



# Development of Augmented Reality (AR) to Support Learning in The Introduction to Information Technology (PTI) Course: A Case Study at Darma Persada University

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**Abstract** — Advances in Augmented Reality (AR) technology offer significant potential for enhancing learning in the Introduction to Information Technology (PTI) course at Darma Persada University, particularly regarding computer hardware concepts that are difficult to comprehend abstractly through conventional textbooks and slides. This study developed a marker-based AR application aligned with the Cisco IT Essentials curriculum, employing the Multimedia Development Life Cycle (MDLC) methodology. The application was built using Unity3D, Vuforia, Blender, and Visual Studio, presenting interactive 3D models, instructional videos, graded quizzes, volume controls, and marker guides distributed via Google Drive. Black-box testing confirmed successful operation on Android devices, and user testing involving 13 respondents demonstrated positive responses regarding ease of use and improved comprehension of the subject matter. The overall average rating was 3.63 out of 5. This application serves as an effective alternative interactive learning medium for the PTI course.

**Keywords** – *Augmented Reality, Introduction to Information Technology, Cisco IT Essentials, Unity3D, Vuforia, MDLC.*

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## I. INTRODUCTION

The rapid advancement of technology in the modern era has given rise to a number of revolutionary innovations, among which Augmented Reality (AR) stands out as particularly transformative. AR is broadly defined as a technology that integrates virtual objects into the physical real-world environment in real time, typically via mobile devices such as smartphones or tablets, enabling users to perceive and interact with digital elements superimposed upon their physical surroundings [1]. AR is generally categorized into two principal types: Marker-Based AR, which relies on two-dimensional visual patterns to trigger and position virtual content, and Marker less AR, which employs GPS, RFID, or sensor-based positioning to determine placement [2].

Prior research has demonstrated the effectiveness of AR in enhancing learning outcomes across diverse educational contexts, including the study of plant and animal cell organelles [3], three-

dimensional geometric shapes [4], and architectural history [5]. Nevertheless, the application of AR within industry-standard curricula such as Cisco IT Essentials remains notably limited.

The Introduction to Information Technology/*Pengantar Teknologi Informasi (PTI)* course at Darma Persada University encompasses computer hardware content drawn from the Cisco NetAcad IT Essentials curriculum. This material is frequently difficult for students to grasp in the abstract, owing primarily to restricted physical access to hardware components that have typically been pre-assembled within computer units. This constraint motivated the development of a marker-based AR application as an interactive learning medium to bridge the gap between theoretical knowledge and tangible comprehension.

This study pursues three principal objectives: (1) to design and develop a marker-based AR application for the interactive visualization of

computer hardware components; (2) to evaluate the impact of the application on students' understanding of the subject matter; and (3) to assess the alignment of the application with the Cisco IT Essentials curriculum through user testing.

## II. METHODOLOGY

### A. Basic Research Design.

This study employed the Multimedia Development Life Cycle (MDLC) method proposed by Luther-Sutopo [6] to develop a marker-based Augmented Reality (AR) application for supporting the Introduction to Information Technology (PTI) course. MDLC consists of six iterative stages: concept, design, material collecting, assembly, testing, and distribution. This method was selected because it is specifically designed for multimedia and interactive learning applications, ensuring systematic development with room for evaluation and revision at each stage [6].

The application was built using the following tools and technologies:

- Unity 3D as the primary game engine for AR scene development and real-time 3D interaction [8].
- Vuforia SDK for marker-based image recognition, allowing the smartphone camera to detect 2D markers and overlay 3D hardware models accurately in real time [9].
- Blender for modelling and optimizing 3D objects of personal computer hardware components.
- Visual Studio 2022 with C# scripting language to implement application logic, scene navigation, quiz scoring system, volume control, and user interaction features [7].
- Lean Touch asset for intuitive mobile gesture controls (rotate, scale, and tap) on Android devices.

### B. Research Methodology Design

The methodology used in this study follows the Multimedia Development Life Cycle (MDLC) framework. This methodology comprises six stages, namely:

1. **Concept Stage** Needs analysis was conducted through observation of PTI lectures, literature review on Cisco IT Essentials curriculum, and identification of student difficulties in understanding abstract hardware concepts. The application was conceptualized to provide interactive 3D visualization of PC components that cannot be physically disassembled.

2. **Design Stage** Several UML diagrams were developed to model the system clearly. A use-case diagram illustrated the main interactions between students and the application (viewing AR models, watching videos, taking quizzes, and accessing marker guides). Activity diagrams were created for key processes, including installing and opening the application, displaying and interacting with 3D models, playing explanatory videos, completing graded quizzes, reading marker guides, and exiting the application [10]. Low-fidelity prototypes of the user interface (main menu, AR camera view, video player, quiz module, and marker download page) were designed using Figma to ensure user-friendly navigation.
3. **Material Collecting Stage** 3D models of PC hardware were sourced and refined in Blender, explanatory videos were recorded, quiz questions (with scoring) were prepared based on Cisco IT Essentials materials, and printable AR markers were created and uploaded to Google Drive for easy student access.
4. **Assembly Stage** All assets were integrated inside Unity 3D. The Vuforia database was configured with the designed markers, C# scripts were written to handle scene transitions, real-time AR rendering, gesture interactions, quiz logic, and volume settings. The final application allows students to scan a marker, view rotatable and scalable 3D hardware models with pop-up descriptions, watch curriculum-aligned videos, take auto-graded quizzes, and access marker guides via Google Drive link.
5. **Testing Stage** Black-box testing was performed to verify all functional features. User acceptance testing was then conducted with PTI students through questionnaires to measure perceived ease of use and improvement in hardware understanding.
6. **Distribution Stage** The application was compiled into an Android Package Kit (APK) file and distributed via Google Drive for direct installation on Android smartphones (version 8.0 and above).

