POLITEKNIK BANTING SELANGOR

VIRTUAL REALITY OF FLIGHT INSTRUMENT

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DEPARTMENT OF AIRCRAFT MAINTENANCE

SESSION 1 2024/2025

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A REPORT SUBMITTED TO DEPARTMENT OF AIRCRAFT MAINTENANCE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR A DIPLOMA ENGINEERING IN AIRCRAFT MAINTENANCE

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"We hereby declare that this report is the result of our own work, except excerpts that we have outlined its sources and this project will be the ownership of polytechnic.

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ABSTRACT

This project is centered on the comprehensive design, development, and evaluation of six essential flight instruments within a virtual reality (VR) environment to enhance aviation training. The project's first phase involves the careful design of these flight instruments, emphasizing accuracy, intuitiveness, and user-friendliness to ensure they are well-suited for the immersive nature of VR. This design process aims to create flight instruments that not only replicate the functionality of their real-world counterparts but also provide a seamless and engaging user experience in a virtual setting. Once the design phase is complete, the project will transition into the development stage, where these meticulously crafted designs will be brought to life using advanced software development tools. The objective is to create precise and fully operational virtual representations of the six fundamental flight instruments, ensuring they function effectively within the VR environment. In the final phase, the project will conduct a thorough evaluation through user testing and feedback collection, focusing on the usability and effectiveness of the VR instruments. This feedback is crucial for refining and improving the virtual tools, allowing for adjustments that better meet the needs and expectations of users. The insights gained from this evaluation process will be instrumental in ensuring that the virtual instruments provide a robust and effective learning experience, ultimately contributing to the advancement of VR-based aviation training.

Keywords: Virtual Reality (VR), Flight Instruments, Aviation Training, User-Friendliness, Software Development Tools

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LIST OF ABBREVATIONS

VR	Virtual Reality
VSI	Vertical Speed Indicator
EVRG	Educational Virtual Reality Games
3D	3 Dimension
IQ	Intelligence Quotient
FSTD	Flight Simulation Training Devices
PC	Personal Computer

CHAPTER 1

INTRODUCTION

1.0 BACKGROUND OF STUDY

Figure 1.1: Six Basic Instrument (penaeroetch.com, n.d)

In aviation, the "six-pack" refers to a group of six fundamental instruments that are essential for ensuring safe and regulated flying [6] [1] . These instruments provide pilots with critical information necessary for navigation, orientation, and maintaining optimal aircraft performance. The six-pack includes the altimeter, airspeed indicator, attitude indicator, heading indicator, turn coordinator, and vertical speed indicator.

Altimeter: This instrument is crucial for indicating the aircraft's altitude above sea level, allowing pilots to maintain optimal flight levels. Accurate altitude information is vital for safe navigation, avoiding obstacles, and ensuring separation from other aircraft.

Airspeed Indicator: By measuring the aircraft's speed relative to the surrounding air, the airspeed indicator helps pilots avoid hazardous situations such as stalls or overspeed. This information is essential for maintaining safe and efficient flight operations.

Attitude Indicator: Often referred to as the artificial horizon, the attitude indicator displays the aircraft's orientation relative to the horizon. This instrument is particularly important in low visibility or instrument flight conditions, enabling pilots to accurately adjust the pitch and bank angles of the aircraft.

Heading Indicator: This instrument functions like a compass but uses gyroscopic technology for improved stability and accuracy. The heading indicator shows the aircraft's directional heading, which is crucial for navigation and maintaining desired flight paths.

Turn Coordinator: The turn coordinator indicates the rate of turn and the coordination of the aircraft during manoeuvres. This information helps pilots execute precise turns and maintain coordinated flight, which is essential for safety and efficiency.

Vertical Speed Indicator (VSI): Measuring the rate of climb or descent, the VSI provides pilots with real-time information on the aircraft's vertical velocity. This data is crucial for managing altitude changes, executing instrument approaches, and ensuring a smooth flight profile.

