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RESEARCH ARTICLE

An Improved Flashcard-Based ICS Mobile Application for Effective Teaching and Learning of DFC10033 – Introduction to Computer System

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ABSTRACT - A mobile application (mobile app) is a software designed to operate on mobile devices such as smartphones and tablets, allowing users to access information or complete tasks quickly and easily without referring to traditional notes like books. In education, mobile apps function as interactive teaching tools that can be accessed easily and quickly by students. One of the initiatives under Continuous Quality Improvement in Polytechnics is the development of a Teaching Aid Tool to enhance students' understanding of the DFC10033-Introduction to Computer System (DFC10033) course. After a Continuous Quality Improvement meeting a held with the course lecturers and coordinators, a decision was taken on improving the teaching of DFC10033 Course. This made the need for additional teaching aid tools inevitable his led to the development of ICS Flashcard-Based Mobile App, which includes graphic elements and explanatory notes to improve students' understanding. This app is available for free on the Google Playstore.A study was then conducted to evaluate the usability and effectiveness of the app for students of the Diploma in Information Technology (Digital Technology) at Polytechnic Sultan Abdul Halim Mu'adzam Shah (Polimas), Jitra, Kedah, who are taking the DFC10033 course from the Department of Information Technology. The development of the app followed the ADDIE model, which consists of five phases: Analysis, Design, Development, Implementation, and Evaluation. This quantitative study involved 171 male and female students aged between 18 and 25 years. Questionnaires were distributed through Google Forms to collect data, which was then analyzed to assess the objectives and effectiveness of the developed application. The results of the study indicate that the ICS Flashcard Mobile App made a positive contribution, with a mean value of Section B=3.77 and Section C=4.65, which, according to the mean score interpretation, indicates acceptance. The app effectively helped students to understand the course concepts more efficiently, aligning with the Continuous Quality Improvement objectives of developing the DFC10033 Teaching Aid Tool application and testing its effectiveness.

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1.0 INTRODUCTION

Mobile applications have become an essential part of our lives today, following the rapid digital transformation happening everywhere. The widespread use of smartphones and the high demand for mobile applications in various sectors, from entertainment to productivity, communication, and education, have transformed how we interact with the world. Education has also greatly benefited from the development of mobile applications, particularly in the field of Teaching Aid Tool.

Smartphone technology such as Android-powered mobile devices have made it possible to provide students and teachers with some flexibilities in learning anytime and anywhere [1]. When combined with other popular educational platforms, multimedia tools such as Google Classroom and Quizlet serves as the basis for a dynamic learning experience that enhances engagement [2]. Teaching Aid Tool has opened up ways for creative learning which adhere to the requirement of contemporary mobile learners. Integrating mobile applications with education helps in lifting up the quality of learning to universal standards, irrespective of our background or age.

The DFC10033 course is a core subject for students pursuing a Diploma in Information Technology (Digital Technology). The primary focus of this course is to introduce various computer components and how they interconnect. Although, the course is foundational, it contains highly technical topics and terminology that students find challenging to understand. While traditional teaching strategies might be used elsewhere, without more effective approaches, it can become an obstacle in the learning process that students must undergo [3]. Therefore, a more exploratory and engaging teaching approach is crucial to help students overcome these challenges

Recently, the potential to develop a Teaching Aid Tool at ICS was realized through the creation of a flashcard mobile learning application. This leaves the distance learning process just a bit easier and helps the students to be more interactive

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while they are at home. It permits students to review course materials repeatedly via mobile technology, encouraging self-directed learning [5]. During the Continuous Quality Improvement meeting for the DFC10033 course, instructors and coordinators discussed the best ways to provide notes and learning materials to students more easily and quickly, without the need to open physical books. As a result, the ICS Flashcard Mobile App was developed as a standalone Teaching Aid Tool for the course. This app is designed with interactive tools like quizzes, flashcards and memory aids to inculcate proper skills in the student within the context of the course, rendering it learning more challenging [5].

While the app is being widely accepted as a supplement to traditional learning, more research will be needed to evaluate its effectiveness. Methods Research design A quantitative study was performed exploring students' experiences using the ICS Flashcard Mobile App.

Although the app is being recognized as a supplement to traditional learning, further research is required to assess its effectiveness. Therefore, a qualitative study was conducted to explore students' experiences with the ICS Flashcard Mobile App. The main aims of this study are as follows:

i. To develop a Teaching Aid Tool application that helps enhance students' understanding and self-directed learning process in the DFC10033 course.

ii. To assess the effectiveness of the ICS Flashcard Mobile App for the DFC10033 course.

The purpose of this study is to illustrate how educational mobile applications can be used a Teaching Aid Tool in contemporary education. The results can also be considered as an innovative passage representing the inclusion of digital technology within education in a more broadly, given variety and change in 21st-century education. Other very important technologies that enable education at students' own pace and according to their preferences as mobile learning, augmented reality or Teaching Aid Tool [3].

The rest of the paper is arranged in the following structure, first provides details on background, and problem statement of the study followed by methodology used in development of this application. The results and analysis follow to assess the app serves its intended purposes. The last part includes a general overview of the findings and some considerations in relation to the Teaching Aid Tool implementation in current educational practices.

In parallel, the article has been reorganized to more specifically present the problem the study aims to address, set the context of IR4.0, and provide a more direct and concise objective statement**.**

2.0 RELATED WORKS

In the current era of educational technology, mobile applications play a crucial role in enhancing learning outcomes and student engagement at the higher education level. With their ability to provide a flexible and dynamic learning experience, mobile applications are essential in supporting modern learning concepts. Research has shown that apps like Quizlet, Kahoot! fit and motivated by providing interactive gamification components [7]. Nevertheless, the ability to utilise such gamified applications reaches limitations with more complex technical courses like DFC10033. Due to their generic nature, these apps do not handle technical terms and concepts in depth which has been a major problem for students. Hence, Teaching Aid Tool such as the ICS Flashcard Mobile App have been developed to meet the learning requirements for depth of technical understanding in this course material.