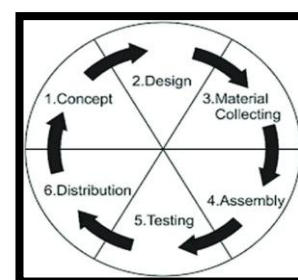


Fig. 1 MDLC Methodology

The developed application runs exclusively on the Android platform and focuses solely on marker-based AR for basic personal computer hardware visualization, in line with the defined research scope.

C. Testing Methodology

Testing was conducted in two stages. The first stage involved Black-Box Testing, in which all application functions including button navigation, marker scanning, 3D model rendering, quiz logic, video playback, and page transitions — were systematically verified. The second stage comprised User Testing, wherein the application was distributed to 13 respondents, consisting of engineering students, alumni, and members of the general public, via Google Drive and APKPure. Feedback was collected through a structured Google Form employing a five-point Likert scale across six evaluation dimensions: page layout, AR display quality, quiz difficulty, correct/incorrect audio feedback, background music, and video audio.

III. RESULTS AND DISCUSSION

The marker-based Augmented Reality (AR) application for the Introduction to Information Technology (PTI) course was successfully developed following the MDLC stages. This section presents the system specification, detailed features of the implemented application, black-box testing results, user acceptance testing, and comprehensive discussion of the findings.

A. System Specification

The hardware and software applications were developed and tested on the laptops and smartphones used by the researchers, with the following specifications laptop hardware:

Device	: IdeaPad L340 Gaming
Operating System	: Windows 10 Home
Processor	: Intel® Core™ -9705H
GPU	: Nvida GTX 1650 Mobile
Memory	: 16 GB
Storage	: 512 GB
Database	: Vuforia

These specifications were chosen to ensure optimal performance in real-time AR rendering using Vuforia SDK, smooth 3D model interaction, and compatibility with the majority of student devices at Darma Persada University. The choice of Android-only platform aligns with the research scope and the high prevalence of Android devices among PTI students.

Device	: Itel S23+
Operating System	: Android 13
Chipset	: Unisoc Tiger T616
GPU	: Mali-G57 MP1

Memory	: 8 GB
Storage	: 256 GB
Resolution	: 1080 x 2400 pixels, 20:9 ratio

B. Applications Features and Interface

The final application offers a complete interactive learning experience consisting of five main modules accessible from the main menu. Upon launching, users are greeted with a clean interface



Fig. 2 Main Menu

that provides direct access to: (1) AR Hardware module, (2) Video Learning, (3) Graded Quiz, and (4) Marker Guide.

In the AR Hardware module



Fig. 3 Scanning in AR Hardware

students scan a printed marker using the device camera. Once detected, a high-quality 3D model of PC hardware components appears overlaid on the real world. Users can rotate, scale, and tap the model to display pop-up descriptions of each part (e.g., CPU, RAM, motherboard, GPU). The Video Learning module

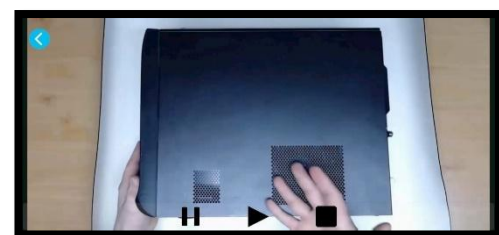


Fig. 4 Video Learning

contains short explanatory videos aligned with the Cisco IT Essentials curriculum. The Quiz module

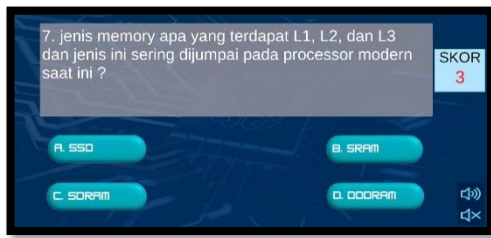


Fig. 5 Quiz

Presents multiple-choice questions with automatic scoring and immediate feedback, including a review of correct answers. Finally, the Marker Guide module.

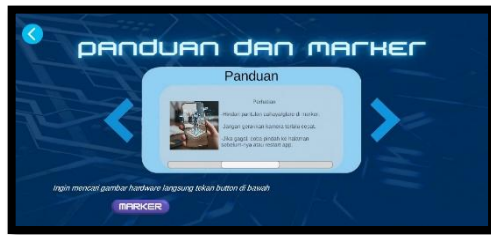


Fig. 6 Marker

links directly to Google Drive for easy download and printing of AR markers. All interactions utilize Lean Touch gestures for intuitive mobile experience, making the application highly user-friendly even for first-time users.

