Usability Testing of DataPintar Mobile Application for Learning Data Measurements among Secondary School Students

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***Abstract*—The evaluation of usability in software applications is a crucial aspect of ensuring that the end product is intuitive, user-friendly, and effectively meets users' goals. Leveraging the ISO 9241-11 framework, this study evaluates the usability of an iOS mobile application, DataPintar, developed specifically to provide interactive learning experiences for data measurement concepts within the Fundamental of Computer Science subject. Focusing on three key components, which are effectiveness, efficiency, and satisfaction, this study was conducted among 30 secondary school students enrolled in The Fundamental of Computer Science course. A total of 14 tasks were administered to the participants, and the results indicated high usability, with a 100% task completion rate and an overall satisfaction score of 87.85%. DataPintar was found to be a promising mobile application for enhancing learning outcomes, as it was easy to use and featured simple tasks. However, the findings suggested that minor adjustments should be made to improve the user experience, such as modifying the arrangement of buttons to ensure information is retrieved with more ease and improving the responsiveness of certain sliders in the mobile application. The study contributes to the advancement of usability evaluation research, focusing on educational mobile applications. This study highlights the importance of incorporating usability evaluations to ensure a user-centred design and rigorous usability testing, ultimately improving learning tools and fostering engagement in secondary education.**

***Keywords*—usability, ISO 9241-11, mobile application, effectiveness, efficiency, satisfaction**

I. Introduction

The rapid advancement of technology has influenced the adoption of current technologies, particularly among younger generations who are digital natives [1]. The use of mobile devices and applications in the teaching and learning process has become a widespread trend and is being adopted across all levels of education, as demonstrated by Voshaar *et al*. [2–5]. The ease of accessibility and the potential interactive features that mobile application offer have made this technology increasingly prominent. As a result, educational institutions are encouraged to design engaging tools that meet the demands of a technology-driven society [5–7]. The use of mobile applications presents promising opportunities and can be leveraged to revolutionise learning experiences beyond traditional classroom settings [8].

The effective use of mobile applications is associated with several contributing factors. Among the most prominent factors are the unique features that attract users interested in using the mobile application [9], the relevance of the mobile application to its target users [10], and its usability, which plays a crucial role in ensuring its effectiveness [11, 12]. Given the increasing demand for mobile applications, it is essential to evaluate the overall quality of the mobile applications and user interactions based on these factors. Therefore, rigorous usability evaluations must be conducted using appropriate methods to ensure that all educational goals are met through the use of this technology, while providing sufficient user engagement [13, 14]. Therefore, the usability evaluation of DataPintar, an IOS-based mobile application specifically designed for educational purposes in aiding data measurement concepts, makes a significant contribution. Compared to other usability evaluations, DataPintar applies the ISO 9241-11 framework while ensuring that this learning tool is tailored to the Malaysian Fundamental of Computer Science curriculum.

To effectively assess the usability of mobile applications, the perspective of the end users plays an important role. Evaluating only the functionality of the mobile application is insufficient. Therefore, users' input is crucial to ensure that the product meets the needs and expectations of its intended users. Consequently, usability evaluations with specific criteria must be used and leveraged to ensure a comprehensive evaluation. Among the key factors that should be addressed and measured in usability evaluation are effectiveness**,** efficiency**,** and satisfaction [15, 16]. Hence, this study evaluates the usability of DataPintar, addressing these key factors while identifying strengths and challenges that arise, with the aim of improving the overall interactivity of the learning tool.

Leveraging the ISO 9241-11 usability evaluation framework, which highlights 3 key components of usability aspects, including effectiveness, efficiency and satisfaction [17]. This study focuses on the evaluation of DataPintar, an iOS mobile application developed to facilitate the learning process of the data measurement topic within the Fundamental of Computer Science curriculum. DataPintar is designed to provide users with an interactive and user-friendly mobile application that can potentially enhance learning outcome. By applying the ISO 9241-11 usability evaluation, this study aims to assess the usability of DataPintar, identify areas for future improvement, and enhance overall user experience.

Previous studies have shown that engagement and independence in learning can be improved through the use of mobile applications, as demonstrated by

Zakaria *et al.* [18, 19]. Therefore, the development of mobile applications like DataPintar has the potential to promote a more effective learning experience for students enrolled in the Fundamental of Computer Science (FoCS) curriculum. To ensure the effectiveness of DataPintar, comprehensive evaluations are essential to gather valuable insights into its overall performance and identify areas for future improvements to achieve educational goals. These findings are crucial as it provide insights into how future research can refine the usability of DataPintar, thereby encouraging greater adoption and fostering a stronger connection within the educational community.

The study focuses on the usability evaluation of DataPintar, assessing its effectiveness, efficiency, and satisfaction in the use of this mobile application. To ensure the usability evaluation accurately reflects the needs of end users, the researcher will conduct usability testing among 30 secondary school students enrolled in the Fundamental of Computer Science curriculum.

II. Literature Review

A. Usability in Educational Applications

Usability in educational applications refers to the degree of effectiveness, efficiency, and satisfaction that users, such as students or educators, experience and how it aids in achieving educational goals. Usability is important, as an educational tool with complex interfaces or poor functionality can negatively affect overall performance and hinder users' motivation and engagement. A study conducted by Roldán-Ruiz *et al.* [20] highlighted the significance of usability evaluations through the development of the Healthy Jeart mobile application. The researcher discovered that improving the usability features of the mobile application helped resolve issues related to information density and enhanced key features such as interactivity, thereby increasing users' engagement and improving learning outcomes. This finding aligns with research by Yáñez-Pérez *et al.* [21] on the development of a mobile application called IndagApp. The study found that aligning content relevance with the current curriculum enhanced overall learning comprehension and improved students' attitudes towards educational content. Usability evaluations can be conducted using different types of measurement tools, such as observational methods like Think-Aloud Protocols and eye-tracking tools, as well as task performance metrics that assess task success rates, time on task, error rate, recovery rate, and click-on stream analysis. Usability can also be measured through questionnaires or surveys using the System Usability Scale (SUS), Post-Study System Usability Questionnaire (PSSUQ), Computer System Usability Questionnaire (CSUQ), and ISO 9241-11.