Furthermore, other studies have suggested that user-interactive and gamified elements should be included in educational apps to encourage self-directed learning [8]. Apps like Quizlet and Kahoot! use these elements to for example via activities that promote active learning as lecturers. Though gamification has been shown to increase motivation, it also runs the risk of students emphasizing better grades over deeper understanding of the material. This may result in surface level studying where students are doing whatever it takes to score the highest without actually grasping the knowledge of what is being taught.

To address this shortcoming, the ICS Flashcard Mobile App has been developed by offering quizzes and flashcards specifically tailored to understanding computer systems concepts. This practice is different from traditional study camp, ensuring higher concentration of students and a more structured learning experience which can further help in comprehending the subject being taught on a larger depth. In order to identify its impact, a complete evaluation of the app demands for quantitative research that measures comprehension and pre-post evaluation of the students.

The ICS Flashcard Mobile App for technical subjects such as DFC10033 might increase the educational power of learning. As reported in [9], an educational app should not only support understanding by simplifying complicated topics but also be responsive to the style of thinking. The visual and interactive elements of the ICS Flashcard Mobile App help students visualize abstract concepts in computer systems; however, this dimension can be problematic. Visualization might become highly complex, potentially leading to confusion and a poor understanding of basic concepts [10]. Therefore, it is crucial to balance the use of interactive elements to avoid complicating the learning process.

Furthermore, the choice of instructional design model is crucial when developing educational apps. The ICS Flashcard Mobile App was created using the ADDIE model, which comprises five phases: Analysis, Design, Development, Implementation, and Evaluation [11]. The ADDIE model provides a structured approach to these processes, but it has its

limitations. One significant drawback is its lack of flexibility for quick modifications compared to models like the Successive Approximation Model (SAM), which has a more dynamic nature. In this context, although ADDIE is suitable for technical courses like DFC10033, the evaluation process must be iterative and continuous. Seeking reviews and performing regular assessments, which include feedback from students, can provide better insights into the app's effectiveness and areas for improvement.

Previous studies also emphasize the importance of a user-cantered approach. Often in development of educational app developers assume that the design is user centric, but they ignore the different ways students from diverse demographic corner learn [12]. To improve this feedback integration process, the ICS Flashcard Mobile App should take into account some of the suggestions raised by DFC10033 students and evaluate how to better configure the app to cater for alternative learning styles. One way of implementing it is by leveraging user feedback to provide different levels of difficulty throughout the app and allowing students to engage with the material that they can understand. This process is not only beneficial to make the app user-friendly but it also motivates students to advance step by step.

There are many advantages of integrating gamification elements, however the concerns with overemphasis still persist. By providing their critical analysis, they point out that when gamification components are not properly designed, it may dissuade student attention from the actual learning goals to concentrating on scores only. To deal with this issue, the ICS Flashcard Mobile App is very careful to never have quizzes and flashcards on subjects that are irrelevant to the course objectives, not just a game. This pragmatic approach enables students to learn difficult and abstract computer system concepts more thoroughly, helping them understand the reasonings behind them. Further studies are required to corroborate that the gamification elements indeed act as learning reinforcement tools and not just temporary motivators.

In conclusion, while mobile learning apps like Quizlet and Kahoot! offer significant benefits, their limitations in the context of technical courses cannot be overlooked. The ICS Flashcard Mobile App aims to fill this gap by combining user-centered design, curriculum-focused content, and appropriate interactive elements. To validate the effectiveness of this app, further studies and continuous evaluations are necessary, including measuring student performance, understanding, and engagement levels over the long term. With a flexible approach that responds to user needs, this app not only has the potential to remain relevant but could also serve as a model for the development of effective, student-centered technical educational tools. Figure 1 and 2 below shows the differences between the ADDIE model and SAM model, as well as the flowchart for the development of the ICS Flashcard Mobile App.

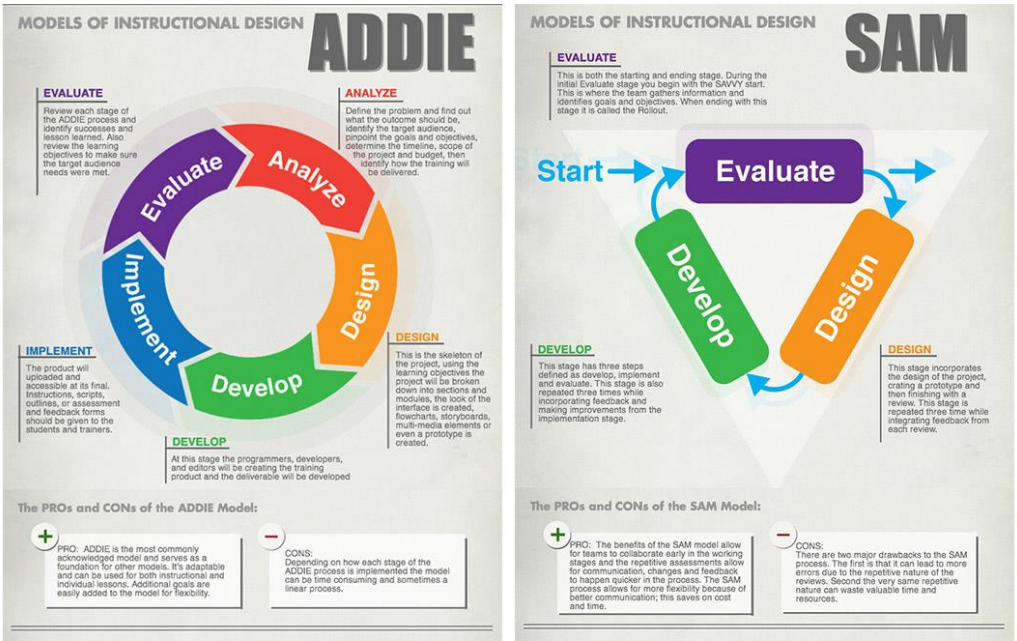

Figure 1. Addie and Sam Model [9]

Figure 2. Flowchart for the development of the ICS Flashcard Mobile App

3.0 METHODS AND MATERIALS

A methodology is a planned structured system of activities for example research, development, practice in the field of classrooms to be organized and smart way to achieve your objectives. The main aim of using a particular methodology is to make each step methodical and goal oriented. When building a learning application, it is important to select the methodology that most suits the users [13]. Therefore, we selected the ADDIE model with an integrated continuous improvement process in a systematic manner to design this application.