C. Black-Box Testing Results

Black-box testing was conducted iteratively throughout the Assembly phase to identify and resolve functional defects prior to user distribution. Table 2 presents a summary of the eight principal test cases evaluated.

Table 1 Black-Box Testing Summary

No	Test Case	Expected Result	Actual Result	Status
1	Launch splash screen	Splash screen displayed; START, EXIT, and Cisco buttons visible	Displayed correctly	Pass
2	Navigate to Main Menu	All navigation buttons (HARDWARE, QUIZ, GUIDE, EXIT) appear and respond	All buttons functional	Pass
3	Scan hardware marker	3D model rendered with name and description overlay	Model displayed accurately	Pass

No	Test Case	Expected Result	Actual Result	Status
4	Interact with 3D model (rotate, zoom, drag)	Model responds to touch gestures via Lean Touch	Gestures performed correctly	Pass
5	Play hardware video	Video plays with pause/play/stop controls	Video plays without error	Pass
6	Complete quiz (10 questions)	Each answer triggers correct/incorrect animation; final score displayed	All feedback and score correct	Pass
7	Open Guide & Marker page	Slideshow with scanning guide, warnings, and credits displayed; MARKER button redirects to Google Drive	All content displayed correctly	Pass
8	Exit application via EXIT button	Confirmation pop-up appears; application closes on confirmation	Confirmation and exit function correctly	Pass

All eight test cases achieved a Pass status, confirming that the application operates as intended on the Android platform. Minor defects identified during iterative testing — including oversized UI elements on certain device resolutions, an inactive quiz button on one question, and simultaneous display of multiple 3D models when two markers were placed in proximity — were resolved prior to user distribution. The overall functional success rate was estimated at approximately 85–90 per cent based on black-box results and subsequent user feedback.

D. User Testing and Respondent Evaluation

Following iterative refinement, the application was distributed to 13 respondents comprising engineering undergraduates, Information Technology alumni, and members of the general public. Quantitative feedback was gathered via Google Form on a five-point Likert scale. Table 3 presents the mean scores across all evaluation dimensions.

Table 2 Mean Respondent Ratings Across Evaluation Dimensions (Scale: 1–5)

Evaluation Aspect	Mean (1–5)	Remarks
Page Layout / UI	4.0	Above average fresh, modern design appreciated

Evaluation Aspect	Mean (1–5)	Remarks
AR Display Quality	3.7	Above average — marker detection generally reliable
Quiz Difficulty	3.7	Above average — difficulty level deemed appropriate
Correct/Incorrect Sound	3.8	Above average — feedback audio slightly loud
Background Music	3.3	Moderate — volume balance requires optimization
Video Audio	3.3	Moderate — audio levels need adjustment
<b>Overall Average</b>	<b>3.63</b>	<b>Positive overall reception</b>

The Page Layout dimension achieved the highest mean rating (4.0/5), reflecting positive reception of the application's visual design. AR Display Quality and Quiz Difficulty each scored 3.7/5, indicating that marker detection was sufficiently reliable and that the quiz content was appropriately challenging for the target audience. The Correct/Incorrect Sound dimension obtained 3.8/5, whilst Background Music and Video Audio both received 3.3/5, suggesting that audio balance across all channels warrants further optimisation.

#### E. Qualitative Feedback Analysis

Qualitative responses indicated that the application meaningfully enhanced respondents' understanding of computer hardware, particularly with regard to components seldom encountered in physical form, such as SSDs and DDR4 memory modules. Several respondents commended the interactive 3D visualisation as a novel and engaging learning experience. Commonly cited areas for improvement included: (1) the need for a clearer indication of marker placement within the Hardware Menu screen; (2) reduction of the application's file size through 3D asset compression; (3) a more responsive UI layout accommodating diverse screen resolutions; and (4) expanded quiz content drawing on a broader range of Cisco IT Essentials topics.

#### IV. CONCLUSION

This study successfully developed a marker-based Augmented Reality application to support learning in the Introduction to Information Technology (PTI)

course at Darma Persada University, employing the Multimedia Development Life Cycle methodology. The application encompasses marker-based 3D hardware visualisation, instructional videos, a Cisco IT Essentials-aligned interactive quiz, and a scanning guidance module, all deployed on the Android platform.

Black-box testing confirmed that all core functions operated correctly, with an estimated functional success rate of 85–90 per cent. User testing conducted with 13 respondents yielded a positive overall mean rating of 3.63 out of 5, with particular appreciation expressed for the application's interface design and the novelty of interactive 3D hardware visualization. The application is demonstrated to be an effective alternative learning medium capable of mitigating the constraints imposed by limited physical access to hardware components in academic settings.

Future development should address: (1) responsive UI redesign to accommodate varying screen resolutions; (2) APK size reduction through 3D asset optimization; (3) addition of 3D models for contemporary hardware components; (4) expanded and randomized quiz question banks; and (5) audio volume optimization across all sound channels.

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