Together, these instruments form the foundation of flight instrumentation in most general aviation aircraft. By providing essential data on navigation, orientation, and performance, the six-pack enables pilots to operate their aircraft safely and effectively under various flight conditions. Understanding and proficiently using these instruments is a fundamental aspect of a pilot's training and operational proficiency.

Figure 1.2: Virtual Reality (VR) (medium.com, n.d)

Virtual Reality (VR) represents a significant technological advancement with far-reaching implications across multiple sectors. Defined as a computer-generated simulation that provides users with the experience of being physically present in an alternate environment, VR immerses individuals through the integration of sight, sound, and touch. This immersive quality distinguishes VR from traditional media, offering a level of engagement and interaction that was previously unattainable.

The proliferation of VR technology has led to its adoption in various fields, including education, gaming, entertainment, healthcare, and tourism. In education, VR enhances learning experiences by providing interactive and immersive environments that facilitate better comprehension and retention of information. In the gaming industry, VR creates rich, immersive game worlds that offer players a highly interactive and engaging experience. The entertainment sector leverages VR to deliver novel forms of interactive content, while in healthcare, VR is used for simulating medical scenarios for training and therapeutic purposes. Additionally, VR has transformed tourism by offering virtual travel experiences, allowing users to explore distant locations from the comfort of their homes.

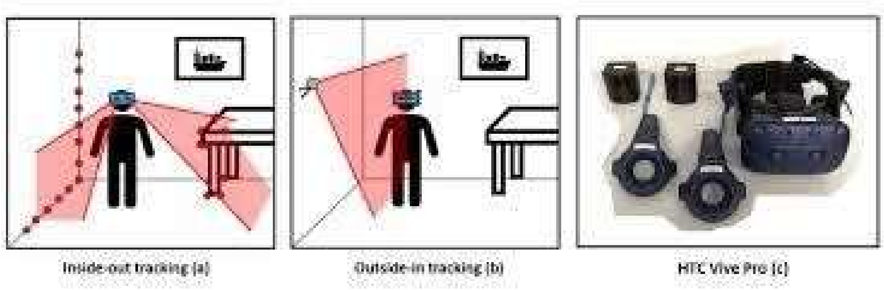


Figure 1.3: Different Tracking Technology (researchgate.net, n.d)

The implementation of VR technology relies on specialized hardware and software. Devices such as the Oculus Rift and HTC Vive headsets are equipped with motion-tracking sensors that monitor users' movements, enabling real-time interaction with the virtual environment. These technological advancements have been pivotal in enhancing the realism and interactivity of VR experiences.

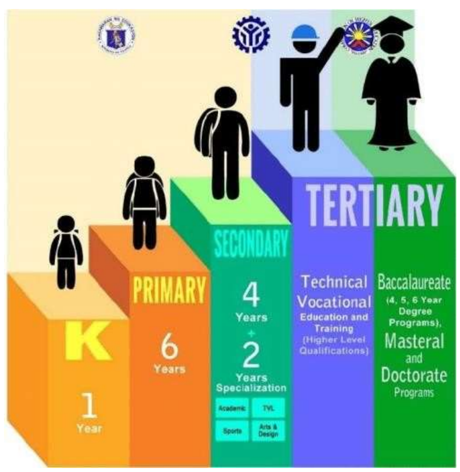


Figure 1.4: The Tertiary Education (researchget.net, n.d)

One particularly transformative application of VR is in the realm of educational gaming, specifically through Educational Virtual Reality Games (EVRGs). EVRGs are designed to cater to various educational levels, from K-12 to tertiary and lifelong learning. They are tailored to achieve specific learning outcomes, making them a versatile tool for diverse educationalcontexts. Primarily utilized outside traditional classroom settings, EVRGs have found significant application in healthcare education, where they simulate clinical scenarios for skill development and training.