The ADDIE model is a widely used framework comprising five major elements: Analysis, Design, Development, Implementation, and Evaluation [14]. Although the phases follow a specific sequence, there are views suggesting that evaluation at each stage requires revisiting previous steps to avoid overlooking any limitations or problems [15]. This iterative process ensures that products, such as mobile applications, are constantly refined to stay relevant to user needs. Figure 3 below illustrates the steps of the ADDIE model used in the development of this application [16].

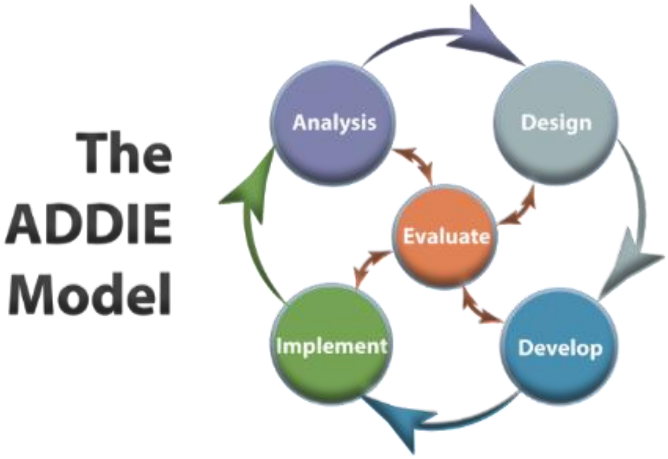

Figure 3. Steps of the ADDIE Development Model [9]

3.1 Phase 1: Analysis Phase

The Analysis phase in the ADDIE model is the foundational and most critical step to ensure that application development is conducted effectively based on real user needs and problems. In this phase, developers examine and determine the data that fits the target users, their problems, and what is needed for success [17]. This process usually requires collection of data like market research, surveys, interviews or with user testing. Through an in-depth analysis helps developers to understand the user priorities and developing an application to cope with it which, as a results, improves the chances of its success.

This course was preceded by a thorough investigation on the academic performance of students in the development. The data analysis showed that knowledgeable areas where performance dropped, were technical and from context for abstract concepts of computing systems. This difficulty demonstrated how there must be a better way of teaching.

This issue was raised to an interdisciplinary discussion between the lecturer and the course coordinator though the formal process of Continuous Quality Improvement. During the discussion, they agreed that there should be a more flexible and accessible learning tool to help students master the course content and serve as an additional medium in teaching and learning [18]. This was the discussion from which emerged our Teaching Aid Tool in developing a mobile application.

In this stage of analysis, the general orientation and objective of the development application was defined. Objectives of these functionalities are, to help students in learning concepts by interaction like take a quiz and flashcards also providing review so that it could be accessed anytime. The overall process of analysis was crucial in order for the development of the ICS Flashcard Mobile App to be truly responsive to student needs as well as directed toward enhancing their academic success. Figures 4 and 5 show the results of the DFC10033 course students' performance and the outcomes of the Continuous Quality Improvement meeting.

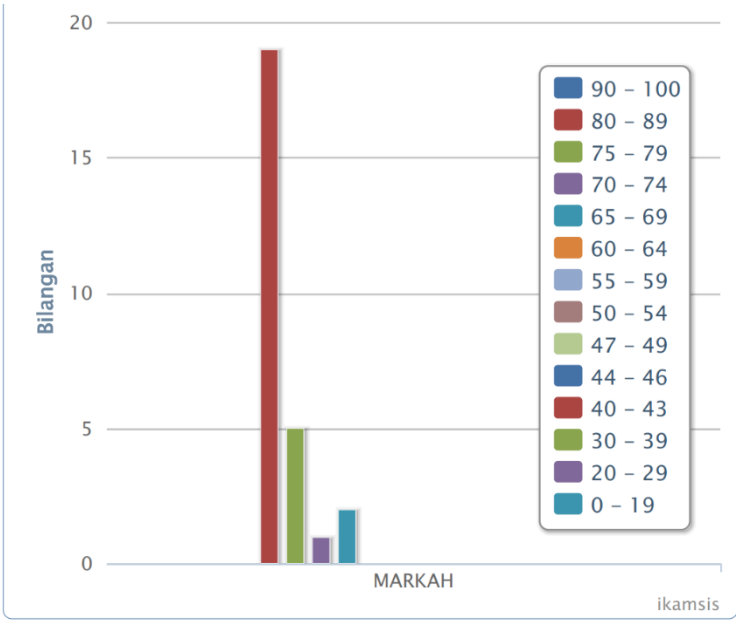

Figure 4. Results of the DFC10033 course students

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PROGRAM DIPLOMA TEKNOLOGI MAKLUMAT (TEKNOLOGI DIGITAL)
SESI 2 2022/2023

KURSUS	PURATA CLO	RUMUSAN	CADANGAN TINDAKAN CQI
DFC10033 INTRODUCTION TO COMPUTER SYSTEM	**DDT 1A, DDT 1B** CLO01P = 74 CLO02P = 91 PLO0003= 64	Pada keseluruhan semua CLO telah mencapai sasaran lebih dari 60% di mana keseluruhan pelajar mencapai purata 70% ke atas.	**Curriculum:** i. Bersesuaian **Instructional:** i. Memastikan semua pelajar menghantar tugasan yang diberikan dan ii. Sentiasa peka dengan isu pelajar terutamanya melibatkan penghantaran tugasan. iii. Memperbanyakkan soalan latihan terutamanya untuk topik yang sukar seperti pengiraan, lukisan rajah dan sebagainya agar pelajar mahir dalam topik tersebut. iv. Mengadakan perbincangan bagi semua soalan tugasan dan soalan-soalan peperiksaan akhir semester lepas. v. Mewujudkan inovasi alat bantuan mengajar (ABM) bagi meningkatkan kefahaman pelajar berkenaan topik tertentu Assessments: Bersesuaian.