The System Usability Scale (SUS) is one of the most widely recognised usability scales commonly used to evaluate the usability of software or systems. It was first introduced by John Broke in 1986. The effectiveness of this measurement tool has been examined in previous research, such as a study by Dahri and Worboys [22], which evaluated the usability of a mobile application designed for a teachers' development programme. Using SUS scales and task completion metrics, the study found that all participants were able to complete the task, with an average task completion time of 5.8 seconds. Another similar study conducted by Worboys *et al.* [23] also utilised SUS scales to evaluate the usability of a mobile application providing exercise guidance and air quality information. The SUS questionnaire was paired with engagement metrics in a 12-week pilot study. Both studies highlighted the importance of SUS in reliably assessing usability across critical dimensions of mobile applications.

Another commonly used usability evaluation scale is the Computer System Usability Questionnaire (CSUQ), first introduced by James R. Lewis in 1995 to evaluate the usability of computer systems, covering aspects such as usefulness to interface quality. For example, studies conducted in 2021 and 2024 used the CSUQ scale to evaluate the usability of augmented reality and game-based applications. In a study by Criollo-C *et al*. [24], the evaluation of an augmented reality mobile application revealed areas for refinement in information quality and interface design, providing the researcher with precise areas for improvement. Another finding by Criollo-C *et al.* [25] in a usability study of a mobile application named CiberSecApp, a gamified application for teaching cybersecurity concepts, found that among the four elements evaluated, information quality required minor improvements, while the remaining elements, such as system usability, interface quality, and overall usage, were deemed satisfactory. Therefore, these studies show how effectively CSUQ can be applied for usability evaluations, providing valuable insights into identifying strengths and areas for improvement in educational applications.

Empirical research over the years has highlighted the effective outcomes related to improving the quality of software applications by using usability evaluation, reinforcing the importance of employing these measurement tools. While previous studies have examined the use of educational mobile applications for teaching and learning, limited studies have been conducted to evaluate the usability of mobile applications using ISO 9241-11, particularly for iOS mobile applications designed to teach concepts within the Fundamental of Computer Science Curriculum. This gap highlights the need for further research to improve the design and effectiveness of such specialized educational tools.

B. Aspects of Usability

The usability of mobile applications can be measured through various aspects, with three key factors being effectiveness, efficiency, and satisfaction. These components are crucial in evaluating whether a mobile application is user-friendly and relevant to end users. Effectiveness relates to the extent to which a mobile application assists users in achieving their educational goals or intentions [26]. The effectiveness of a mobile application can be measured using key indicators such as task rate success, accuracy of the outputs, and error occurrence. These key indicators have proven to be reliable in measuring effectiveness, as demonstrated by the Healthy Jeart and IndagApp mobile application usability evaluation studies, which both showed measurable improvements in user engagement and learning outcomes [20, 21]. Efficiency refers to the resources required for users to achieve their educational goals. According to [23],

efficiency is determined by the speed at which users complete specific tasks within an application. It is associated with elements such as the time and effort needed to complete tasks. There are three key indicators of efficiency, which are the time spent on a specific task, the number of steps required to complete the task, and the effort needed to correct errors within the task. Findings from empirical research have found that these key indicators effectively predict efficiency. For example, a recent study by Criollo-C *et al*. [24] evaluated the PSAU mobile application used to aid data mining techniques. The study showed a high task completion rate, indicating very good efficiency levels.

The last aspect is related to satisfaction, an aspect to evaluate users' comfort level and their overall positive attitude towards the use of the mobile application [25]. Satisfaction levels can be measured through user satisfaction ratings, emotional responses (e.g., frustration or enjoyment), and the likelihood of recommending this mobile application for future use. For example, a usability evaluation study of the Jaga Sehat mobile application [26] found that users showed high satisfaction levels and were likely to recommend the application to others.

C. Usability Evaluation Using ISO 9241-11 Framework

The ISO 9241-11 framework is an international standard used as guidelines to evaluate the usability of a prototype through various aspects of human interaction. As illustrated in Fig. 1, the ISO 9241-11 model emphasizes the context of use in evaluating usability. Usability is determined by how well a prototype meets three aspects including effectiveness, efficiency, and satisfaction [27, 28]. Effectiveness refers to the extent to which a product or prototype can be used to achieve certain goals. Efficiency refers to aspects such as time and effort required to achieve the intended goals. Lastly, satisfaction assesses a user's overall experience, such as a positive attitude or discomfort after using the prototype or product.

Four elements influence usability in context of use, which are users, tasks, equipment, and environment. Users are influenced by factors such as skills, knowledge, and experience. The task is related to the activities performed by users to achieve the intended goals. Equipment refers to the hardware, software, and materials used during usability tests, and environment refers to the physical and social environments in which the product or prototype is used. The importance of these elements is demonstrated in a study conducted by Afifa [29] where a researcher evaluated the usability evaluation of a mobile application designed to assist low-vision children. The study incorporated all four elements, including tasks, equipment, and user needs, to measure the application's effectiveness, efficiency, and overall satisfaction.