The benefits of EVRGs are manifold [3] . They significantly increase student engagement by providing an immersive learning experience that makes education more enjoyable and memorable. Additionally, EVRGs facilitate practical skills development by offering hands-on virtual experiences that mimic real-world tasks. The accessibility of VR also supports diverse learning styles, making education more inclusive and adaptable to individual needs.

Figure 1.5: Diploma Engineering in Aircraft Maintenance (sinarbestari.sinarharian.com.my, Oct 21, 2024)

At Politeknik Banting Selangor, students pursuing a diploma in Aircraft Maintenance Engineering gain comprehensive knowledge of the six basic flight instruments—altimeter, airspeed indicator, attitude indicator, heading indicator, turn coordinator, and vertical speed indicator. These instruments are vital for ensuring safe and effective flight operations by providing crucial information about the aircraft's altitude, speed, orientation, and direction. The understanding and application of these instruments are introduced through several key modules, including **Avionic Practices (Semester 2)**, **Module 5: Digital Techniques Electronic Instrument Systems (Semester 3)**, and **Module 11: Turbine Aeroplane Aerodynamics, Structures, and Systems (Semester 3)**.

In **Avionic Practices (Semester 2)**, students begin with practical exposure to avionic systems, focusing on the maintenance, calibration, and troubleshooting of basic instruments. This hands-on training allows students to understand the functionality and importance of these devices in real-world scenarios. Moving into **Module 5: Digital Techniques Electronic Instrument Systems (Semester 3)**, the emphasis shifts to the digital and electronic principles that underpin modern flight instruments. Students learn about gyroscopic systems, digital displays, and signal processing, which are essential for advanced aviation systems. **Module 11: Turbine Aeroplane Aerodynamics, Structures, and Systems (Semester 3)** further expands this knowledge by connecting the role of instrumentation to aircraft aerodynamics, turbine systems, and structural integrity, enabling students to see how these instruments interact with the aircraft as a whole.

To enhance the learning experience, Virtual Reality (VR) technology is integrated into the curriculum. Through VR, students can explore and interact with virtual cockpits, gaining practical experience without the need for physical aircraft. For example, they can practice diagnosing and repairing instrument issues, simulate flight conditions, and observe how instruments respond to different scenarios. In **Module 11**, VR also allows students to visualize turbine systems and their relationship with aerodynamics, helping them better understand complex interactions. This immersive learning method complements traditional classroom teaching and practical workshops by providing a safe, cost-effective, and highly engaging way for students to learn.

The use of VR technology is particularly beneficial for overcoming the limitations of traditional training methods, such as the limited availability of physical aircraft and time constraints in practical sessions. By simulating real-time scenarios, VR allows students to repeat tasks and refine their skills without fear of damaging actual equipment. Additionally, it prepares students for the rapidly advancing technological landscape in modern aviation, where digital systems and virtual tools are becoming increasingly important.

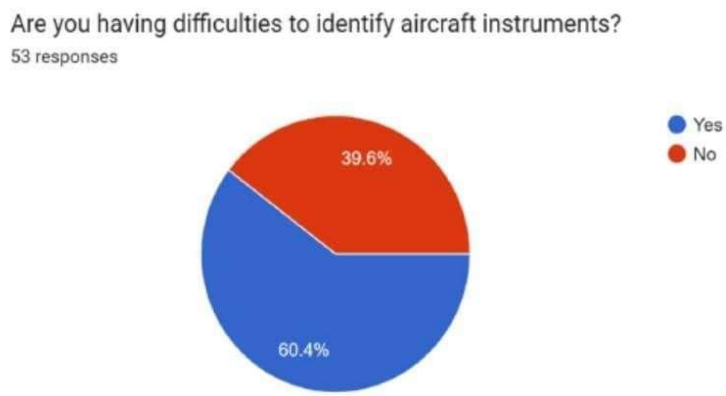
This blended approach of theoretical learning, practical training, and VR integration equips students with the knowledge and skills needed to excel in the aviation industry. It ensures they not only understand the principles behind flight instruments but can also apply this knowledge effectively in their future careers as aircraft maintenance engineers.