Figure 5. Results Continuous Quality Improvement discussion with lecturer and course coordinator

3.2 Phase 2: Design Phase

The design phase of the ADDIE model is the stage where the appearance and structure of the application are being developed. During this phase, the looks and feel of the application and its structure are developed. In this stage, it describes precisely how an educational tool or application will be built. In the context of ICS Flashcard Mobile App development this are some of the most important points to cater, ensuring that app meets the user needs competitive with regards to its educational objectives.

First, determining the application usage strategy This will help to know in which route of using is suitable for the students like do they want or interact with the apps and what are preferable manners, through self- learn or teacher learnt. The process considers the application to be in alignment with the goals obviously remembering quickening the way toward learning [19].

The next step is to design the application's user interface (UI). With the ICS Flashcard Mobile App, this looks like a seamless experience designed for accessibility and ease of use for students. The layout and design of the application should be visually aesthetic, with well-structured.

Third, creating the app to contain evaluation mechanisms is important for the students and lecturers. Interactive quizzes or activity can be embedded to assess students' understanding of the material. This evaluation tools are benchmarks for student progress and feedback to be used in revising future versions of the app. In addition, input and content for the app must be well-organized, it is a key component of design [21]. These evaluation tools serve as benchmarks for student progress and provide feedback for potential improvements in future versions of the app.

Overall, the design phase in developing the ICS Flashcard Mobile App ensures that the application is built with a comprehensive and detailed approach, aimed at effectively meeting students' learning needs. Figure 6 shows the interface design and sketched menus of the ICS Flashcard Mobile App that is intended to be developed, along with the QR code.

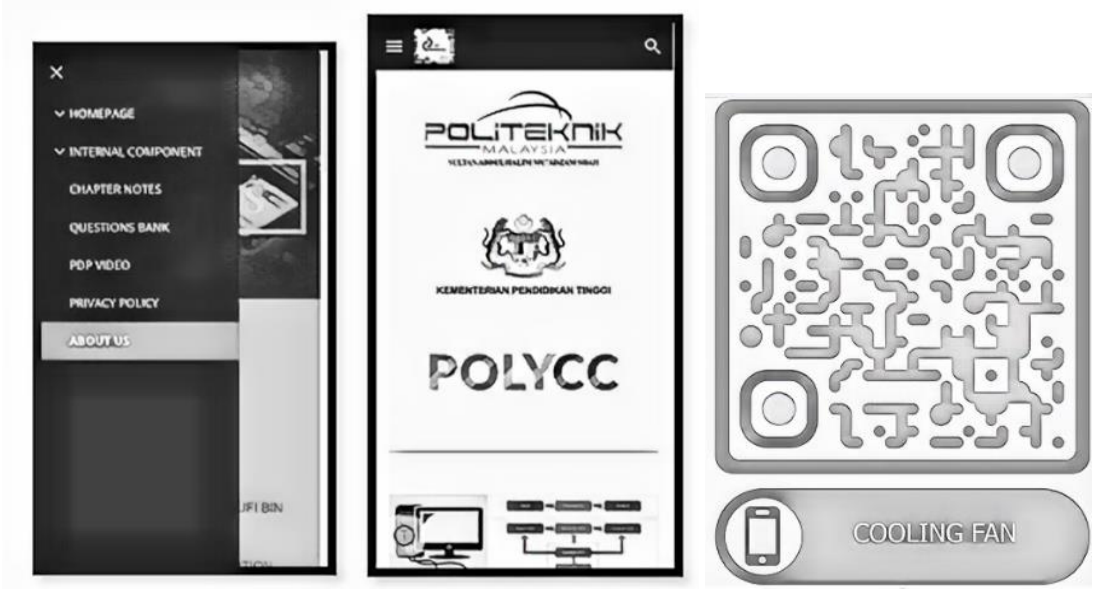

Figure 6. Design of the ICS Flashcard Mobile App with QR CODE

3.3 Phase 3: Development Phase

The development phase in the ADDIE model is the stage where all the planning done during the design phase begins to be realized. At this point, developers start to create and produce the components that were designed to ensure that the application being developed functions fully. After completing the design phase, developers move to the third phase, which is Development. This phase takes all the outcomes from the planning and design stages and turns them into a concrete form. The elements planned during the design phase are now being technically developed, including producing the designed interface, ensuring smooth navigation between menus, and building interactive features like quizzes or Q&A sections to test students' understanding. According to [22], a successful development phase hinges on translating design elements into functional components, aligning with instructional objectives and user requirements.

The graphic components and explanatory notes carefully arranged in the design phase are also integrated into the application. For example, the ICS Flashcard App, which contains seven main menus which is Homepage, Internal Component, Chapter Notes, Questions Bank, PDP Video, Privacy Policy, and About Us is developed based on the structure set during the design phase. In this development phase, the focus is ensuring that each planned component is

implemented accurately and functions properly to meet user needs, as outlined during the design phase. As [23] states, the integration of planned components is crucial to achieving a user-friendly interface that supports learning objectives.

In conclusion, the development phase is a logical extension of the design phase, where all the planning is put into practice to produce an effective and user-friendly application, as anticipated during the design process. This ensures that the developed ICS Flashcard Mobile App application meets the technical requirements to achieve the set objectives. The figure below shows the development of the application menus, along with the QR code, after completing the design phase. As highlighted by [24], ensuring that each component aligns with the set objectives is key to the application's success. Figure 7 shows the menu that was developed from the sketch made during the analysis phase.