1) Context of use

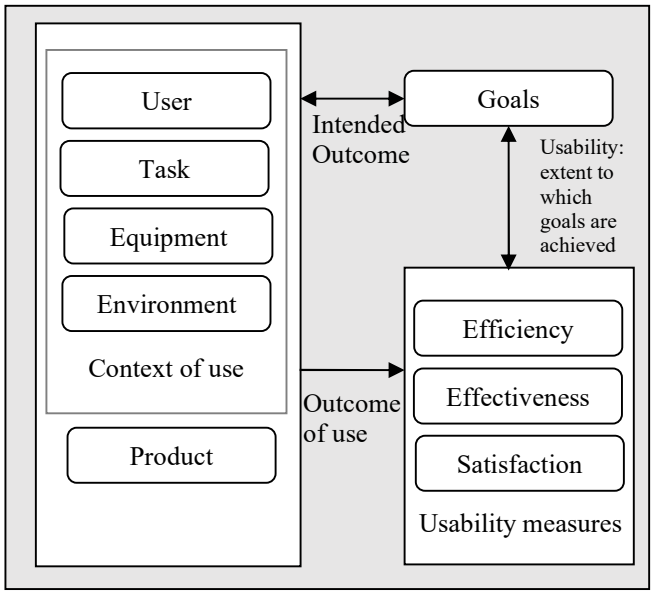

Fig. 1. ISO 9241-11 usability model.

Other studies have also implemented this framework in their usability evaluation, as demonstrated by Roldán-Ruiz *et al.* [20, 21] through the development of mobile application. Both findings indicated that the ISO 9241-11 framework was effective in refining the software by highlighting its strong features and areas of improvement.

D. DataPintar Mobile Application

Existing educational tools have been used to enhance students' comprehension of data measurement topics within the Fundamentals of Computer Science subject, such as web-based applications, mobile applications, and software. However, the current resources lack interactive features [30] and are delivered in English, which may pose a language barrier for Malaysian students. Table 1 summarises the comparison between the current educational tools and the benefits of DataPintar.

Table 1. Comparison of DataPintar with existing educational tools suggested in the fundamentals of computer Science form 1 textbook and available on Google Play Store

Feature	DataPintar (iOS Learning App)	IrfanView (Image Viewer & Editor) (Software suggested in the FoCS Textbook)	Web-Based Notes (URL links provided in the FoCS Textbook)	Nota ASK (Android Based Learning App)
Primary Purpose	Teaching data measurement concepts in Fundamentals of Computer Science	Viewing, editing, and converting images	Providing notes about data measurement	Providing static notes on data measurement
Interactivity	Sliders, calculators, quizzes, audio explanations	Basic image editing, no learning tools	Mostly static text, no interactive features	Limited interactivity
Learning Approach	Hands-on, active learning with real-time feedback	Hands-on experience	Passive learning	Passive reading
Curriculum Alignment	Designed based on Malaysian school curriculum (Fundamentals of Computer Science)	Not aligned with any curriculum	General information and is not fully aligned with syllabus	Aligned with curriculum, but lacks interactive elements
Assessment & Feedback	Quizzes and interactive tasks	No assessments or feedback	No assessments provided.	Provide quizzess

Feature	DataPintar (iOS Learning App)	IrfanView (Image Viewer & Editor) (Software suggested in the FoCS Textbook)	Web-Based Notes (URL links provided in the FoCS Textbook)	Nota ASK (Android Based Learning App)
Language Accessibility	Malay	English only	Mostly in English	Malay
Platform	Mobile Application	Windows desktop software	Web-based & mobile-friendly	Mobile Application
File Format Exploration	Students can experiment with resolution, bit depth, and file size	Allows users to change resolution but with no explanation	Provides explanations but no interactive tools	Only explains file formats, no hands-on exploration

Based on the comparison of current educational tools used within teaching and learning environments for data measurement topics, DataPintar shows promising potential in enhancing learning experiences. Unlike other tools, it is also aligned with the current Malaysian curriculum. The comparison in Table 1 demonstrates that while existing tools used provide limited support in terms of curriculum alignment, language and interactive features, DataPintar mobile application addresses these gaps. By doing this, DataPintar can provide an application that supports comprehension of abstract concepts and is suitable for the current curriculum in Malaysia.

DataPintar is an iOS mobile application specifically designed to aid in learning data measurement concepts within the Fundamentals of Computer Science syllabus as shown in Table 2. The design and development of this mobile application were guided by the ADDIE model (Analyse, Design, Develop, Implement, and Evaluate). Based on the nominal group technique conducted, the researcher identified key issues and the need for interactive learning tools [31], such as mobile learning applications, to assist the learning process. The design of this mobile application aligns with the current curriculum within the Fundamentals of Computer Science subject.

Table 2. Data measurement syllabus

Standard Content	Learning Standard	Performance Standard Interpretation
Data Measurement	Students should be able to:	
	1. Accurately state the unit of measurement for digital images and digital audio.	States the unit of measurement for digital images and digital audio.
	2. Compare file sizes using different formats through methods such as Joint Photographic Experts Group (JPEG) and Image File Format (GIF).	Explains the effect of file size changes.
	3. Measure file size based on resolution and bit depth for digital images, as well as sampling rate and bit depth for digital audio.	Compares the effects of adjusting resolution, sampling rate, and bit depth on file size.
	4. Predict size changes based on file formats and the compression methods used for images and audio.	Suggests suitable file formats for different types of images and audio based on file size and quality.

DataPintar provides notes in text, audio, and interactive functions such as sliders and buttons to enhance student engagement through experiential learning. This mobile application also includes features such as data converters, image, and audio calculators to simulate correct outputs, ultimately providing immediate feedback for students while learning. Additionally, a set of quizzes has been included to evaluate students' overall knowledge after using the mobile application.