In summary, VR technology stands at the forefront of digital innovation, offering transformative potential across various industries. Its application in educational gaming, particularly through EVRGs, exemplifies its capacity to revolutionize learning by providing immersive, engaging, and practical educational experiences. This thesis explores the impact and implications of VR in educational settings, with a focus on the pedagogical benefits and challenges of integrating EVRGs into modern curriculum.

1.2 PROBLEM STATEMENT

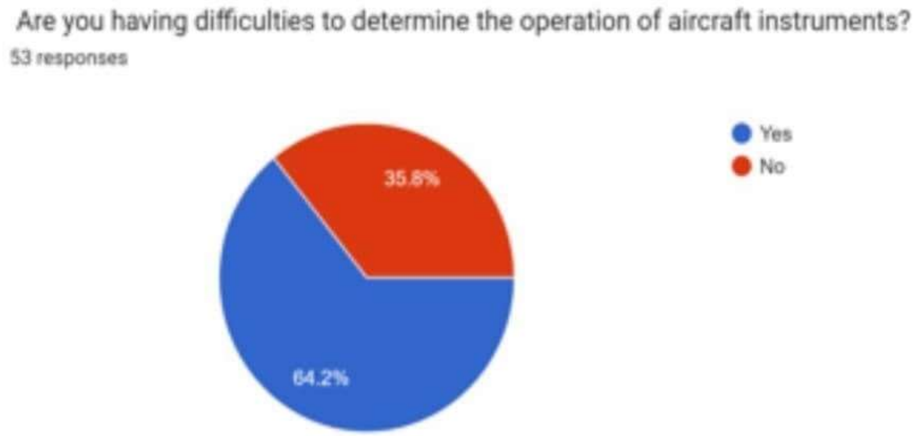
Based on substantial survey data and input from students and instructors in aircraft maintenance engineering education, it is clear that numerous major problems inhibit effective learning and teaching experiences for basic Six Packs and aircraft instrument concepts.

1. Students encounter difficulty in identify aircraft instruments.



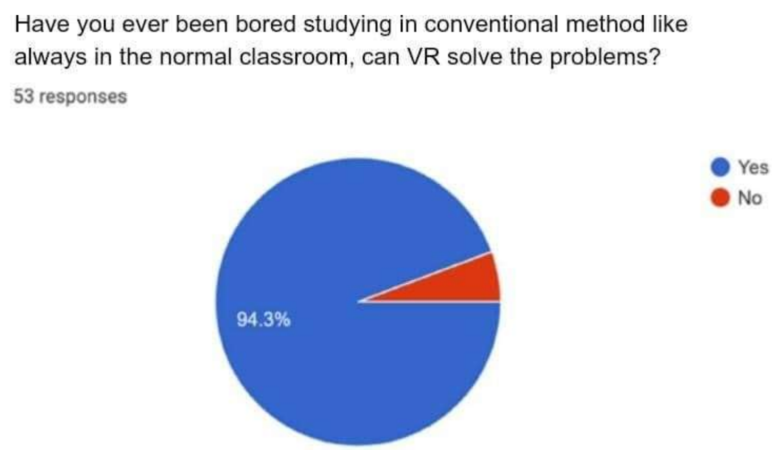
As many aircraft instruments include complicated markings, dials, and displays that can be confounding at first glance, and because many instruments seem same, students frequently struggle to recognise them. It might be challenging to recognise different instruments and comprehend their distinct functions in the cockpit without practical experience or interactive resources. Furthermore, to rapidly and reliably recognise the tiny variations in shapes, labels, and functions, one needs frequent exposure and concentrated attention—two things that traditional learning methods might not be able to deliver.