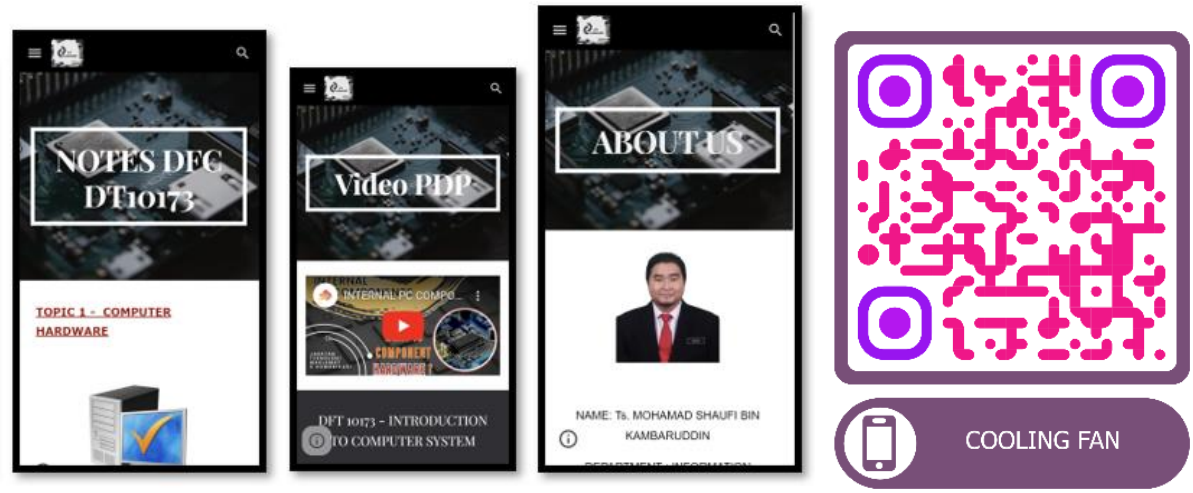

Figure 7. Menus on the ICS Flashcard Mobile Apps with QR Code

3.3 Phase 4: Implementation Phase

The implementation phase in the ADDIE model refers to the actual execution of all the planning and development carried out in the previous phases. During this phase, the main concern is that the product or application can work in a real context with authentic users. This phase is about rolling out the product to the end-users and making sure that everything runs perfectly with a watchful eye for any malfunctions. According to [25], effective implementation is critical for identifying usability issues and refining the product to meet the needs of its target audience. The collection of the user feedback is a most crucial part in this phase, because it will help the developers to identify, whether there are any weaknesses or issues that were not visible with just alone development.

In the context of ADDIE, the implementation phase includes not only product testing but also launch strategies and continuous support to ensure a smooth user experience. As stated by [26], involving target users in testing allows developers to identify areas for improvement and adapt the product to better meet user expectations. For the ICS Flashcard Mobile App, this step includes making the ICS Flashcard Mobile App available, accessible and useful to the intended users in Google Play Store. The tests are performed with students from the Diploma in Information Technology (Digital Technology) program at the Department of Information Technology, Polimas which is the main target user for this application. Some of the students test the app and give feedback using it in a real context. This feedback is gathered through surveys that are organized via Google Forms from the developers, where students fill out after have tried the app. The survey aims to gather both qualitative and quantitative feedback on their usage experience and identify any technical issues or features that could be improved.

The success criteria for this implementation phase are based on how well the application meets user needs, assessed through metrics such as usage rates, user satisfaction, and the level of user adaptation to the application. As highlighted in [27], continuous evaluation and iteration during the implementation phase are essential to enhance the product's effectiveness. If necessary, improvements will be made based on the feedback from users before the app is officially launched to the public. Figure 8 below shows that the ICS Flashcard Mobile App is already available on the Google Play Store, making it easy for users to download and try the app in a real-world setting.

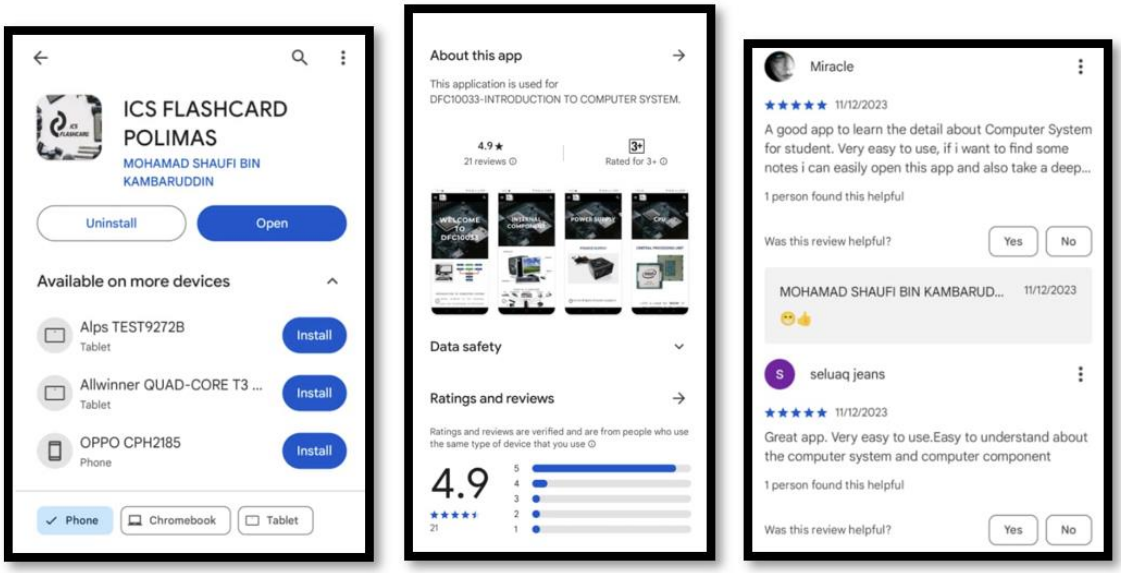

Figure 8. ICS Flashcard Mobile App is already available on the Google Playstore

Once this application has been published on the Playstore, it allows students to easily download and install it on their smartphones. Once installed, students can begin using the ICS Flashcard Mobile App to learn about PC hardware components. This app integrates with the student smartphone by scanning ICS Flashcard Mobile App QR code to receive detailed explanations about hardware components. In addition, the app provides a variety of notes and information that students can access directly. With this app, students can obtain information more quickly and efficiently, without the need to open textbooks or manually search for sources.

In conclusion, the ICS Flashcard Mobile App is a highly effective tool for bringing information to the fingertips of students easily and efficiently. It not only simplifies the learning process but also makes students more independent in their reasoning and idea generation. exploring knowledge about computer parts. Figure 9 shows the briefing session on how to use and user testing of the ICS Flashcard Mobile App with students.