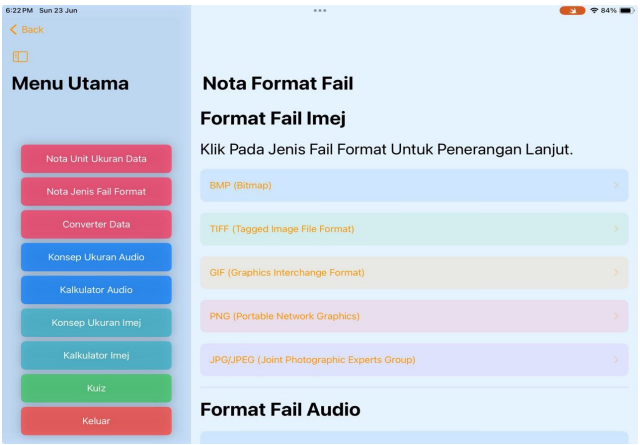

Fig. 2. Notes section in DataPintar application.

As shown in Fig. 2, the section of the mobile application contains notes related to image and audio formats. Users can access the notes by clicking the two top buttons on the upper left side of the application. Users are required to click on the subtitles to obtain more information. This interface is specifically designed in Bahasa Malaysia to cater to the end user's needs.

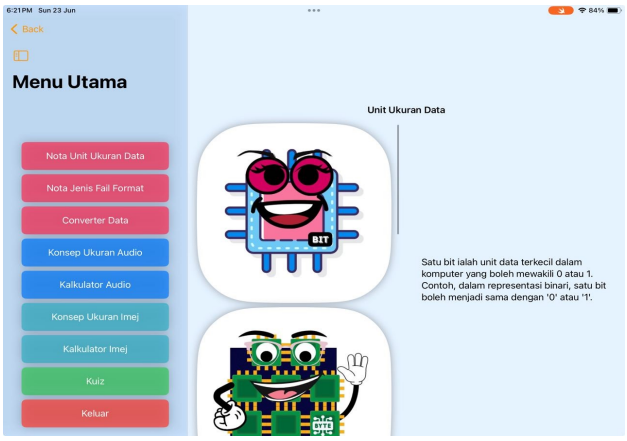

Fig. 3. Notes section in DataPintar application.

Fig. 3 displays the note section where users are also provided with audio tools, when the characters within the application is clicked, the notes are explained in audio mode. This feature supports students with reading difficulties and those who benefit from auditory learning.

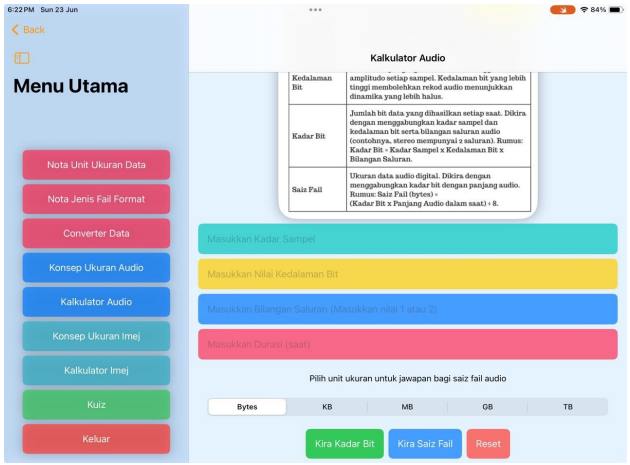

Fig. 4. Example audio calculator.

Fig. 5. Example of image calculator.

Fig. 4 shows the interface for audio calculator where users can manipulate outputs based on the inputs in the sample rate, bit depth and channel textbox. This feature allows users to experiment in real-time and understand how these values influence file size.

Fig. 5 represents the Image Calculator where users can input values in the resolution and bit depth textbox to explore how the file sizes change according to the value given.

III. Materials and Methods

A. Usability Testing Framework

Various assessments were considered in determining the most suitable usability evaluation method for the DataPintar mobile application. Table 3 highlights the comparison among four usability evaluations that have been used in previous studies.

Table 3. Comparisons of usability evaluation

Method	Evaluation Focus	Strengths	Limitations	Past Research
ISO 9241-11	Effectiveness, Efficiency, Satisfaction	1. Comprehensive and evaluates usability in *context of use* (users, tasks, environment) 2. **Internationally** recognized through **the standardized** framework **Structured. Structured** approach and **focuses on** task success**,** time efficiency, and user satisfaction	1.Requires task-based usability testing**,** which takes more effort than simple surveys	[26, 32]
System Usability Scale (SUS)	Overall usability score	1.Quick **and** widely used 2. Provides a usability benchmark across studies	1.Only provides a single usability score, however lacks detailed insights into task performance 2. Does not **assess** learning effectiveness	[21, 22]
Computer System Usability Questionnaire (CSUQ)	User satisfaction, ease of use	1. Provides a structured survey on ease of use and satisfaction	**1.** Does not measure task success rates, efficiency, or real-world usability	[24, 25]
Heuristic Evaluation	Compliance with usability principles	1. Expert-driven**:** Identifies design flaws early 2. Cost-effective for early-stage evaluations	1. Does not involve real users and relies on expert judgment 2. May miss student-specific usability challenges	[33, 34]

To ensure a comprehensive usability assessment that incorporates both task-based evaluation and surveys, the ISO 9241-11 framework was chosen. This framework is a suitable evaluation tool for refining the application, ensuring that the final product is user-friendly, interactive, engaging, and free of errors. Compared to SUS and CSUQ usability evaluations, ISO 9241-11 focuses on elements such as task success, efficiency, and user satisfaction [26, 32]. The ISO 9241-11 framework also focuses on real user interaction, whereas heuristics evaluations typically rely on expert judgement, making them less effective in capturing students' experiences. Therefore, ISO 9241-11 is the most suitable usability evaluation method for assessing the DataPintar mobile application.

