the items effectively captured participants' perceptions regarding the benefits of mobile learning. The Skills Development scale also demonstrated good internal consistency ($\alpha = 0.81$), indicating reliable responses regarding how mobile learning impacted participants' skill acquisition. Meanwhile, the Cognitive Load scale yielded an acceptable reliability score (α = 0.74), indicating consistent but slightly variable perceptions of mental effort among participants.

4. FINDINGS AND DISCUSSION

The pilot test conducted among 30 government servants in the Valuation and Property Services Department in Kota Bharu aimed to explore the relationships between perceived usefulness of mobile learning, cognitive load, and skills development. The results from the pilot study provide valuable insights into how mobile learning can impact skills development in this specific context, while also highlighting the role of cognitive load as a mediating factor. The following discussion elaborates on the findings and their implications for mobile learning in the workplace.

4.1 PERCEIVED USEFULNESS OF MOBILE LEARNING

One of the key findings from the pilot test was the high perceived usefulness of mobile learning among the respondents. With a mean score of 4.2 out of 5, respondents indicated that they found mobile learning to be a valuable tool for enhancing their skills and job performance, as summarised in Table 2. This finding is consistent with previous research, which suggests that employees are more likely to engage with technology when they perceive it as helpful in enhancing their work (Davis, 1989). For government servants in technical fields such as property valuation, the ability to access learning materials, guidelines, and regulatory updates on mobile platforms offers flexibility and convenience, which enhances the perceived value of mobile learning.

The positive perception of mobile learning's usefulness aligns with the Technology Acceptance Model (TAM), which posits that perceived usefulness is a key determinant of technology acceptance and use. The high score in this area suggests that, if designed effectively, mobile learning tools have the potential to significantly enhance employees' skills by providing real-time access to information relevant to their tasks, which is essential for professionals in rapidly evolving fields like property valuation.

Key Findings	Implication
High perceived usefulness of mobile learning	Participants view mobile learning as valuable for enhancing job performance.
Aligns with the Technology Acceptance Model (TAM)	Perceived usefulness is crucial for the adoption of technology.
Provides flexibility and convenience for learning	Mobile learning offers professionals convenience, enhancing their engagement.

Table 2: Summary of Findings for Perceived Usefulness of Mobile Learning

4.2 SKILLS DEVELOPMENT AND MOBILE LEARNING

The results also revealed a moderate-to-high mean score for skills development (3.8 out of 5), indicating that respondents believed mobile learning had a positive contribution to their professional development. The pilot test suggests that mobile learning has a noticeable effect on skills development, specifically in areas such as property valuation, market analysis, and regulatory compliance. This finding is consistent with research by Moore (2020), who argues that mobile learning can enhance the development of technical skills by providing access to up-to-date resources and facilitating continuous learning.

However, it is important to note that while the respondents felt mobile learning contributed to their skills development, the improvement was not overwhelming. This may be due to the relatively short duration of the pilot test and the limited sample size, which may not fully capture the long-term effects of mobile learning. Future studies with larger samples and extended timelines are necessary to validate these findings and assess the long-term impact of mobile learning on skills development.

Key Findings	Implication
Moderate-to-high perceived impact on skills development	Mobile learning has a positive impact on professional growth in areas such as property valuation and market analysis.

Table 3: Summary of Findings for Skill Development and Mobile Learning

4.3 COGNITIVE LOAD AND LEARNING OUTCOMES

A key focus of this pilot test was to explore the role of cognitive load in the relationship between perceived usefulness and skills development. The analysis revealed a moderate negative correlation between perceived usefulness and cognitive load ($r = -0.45$), indicating that participants who found mobile learning to be useful experienced lower cognitive load levels. This implies that effective mobile learning tools, when perceived as valuable, may reduce the mental effort required for learning, making the process smoother and more engaging.

While the negative correlation between cognitive load and skills development was not statistically significant (r = -0.30), the pilot test still suggests that excessive cognitive load may hinder the effectiveness of mobile learning. This aligns with Sweller (2020), who posits that instructional materials should be designed to minimise unnecessary cognitive load, thereby enhancing learning outcomes. For government servants engaged in tasks such as property valuation, complex content, or poorly designed mobile learning resources could overload learners' cognitive capacity, leading to reduced engagement and effectiveness in skills development.

The findings suggest that mobile learning tools should strive to strike a balance between the amount of information presented, ensuring it is neither too overwhelming nor too simplistic. Designing content that is easy to navigate and digest, while still challenging enough to foster skill development, is crucial for maintaining a manageable cognitive load.

Key Findings	Implication
Moderate negative correlation between perceived usefulness and cognitive load	A lower cognitive load is associated with a higher perceived usefulness of mobile learning.
Negative correlation between cognitive load and skills development (non-significant)	While cognitive load affects learning outcomes, the effect may not be statistically significant.

Table 4: Summary of Findings for Cognitive Load and Learning Outcomes

4.4 MEDIATING ROLE OF COGNITIVE LOAD

The mediation analysis conducted in this pilot test revealed that cognitive load partially mediates the relationship between perceived usefulness and skills development. Specifically, when cognitive load was lower, the positive effect of perceived usefulness on skills development was more substantial. This suggests that while the perceived value of mobile learning is important, its effectiveness is contingent on how well the cognitive demands are managed.

This finding aligns with the work of Paas and Van Merriënboer (2020), who emphasise that cognitive load should be managed effectively to ensure that learners can process new information without becoming overwhelmed. In the context of government servants in the Valuation and Property Services Department, where tasks can be complex and require focused attention, the design of mobile learning content that reduces unnecessary cognitive load may be critical for enhancing learning outcomes.

Key Findings	Implication
Cognitive load partially mediates the relationship between perceived usefulness and skills development.	Cognitive load influences how perceived usefulness impacts skills development.
When cognitive load is well-managed, skills development improves	Effective cognitive load management can enhance the impact of perceived usefulness on learning outcomes.

Table 5: Summary of Findings for the Mediating Role of Cognitive Load

5. CONCLUSION

In conclusion, the pilot test provided valuable insights into how mobile learning can support skills development among government servants in the Valuation and Property Services Department in Kota Bharu. The results suggest that mobile learning is perceived as a useful tool for improving job performance, and cognitive load plays a significant role in mediating the relationship between perceived usefulness and skills development. The findings underline the importance of designing mobile learning content that is engaging, relevant, and cognitively manageable. These insights will be useful in guiding the development of mobile learning programs tailored to the specific needs of public sector employees in specialised fields, such as property valuation.

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8. AUTHORS' CONTRIBUTION

Ayu Kamareena Abdullah Thani is responsible for designing the survey instrument and data collection process. An Nur Nabila Ismail and Nik Mohamad Shamim Nik Mohd Zainordin contributed to the analysis of the results. Nurhidayah Rosely and Noor Rahmawati Alias contributed to the writing of the manuscript. All authors offered valuable feedback and contributed to shaping the research, analysis, and manuscript.

9. CONFLICT OF INTEREST DECLARATION

We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to IJELHE.

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