Figure 9. Briefing session with students ICS Flashcard Mobile Apps

3.3 Phase 4: Evaluation Phase

The evaluation phase is the last phase in the ADDIE model. In this phase, the effectiveness of a product or application is assessed to ensure that it meets the objectives set. The purpose of this phase is to check if a product or application meets the objectives that have been set it is in terms of its usability. User feedback is essential while carrying out this phase, to understand and evaluate the impact of the developed product and make necessary improvements. According to [28], the primary goal is to collect data that helps determine how well the developed application or product impacts the target users.

For the evaluation of the ICS Flashcard Mobile App, feedback was gathered from external users to assess the effectiveness of the developed application. A survey was distributed to students of the Diploma in Information Technology (Digital Technology) from the Department of Information and Communication Technology (JTMK) at Politeknik Sultan Abdul Halim Mu'adzam Shah (Polimas), Jitra, Kedah. A quantitative approach was used, with a sample of one hundred and fifty-three (153) male and female students aged between 18 and 25, currently enrolled in the DFC10033 Introduction to Computer Systems (ICS) course. The importance of quantitative evaluation in educational technology was emphasized in [29], which highlighted how structured data collection provides valuable insights into user experience.

The survey instrument was divided into three sections: Section A, which covered respondent demographics such as gender, age, ethnicity, and prior education before enrolling at Polimas; Section B, which focused on students' knowledge of the ICS course offered; and Section C, which examined students' perceptions of the ICS Flashcard Mobile App in the teaching and learning process. Seven items were used to measure students' knowledge, while eight items were used to assess their perceptions of the application. This study involves two variables the dependent and independent variables. The dependent variable is represented by students' knowledge, while the independent variable is represented by their perceptions of the application

Respondents' scores were measured using a five-point Likert scale: 1 (strongly disagree), 2 (disagree), 3 (unsure), 4 (agree), and 5 (strongly agree). This scale helped determine the level of agreement among respondents concerning the survey items, particularly in relation to their knowledge of the ICS course and their perceptions of the ICS Flashcard Mobile App in the learning process. To describe the level of the variables as either high or low, the following mean classification was used as a reference. As noted by [30], the use of Likert scales in educational technology research allows for the measurement of user perceptions in a structured and quantifiable manner.

The collected data was analyse using Statistical Package for the Social Sciences (SPSS version 27.0). In the initial stage of analysis, outliers were removed to ensure data cleanliness. Descriptive statistics were used to analyse the sociodemographic background of respondents and to obtain frequencies and percentages. Data collection was carried out through Google Forms, and both statistics used were aligned with the study's objectives and measurement scales. Through this phase, the results will provide a clear understanding of the effectiveness of the application in helping students grasp the concepts they are learning and the extent to which the application is accepted by its users. Table 1 and Figure 10 present a mean score interpretation table and the questions from the questionnaire used in this survey

Table 1. Mean Score Interpretation Table

Mean Class	Definition
1.00 – 2.00	Very Low
2.01 – 3.00	Low
3.01 – 4.00	Moderate
4.01 – 5.00	High

Figure 10. The survey given to users was conducted through Google Forms.

4.0 RESULTS AND DISCUSSION

In this section, the data analysis obtained from the survey will be discussed to provide insights into the effectiveness of the ICS Flashcard Mobile App based on user feedback. The results from the descriptive analysis, such as mean scores and percentages, will be used to assess the students' knowledge of the ICS course as well as their perceptions of the application. This evaluation aims to determine how well the app has helped students understand the concepts taught and the extent of their acceptance of using technology in the learning process. Additionally, these findings will be compared with the study's objectives to evaluate the overall effectiveness of the developed application

4.1 RESPONDENTS' DEMOGRAPHICS

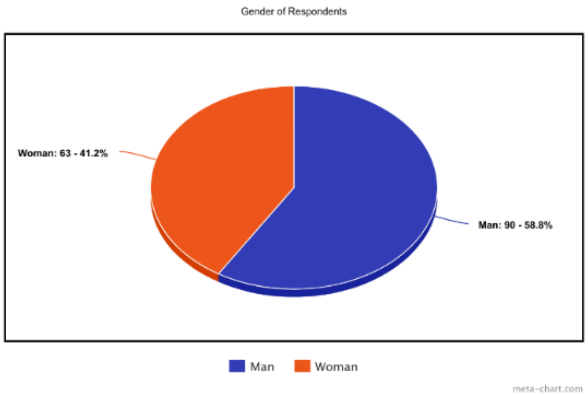

Figure 11. Gender of Respondents

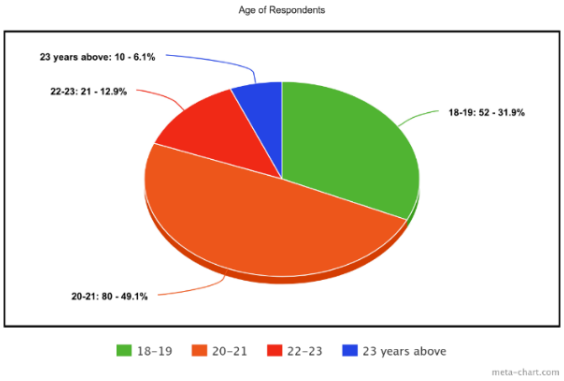

Figure 12. Gender of Respondents

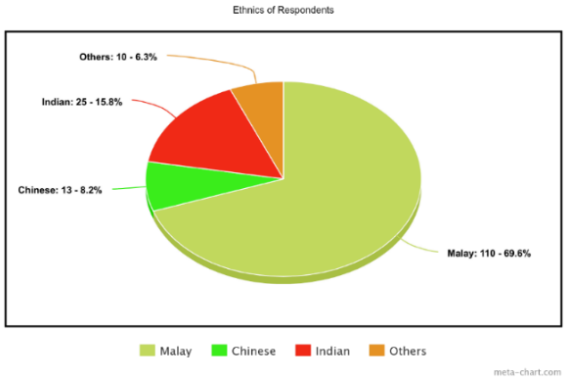

Figure 13. Ethics of Respondents

Table 2. Students Academic Stream Before Entering Polytechnic

Stream	Numbers	Percentage
Engineering	14	9.15%
Science	52	34 %
Art and Humanities	18	11.8%
Others	17	11%
College Community	52	34%