1) Participants

The participants selected for this usability test consisted of 30 form 1 students enrolled in The Fundamental of Computer Science subject in secondary school. This group were chosen as they are among the target users of this application. A total of 30 participants was deemed sufficient to identify errors within the software. While this is a relatively small number of participants, it aligns with [35], which states five users are enough to detect approximately 85% of usability evaluation errors. Another study by Woolrych and Cockton [36] specifies that the effectiveness of this approach is influenced by specific test conditions such as task complexity and user variability. However, for statistical confidence, 20 to 40 users are required to ensure reliable confidence intervals. This aligns with previous usability studies on mobile applications, such as those by Buana *et al.* [37, 38], which also used

sample sizes ranging between 15 to 30 participants. Therefore, the number of participants in this study is considered sufficient to produce reliable feedback, and the findings from this test will represent actual end users of the final product.

2) Data collection and analysis

To evaluate the usability of DataPintar, the researcher followed the ISO 92441-11 framework as a guideline to access the level of efficiency, effectiveness, and satisfaction of using this mobile application in learning data measurements concepts. To ensure the usability test was conducted accordingly, three procedures were used in Fig. 6:

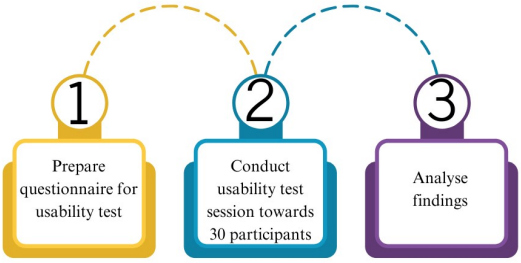

Fig. 6. Procedure for usability testing of DataPintar.

In the first step, the researcher prepared the questionnaire for testing the usability of DataPintar, planned the task requirements for participants, and recruited suitable participants for this test. The questionnaires were adopted from a previous study by Ahmad and Hussaini [39] that focused on usability aspects using ISO 9241-11 dimensions. In the second step, the researcher conducted the usability test by explaining the tasks and requirements to each participant needed to conducted before they began the usability test. Additionally, textbooks and worksheets with correct answers were provided for participants to refer to while testing the mobile application. After completing the tasks, participants were given the questionnaire to fill out. All collected data were analysed using SPSS.

3) Testing environment

The usability testing of the DataPintar mobile application was conducted in a secondary school with 30 Form 1 students enrolled in the Fundamental of Computer Science subject. All participants had prior knowledge of data measurement topics, and each participant was given enough time to complete the assigned tasks using the mobile devices. Before the test was conducted, participants were given prior notice, and a facilitator was appointed to assist and monitor the session. Due to time constraint and the availability of participants, the testing was divided into three sessions, with 10 participants in each session. During each session, the facilitator followed a structure procedure by explaining the test activities that needed to be performed, monitoring the test activities, and distributing the questionnaires.

4) Questionnaire design

The questionnaire comprises three sections. Section A consists of demographics of the participants, while section B contains 5-point interval scale questions designed to measure the three usability elements, which are effectiveness, efficiency, and satisfaction. Additionally, two open-ended questions were included in Section C to identify occurring issues and gather future recommendations for improving the overall usability of the mobile application.

5) Task criteria

Participants were asked to complete tasks associated with the app's key features. Task-based testing is an important element in evaluating the usability of an application, as demonstrated in a previous study related to an augmented reality mobile application for medical education [40]. Table 4 highlights the criteria evaluated in this usability testing and these tasks include:

Table 4. Task criteria for the usability testing

Module	Task Criteria	
Login	Task 1	Log in the app and provide name
Data Measurement Notes Menu	Task 2	Select information and read information
	Task 3	Check the audio function for each note
Types of Fail Formats Menu	Task 4	Select and read information
	Task 5	Check whether buttons are functioning properly
Data Converter Menu	Task 6	Convert data using the worksheet provided and check whether the output is correct or not
Audio Concepts Menu	Task 7	Select and read information
	Task 8	Check whether buttons are functioning properly
Audio Calculator Menu	Task 9	Calculate audio file size using this menu and compare it to the worksheet provided. Check whether the output is correct or not
Image Concepts Menu	Task 10	Select and read information
	Task 11	Check whether buttons and sliders are functioning properly
Image Calculator Menu	Task 12	Calculate image file size using this menu and compare it to the worksheet provided. Check whether the output is correct or not
Quiz Menu	Task 13	Answer all questions and check whether all buttons are functioning correctly.
Exit Menu	Task 14	Exit the application using the exit button

Each task is designed to test the app's usability across the dimensions of effectiveness, efficiency, and satisfaction.

IV. Results and Discussion

The first section explains the demographics of the participants involved in the usability test. The demographics data are in Fig. 7.

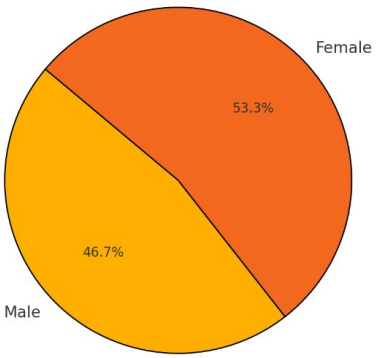

Fig. 7. Participants based on gender.

A total of 30 participants took part in the usability evaluation. 14 (46.7%) were male, while the remaining 16 (53.3%) were female, and all participants were 13 years old.