Based on the figure 9-11 above, percentage analysis of demographics, 58.8% (90) of the respondents in this study were male, while 41.28% (63) were female, indicating that the majority of the participants were male students. In terms of age groups, 27.5% (52) of the students were aged 18-19, 52.3% (80) were aged 20-21, 13.7% (21) were aged 22-23, and 6.5% (10) were 23 years old and above. The ethnic breakdown showed that 71.9% (110) of the students were Malay, 8.5% (13) were Chinese, 16.3% (25) were Indian, and 6.5% (5) belonged to other ethnicities such as Siamese, Iban, and others. Regarding their educational background prior to joining the Polytechnic, 34% (52 students) came from pure science streams and community colleges, 11.8% (18 students) were from arts and humanities, and the remainder were from engineering and other streams.

This demographic analysis is crucial in linking the first objective of the project, which is to develop a mobile app that helps students understand the concepts of the DFC10033 course. By understanding the demographic backgrounds of users, the ICS Flashcard Mobile App can be developed to be more inclusive and suited to the needs of students from various backgrounds, whether in terms of age, gender, ethnicity, or prior educational streams. As [31] suggests, tailoring educational tools to the diverse demographic characteristics of users can significantly enhance their learning experience. For instance, male and female students may have different learning styles, and students from science or arts backgrounds may require different approaches in grasping the course concepts.

Additionally, this analysis ties into the second objective of the project, which is to evaluate the effectiveness of the app. By analyzing the demographics of the users, we can assess whether the app functions well for all categories of students or if certain groups may encounter difficulties in using it. As noted in [32], demographic factors such as age and prior educational experience can influence the effectiveness of educational technology, making it essential to consider these aspects during evaluation. For example, younger students may be more receptive to technology compared to older students, which affects how effectively they can use the app. This analysis allows us to measure the app's acceptance and effectiveness in helping students comprehend the DFC10033 course, ensuring that the app meets the set objectives. Furthermore, [33] emphasizes that understanding user demographics is vital for continuous improvement and adaptation of educational applications to meet diverse needs.

4.2 STUDENT KNOWLEDGE REGARDING THE COURSE

In Section B of the questionnaire, seven (7) questions were presented to the respondents. This section aims to identify the students' knowledge regarding the ICS course offered. The feedback received has been recorded and is displayed in Table 3 below.

Table 3. Student Knowledge Regarding the Course

Num.	Items	Scale					Mean
		1	2	3	4	5	
B1	I have experience in performing computer assembly practice	5 (3.3)	9 (5.9%)	27 (17.6%)	28 (18.3%)	84 (54%)	4.15
B2	I have had initial exposure to the basics of computer component assembly	1 (7%)	13 (8.5%)	30 (19.6%)	35 (22.9%)	74 (48.4%)	4.09
B3	I can perform computer assembly practice without referring to notes	6 (3.9%)	24 (20.3%)	43 (32.7%)	40 (21.6%)	40 (15.7%)	3.54
B4	I find it difficult to identify the function of computer components	15 (9.8%)	31 (20.3%)	50 (32.7%)	33 (21.6%)	24 (15.7%)	3.13
B5	I often get confused about the types and components of computers during practice	14 (9.2%)	35 (22.9%)	54 (35.3%)	21 (13.7%)	29 (19%)	3.10
B6	Through computer assembly practice, I can identify the actual computer components	1 (0.7%)	9 (5.9%)	24 (15.7%)	41 (26.8%)	78 (51%)	4.21
B7	I feel that computer assembly practice requires learning aids	3 (2%)	7 (4.6%)	29 (19%)	34 (22.2%)	80 (52.3%)	4.18

Based on the analysis of Section B, items such as B1, B2, B6, and B7 recorded high mean scores, indicating that the majority of students felt they received good exposure during the practical computer assembly sessions and ICS Flashcard Mobile App was very helpful in the learning process. For example, B1: "I have participated in a practical computer assembly" recorded a mean score of 4.15, with 54% of students strongly agreeing and 18.3% agreeing. This shows that most students had solid practical experience in computer assembly. Similarly, B2: "I received initial exposure to the basics of computer component assembly" recorded a mean score of 4.09, with 48.4% strongly agreeing and 22.9% agreeing, reflecting sufficient initial exposure for the students. As noted in [34], practical exposure is crucial in enhancing students' understanding of complex subjects, reinforcing the importance of hands-on learning experiences.

B6: "Through the practical computer assembly, I could identify the actual computer components" recorded the highest mean score of 4.21, with 51% strongly agreeing and 26.8% agreeing, indicating that the practical sessions were very effective in helping students identify computer components. For B7: "I feel that practical computer assembly requires learning aids," the mean score was 4.18, with 52.3% strongly agreeing and 22.2% agreeing, showing that ABM played an essential role in enhancing students' understanding. This aligns with findings from [35], which suggest that learning aids significantly improve the practical learning process by providing structured support.

On the other hand, items such as B3, B4, and B5 recorded lower mean scores, reflecting some challenges faced by the students. For example, B3: "I can perform a practical computer assembly without referring to notes" recorded a mean score of 3.54, with 32.7% of students unsure, indicating moderate confidence among students in performing the assembly without notes. B4: "I find it difficult to identify the functions of computer components" recorded a mean score of 3.13, and B5: "I am often confused by the types and components of computers during practical sessions" recorded a mean score of 3.10, suggesting confusion and difficulty in identifying the functions and types of computer components. According to [36], such difficulties highlight the need for additional support and reinforcement to aid learners in complex tasks, emphasizing the importance of targeted interventions within educational tools.

In conclusion, these findings show that the ICS Flashcard Mobile App successfully achieved the first objective of the project, which was to help students understand the basic concepts of the DFC10033 course through effective practical exposure. However, concerning the second objective, there is still room for improvement in enhancing the app's effectiveness, particularly in helping students overcome practical challenges such as accurately identifying components and reducing confusion. Therefore, additional Teaching Aid Tool or support features within the app are recommended to meet the needs of students who are still facing difficulties in their learning process. The study results indicate that the mean value for the variables in Section B is 3.77, which, according to the mean classification table, shows that this variable is well-accepted. Table 4 below presents the descriptive statistics for the overall mean results of Section B.