Fig. 8 presents the distribution of devices that each participant had access to. From the data collected, all 30 participants (100%) had access to mobile phones. A total of 13 participants (43.33%) had access to tablets, 11 (36.7%)

had access to laptops, and 10 (33.3%) had access to desktops, making desktops the least accessible device. This distribution highlights the device type levels of accessibility among participants. In addition, all participants had internet access both at home and at school.

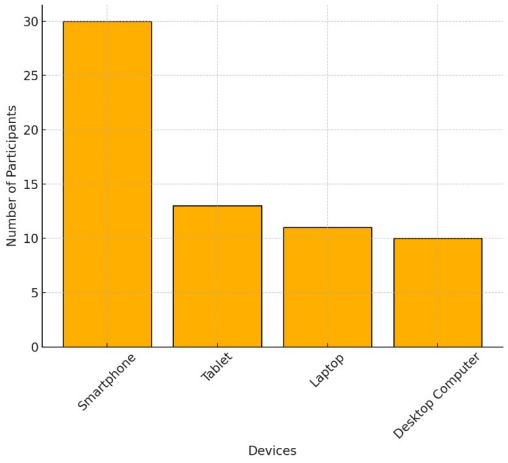

Fig. 8. Device access among participants.

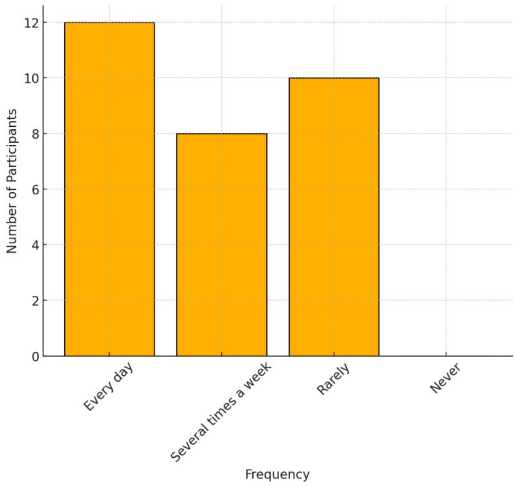

Fig. 9. The frequency of using technology for learning.

Fig. 9 illustrates the time spent using technology for learning. A total of 12 participants (40%) used technology for learning every day, 8 (26.7%) used technology several times a week, and 10 (33.33%) rarely used technology for learning. This indicates that while all participants were exposed to technology, their usage levels varied.

Fig. 10 features participants actively engaged in completing the tasks, whereas Table 5 reports the duration required for each task.

Table 5. Task completion for the usability testing

Tasks	1–10	11–20	21–30	31–40	>40	Average Time
Task 1	30	0	0	0	0	2.5
Task 2	0	10	15	5	0	30
Task 3	0	8	20	7	5	32.5
Task 4	0	5	25	10	10	35
Task 5	0	3	20	15	12	37.5
Task 6	0	6	18	15	11	34
Task 7	0	9	22	12	7	31
Task 8	0	8	25	10	7	33.5
Task 9	0	5	20	15	10	36
Task 10	0	7	25	10	8	34.5
Task 11	0	6	23	12	9	32
Task 12	0	10	20	15	5	30
Task 13	0	0	5	10	5	35
Task 14	28	2	0	0	0	4

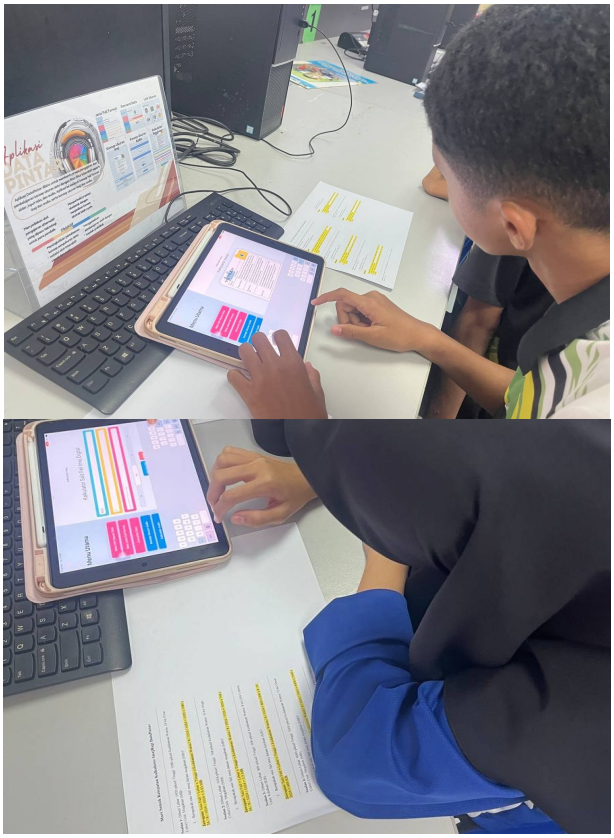

Fig. 10. Participants completing the task.

Each participants were given 14 tasks to complete before answering the questionnaire. All 30 participants achieved a 100% task completion rate, indicating that the DataPintar mobile application is highly effective. The fastest tasks to complete were task 1 and Task 14, which took only 1 to 20 seconds, indicating the straightforwardness and user-friendly design of the application. The majority of participants took less than 10 seconds to complete each task, primarily due to the basic operations required, such as logging in and exiting the application.

Participants completed the next 10 tasks (Tasks 2 to 12) within an average of 20 to 50 seconds per task. These tasks were more complex to conduct, such as reading information (Task 2, 7, and 10), checking button functionalities (Task 3, 5, 8, and 11), performing calculations (Task 6, 9, and 12), and answering quizzes (Task 13). As these tasks required additional effort to verify outputs against the provided worksheet, participants took longer to complete them.

The longest task to complete was task 13, where participants had to answer a set of quiz questions and check the functionality of each button. All participants took over 35 seconds to complete this task, indicating that it was more demanding than the others. This was likely due to the number of questions participants needed to go through and the number buttons they needed to check. Two other tasks that required a greater amount of time were Task 9 and Task 12, where participants were required to test the functionality of the audio and image calculator by comparing the output with the worksheet provided. The duration is significant with the task given, as participants needed extra time to ensure that the output was correct.

The variability of time needed to complete each task indicates that while most tasks were completed quickly, some required additional time depending on their complexity.

However, the DataPintar mobile application demonstrates high effectiveness and efficient, with only a few tasks requiring extra time for completion.

A. Reliability of Items in Each Construct

The reliability of each item within the construct was measured to determine whether each item effectively assessed the intended usability aspects. A reliability test was conducted using SPSS, and the analysis indicated that Cronbach's Alpha presented a score of 0.907, indicating that each construct was consistent among the questionnaire items. This aligns with [41], which states that a Cronbach's Alpha score above 0.9 is considered very good. The interpretation scale used for evaluating Cronbach's Alpha is provided in Table 6. Therefore, all 20 items in the questionnaire were deemed effective for measuring the usability elements of effectiveness, efficiency, and satisfaction.

Table 6. Strength of association determination

Alpha Coefficient Range	Strength of Association
< 0.6	Poor
0.6 to < 0.7	Moderate
0.7 to < 0.8	Good
0.8 to < 0.9	Very Good
≥ 0.9	Excellent

Table 7. Usability questionnaire analysis

Question	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
Q1	0	0	0	0	0	0	9	45	11	55
Q2	0	0	0	0	0	0	8	40	12	60
Q3	0	0	0	0	6	30	14	70	0	0
Q4	0	0	0	0	0	14	13	65	7	35
Q5	0	0	0	0	0	0	19	95	1	5
Q6	0	0	0	0	0	0	9	45	11	55
Q7	0	0	0	0	0	0	11	55	9	45
Q8	0	0	0	0	0	0	12	60	8	40
Q9	0	0	0	0	0	0	15	75	5	25
Q10	0	0	0	0	0	0	2	10	18	90
Q11	0	0	0	0	0	0	14	70	6	30
Q12	0	0	0	0	0	0	16	80	4	20
Q13	0	0	0	0	0	0	17	85	3	15
Q14	0	0	0	0	0	0	12	60	8	40
Q15	0	0	0	0	0	0	18	90	2	10
Q16	0	0	0	0	0	0	18	90	2	10
Q17	0	0	0	0	0	0	1	5	19	95
Q18	0	0	0	0	0	0	2	10	18	90
Q19	0	0	0	0	1	5	10	50	10	50
Q20	0	0	0	0	0	0	9	45	10	50
Frequency	0	0	0	0	7	1.75	229	57.25	164	41

Table 7 summarises participants' responses to each usability questionnaire item. Results from the first item (Q1) of the usability questionnaires indicated that all participants agreed (45%) and strongly agreed (55%) that the DataPintar mobile application was easy to use, indicating that the design was user-friendly and intuitive. Item Q2 also received positive feedback, where (40%) agreed and (60%) strongly agreed that the application was comfortable to use on the tablet devices given. A total of 65% of participants agreed and 65% strongly agreed with item Q4, which relates to the clarity of information in the DataPintar application. As for item Q10, which relates to the organisation of information, 10% of participants agreed, while the remaining 90% strongly agreed that the organisation of information within the application was well-structured and easy to follow. For the ease of navigation aspect in item Q17, 95% of participants strongly agreed that the application was very easy to navigate. Additionally, 45% agreed and 55% strongly agreed that the mobile application was easy to learn (Q6).

Regarding the functionalities of DataPintar, 60% of the participants agreed and 40% strongly agreed that the application facilitated faster task completion (Q8). Furthermore, 90% agreed and 10% strongly agreed that the steps needed to accomplish tasks were simple and easy (Q15). As for the availability of all expected functionalities, 80% of participants agreed that the mobile application provided all the necessary functions, while the remaining 20% strongly agreed (Q12).

Although most items received strong positive feedback, participants found that certain improvements might be needed regarding the ease of finding information (Q3). A total of 30% of participants responded neutrally, while the remaining 70% agreed. This indicates that minor improvements may be necessary to improve the user experience in locating information within the application. Regarding overall satisfaction (Q20), 95% of participants expressed agreement and strong agreement, while the remaining 5% responded neutrally. This indicates that minor improvements may be needed to fully meet user expectations.

As shown in Table 8, the analysis indicates a high level of user satisfaction among the 30 participants regarding the usability of the DataPintar mobile application.

The overall satisfaction rate was 87.85%, with the majority of participants selecting "agree" (55.25%) and "strongly

agree" (41%). This highlights that most participants provided positive feedback on the usability of the DataPintar mobile application. The overall findings show a high usability level and user satisfaction after using the DataPintar mobile application. All participants responded positively to the ease of use, clarity of information, and efficiency in task completion. However, slight improvements may be needed to make the application more effective and efficient in fully satisfying user needs. To ensure a stronger interpretation of satisfaction results, we examined it between average task completion and discovered that shorter completion rates, suggesting that DataPintar mobile application is intuitive and easy to use. Although no correlation towards individual tasks with satisfaction was made, both independent measures regarding efficiency and satisfaction aided in reinforcing the overall usability of this mobile application. By triangulating these findings, helps to provide a holistic evaluation which can reduce over-reliance and self-reported data issues that can lead to bias.