Table 4. Descriptive Statistics for Overall mean results of variable Section B

	N	Minimum	Maximum	Mean
MeanSection_B	153	2.43	5.00	3.7768
Valid N(listwise)	153			

4.2 STUDENTS PERCEPTION REGARDING THE APPLICATION

In Section C of the questionnaire, eight (8) questions were presented to the respondents. This section identifies Students' Perceptions of the Developed Application. The feedback received has been recorded and is displayed in Table 5 below.

Table 5. Students Perception Regarding the Application

		Scale					
Num.	Items	1	2	3	4	5	Mean
C8	This application is easy to download.	0 (0%)	1 (0.7%)	11 (7.2%)	27 (17.6%)	114 (74.5%)	4.59
C9	This application greatly helps me understand the learning topic (computer components).	0 (0%)	0 (0%)	9 (5.9%)	30 (19.6%)	114 (74.5%)	4.65
C10	The developed navigation menu is user-friendly.	0 (0%)	0 (0%)	11 (7.2%)	40 (27.1%)	102 (66.7%)	4.64
C11	The font size in this application is clear and easy to read.	0 (0%)	0 (0%)	6 (3.9%)	41 (26.8%)	106 (69.3%)	4.64
C12	I use this application to obtain information about computer components.	0 (0%)	0 (0%)	12 (7.8%)	30 (19.6%)	111 (72.5%)	4.64
C13	I use this application as a reference and reinforcement for related topics.	0 (0%)	0 (0%)	8 (5.2)%	39 (25.5%)	106 (69.3%)	4.64
C14	This application can be accessed at any time when needed.	0 (0%)	0 (0%)	6 (3.9%)	37 (24.2%)	110 (71.9%)	4.67
C15	The provided information is clear and concise.	0 (0%)	0 (0%)	6 (3.9%)	32 (20.9%)	115 (75.2%)	4.71

Based on the analysis of Section C, items such as C8 to C15 recorded high mean scores, indicating that the majority of students have a positive perception of the ICS Flashcard Mobile App in terms of ease of use, understanding of the learning topics, and clarity of the information provided. For example, C8: "This application is easy to download" recorded a mean score of 4.59, with 74.5% of students strongly agreeing, indicating that the application is easily accessible to students. This aligns with findings from [37], which emphasize that accessibility plays a crucial role in user adoption and satisfaction of educational applications.

Item C9: "This application helps me understand the learning topic (computer components)" recorded a mean score of 4.65, showing that the application successfully helps students understand the concepts taught. This is in line with the first objective of the study, which is to develop a mobile application that assists students in understanding the concepts in the DFC10033 course. As noted by [38], effective digital learning tools enhance students' comprehension by providing interactive and clear content, reinforcing the importance of such applications in education.

Additionally, items C10 to C15 recorded mean scores between 4.64 and 4.71, with the majority of students strongly agreeing that the application is user-friendly, can be accessed at any time, and provides clear information. These scores indicate that the application is effective in supporting the learning process, thereby fulfilling the second objective of the study, which is to evaluate the effectiveness of the ICS Flashcard Mobile App in helping students master topics in the DFC10033 course. According to [39], user-friendliness and accessibility are key factors in the success of educational technology tools, significantly influencing students learning outcomes. The study results indicate that the mean value for the variables in Section B is 4.65, which, according to the mean classification table, shows that this variable is very well-accepted. Table 6 below presents the descriptive statistics for the overall mean results of Section C.

Table 6. Descriptive Statistics for Overall mean results of Section C

	N	Minimum	Maximum	Mean
MeanSection_C	153	3.00	5.00	4.6593
Valid N(listwise)	153			

5.0 CONCLUSIONS

Overall, this analysis shows that the mobile application developed successfully achieved both study objectives, with students expressing high satisfaction with the functionality and effectiveness of the application in their learning process. The results of the study indicate that the ICS Flashcard Mobile App made a positive contribution, with a mean value of the overall variable section B and C. This study demonstrates that the ICS Flashcard Mobile App is effective in enhancing students' understanding of the concepts taught in the DFC1003 course. The key findings reveal that the majority of students provided very positive feedback regarding the ease of use of the app, their comprehension of the learning topics, as well as the clarity and accuracy of the information delivered. The application aids students in understanding complex topics more interactively and practically, providing them with a deeper and more effective learning experience. This aligns with the study's objective, which is to develop a mobile application that assists students in grasping the concepts of the DFC1003 course and to assess the effectiveness of the ICS Flashcard Mobile App in helping students master the topics taught. According to [40], mobile learning applications play a significant role in enhancing students' understanding by offering an interactive platform for complex subjects.

The broader impact of this study suggests that the integration of technology in education, particularly through the development of teaching aids like the ICS Flashcard Mobile App, can enrich the teaching and learning process. The application not only helps students understand practical concepts more easily but also has the potential to be continuously used as a teaching tool in other courses. This paves the way for the wider use of technology in the education system, in line with efforts to improve teaching quality through innovation and continuous improvement.

Furthermore, this study highlights the need for ongoing enhancements based on user feedback to ensure that the developed application remains relevant and effective in supporting learning. This approach not only helps meet the current needs of students but also prepares educational institutions like Polimas to continue supporting more efficient and innovative learning, in line with technological advancements and industry needs. The development and use of such technology have the potential to transform the educational landscape and significantly improve student learning outcomes.

As a recommendation for the future, it is suggested that the development of innovative learning applications like ICS Flashcard Mobile App be expanded and applied to more courses. This would not only provide similar benefits to other students in understanding their courses but also support the advancement of education towards broader integration of technology in teaching and learning.

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AUTHORS CONTRIBUTION

Ts. Mohamad Shaufi Bin Kambaruddin (System Developer; Writing & Editing)

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CONFLICT OF INTEREST

The authors declare no conflicts of interest

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