Table 8. Satisfaction rate analysis

Scale Options	Scale Number	Total of Answers	Max Possible Value	Actual Total Value	Satisfaction Rate
Strongly Disagree	1	0	0 × 5 = 0	1 × 0 = 0	
Disagree	2	0	0 × 5 = 0	2 × 0 = 0	
Neutral	3	7	7 × 5 = 35	3 × 7 = 21	
Agree	4	229	229 × 5 = 1145	4 × 229 = 916	
Strongly Agree	5	164	164 × 5 = 820	5 × 164 = 820	
Total	-	400	2000	1757	(1757/2000) × 100 = 87.85%

The findings from the usability evaluation of DataPintar, using the ISO 9241-11 framework, were compared to previous studies applying the same approach. Table 9 summarises the findings of DataPintar and three other mobile applications that have been assessed using the same framework.

Table 9. Usability ISO 9241-11 benchmark comparison

Usability Metric	DataPintar	UniKL Link App [39]	Sirah Nabi Game [42]	Healthy Jeart App [20]
Task Completion Rate	100%	100%	Not explicitly stated	100%
Satisfaction Score	87.85%	82.15%	2.68–2.97 mean	5.4 Likert scale
Efficiency (Average Task Time)	30-35s per task	<10s for simple tasks, >60s for complex ones	Efficiency score: 2.03 - 2.47	Navigation & clarity were well-rated, but information density was a challenge
Usability Issues	Hidden buttons, unresponsive sliders, need for better feedback	Some tasks are too complex, slow response times	Game controls, font size, and content clarity	Information overload and feedback mechanisms need improvement
Evaluation Model Used	ISO 9241-11	ISO 9241-11	ISO 9241-11, Mobility & Playability	ISO 9241-11 (Content, Navigation, Utility, Feedback, Appraisal)
Impact on Learning Engagement	High due to the interactive user interface	Moderate, mainly for administrative tasks	High engagement due to gamification	Strong engagement, but content complexity may affect comprehension
Retention and Learning Outcomes	Not explicitly measured, but usability suggests better retention	No learning-related outcome measured	Teachers noted improved understanding of Sirah topics	Users reported increased awareness of health habits, but no formal retention assessment

Based on the usability evaluation, all mobile applications showed high usability ratings. However, minor setbacks were identified. Similarly to DataPintar's usability finding, the Healthy Jeart application also highlighted minor issues regarding information overload, which aligns with DataPintar's overall satisfaction results (87.85%). This suggests that minor improvements, such as readjusting the user interface, could further enhance usability of the mobile application. In terms of efficiency, completion time rates varied across different applications, suggesting that the time required to complete each task depends on task complexity. Another similar finding was that all mobile applications demonstrated moderate to high learning engagement. However, they were unable to measure retention and learning outcomes using this framework alone.

V. Conclusion, Limitations and Future Work

The usability evaluation of DataPintar, an iOS mobile application to aid in learning data measurement concepts within the Fundamental of Computer Science curriculum, was conducted using the ISO 9241-11 framework. Components such as effectiveness, efficiency, and satisfaction were evaluated through a series of tasks and questionnaires. Findings from the research indicate that DataPintar showed high usability among participants, with a 100% task completion rate and an 87.85% overall satisfaction level, indicating strong usability and alignment with students needs.

However, minor improvements were suggested to enhance the overall experience, including modifying certain buttons to improve information retrieval, adjusting sliders that are less responsive, and providing feedback features in specific areas of the mobile application. By addressing these challenges, the DataPintar mobile application can be further improved to increase overall satisfaction and effectiveness, making it a more interactive, engaging, and effective learning tool This study contributes to understanding how evaluation frameworks can inform the development of other educational

applications in the future. Using the ISO 9241-11 framework, this study demonstrates the assessment of educational tools, particularly within the Malaysian curriculum, while highlighting issues that may arise and serve as design considerations for future studies in this area. As mobile learning has become a trend in today's teaching and learning environment, this study contributes to the expanding body of knowledge, focusing on the importance of usability evaluations in enhancing the effectiveness of learning tools. Usability and learning outcomes are both significant contributing factors. Past research demonstrates a correlation between usability and learning outcomes, where applications with high usability have been shown to increase engagement and retention [43, 44]. While the current study focuses on usability aspects of the mobile application, cognitive load plays a critical role, especially for interactive learning experiences. The design of DataPintar incorporates interactive features that include quizzes, sliders, images and audio to increase comprehension and overall engagement. However, according to Sweller [45], integrating these elements must be done carefully to avoid extraneous cognitive load, therefore leading to learning interference. While these features can enhance motivation, it may need more mental effort, particularly for secondary school students who may struggle cognitively to many types of input. Therefore, future studies should consider exploring the cognitive load aspects to better understand the balance required between engagement and mental effort in using educational applications. Despite these promising results, this study has limitations due to small sample and learning outcomes that have not been measured directly through pre and post-evaluations. While this study focuses on usability, the educational effectiveness is equally important. To address this future research will explore the impact of using DataPintar on learning outcomes by conducting pre- and post-tests, cognitive load analyses, and including diverse user demographics. Additionally, long-term evaluations should be conducted to assess the effectiveness of the mobile application over time. By addressing these strategic steps, researchers can gain a more comprehensive understanding of the app's effectiveness and contribute to the development of educational tools that align with students' needs and technological advancements, while informing the design of other educational mobile learing applications

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Siti Saidah Mohammed Selamat designed, developed the mobile application, tested, and wrote the article. Nor Hafizah Adnan supervised the design, development, and testing of the mobile application, reviewed and edited the article. All authors had approval for the final version of the article.

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