2. Students struggle to grasp how aircraft instruments work and operate.



Since flight instruments have complicated processes and expert knowledge, many students find it difficult to understand how they operate. The hands-on, immersive experience required to completely understand the instruments' capabilities and interactions is frequently absent from traditional learning approaches like textbooks and lectures. Furthermore, actual aircraft or simulators can be expensive and challenging to frequently access, which restricts hands-on training. Students could find it difficult to visualise and memorise how each part functions in real-world situations if they are unable to interact directly with these tools in a reliable, organised setting.

3. Students are facing boredom in conventional method.



Due conventional methods to learning flight instruments are typically passive and primarily theory-based, students frequently find them boring. The dynamic, hands-on experience that makes learning interesting and memorable might not be offered by traditional lectures and textbooks. Students could so struggle to maintain their motivation and relate what they're learning to practical uses. They may rapidly become disinterested if there are no interactive components that let them experiment and explore, which makes it more difficult for them to comprehend and remember the details of how these instruments operate.

Given these difficulties, immediate action is needed to address the gaps in knowledge, training, and participation in fundamental Six Packs and aircraft instrument principles. Failing to do so compromises not just the efficacy of teaching efforts but also the academic performance of students. Ensuring the best possible learning outcomes for all parties involved is crucial, emphasizing the need for innovative approaches that promote visualization, improve instructional effectiveness, and reduce the likelihood of classroom boredom.

1.3 PROJECT OBJECTIVES

1.3.1 General Project Objectives

The use of technology in aviation education has completely transformed how pilots are trained in this dynamic field. One area of emphasis is being adept with the six fundamental flight instruments, which are essential for safe flight. The main goal of creating a virtual reality (VR) training program specifically for learning these vital tools is outlined in this essay. Through the utilization of virtual reality technology, the initiative seeks to improve pilot training, skill, and ultimately, aviation safety.

1. To Design of Basic Instruments in VR

   The project also focuses to design the six basic flight instruments to be implemented in virtual reality. This design phase will ensure that the instruments are not only accurate but also intuitive and user-friendly within the VR environment.

2. To Development of Virtual Reality Instruments.

   The objective of this project is to develop the designed instruments in a virtual reality environment using appropriate software development tools. This involves creating accurate and functional virtual representations of the six fundamental flight instruments.

3. To Demonstrate of User Testing and Feedback.

   The program aims to evaluate user testing and gather feedback on the usability and effectiveness of the virtual reality instruments. This step is crucial for refining the virtual tools to ensure they meet the needs of users and provide an effective learning experience.

This project is important because it leverages the immersive qualities of virtual reality technology to transform aviation training. By providing trainees with realistic and engaging virtual environments, the program seeks to increase user competence and enhance aviation safety. Moreover, the creation of a VR-based training program represents a paradigm shift in aviation education, paving the way for further advancements in immersive learning and instructional technologies. Ultimately, the goal of this project is to equip users with the knowledge and skills necessary to fly competently and confidently, thereby contributing to safer skies and more effective pilot training.

1.3.2 Specific Individual Project Objectives

1.3.2.1 Product Structure

The specific project objectives are:

Figure 1.6 : Motion Controller (d1store.com, n.d)

Figure 1.7 : Oculus Quest 2 (smvkt.com, n.d) Figure 1.8 : HTC Vive Pro (vive.com, n.d)

1. To design structures that incorporate three different types of VR technologies in the market: motion controllers, Oculus Quest 2, and HTC Vive Pro.
2. To develop structures that support learning sessions, helping students understand the concept of the six basic flight instruments in aircraft.
3. To demonstrate structures that align with educational curriculum requirements, ensuring relevance and usability in formal educational contexts.

1.3.2.2 Product Mechanism

The specific project objectives are:

1. To design the VRFI software generates a virtual cockpit with realistic flight instruments, modeled to look and behave like actual aircraft panels.
2. To develop the VRFI system through VR that focuses on a specific instrument, detailed information about its function is displayed
3. To demonstrate using the VR controllers or motion sensors, simulating real-world actions like adjusting instrument settings or toggling switches

1.3.2.3 Software / Programming

The specific project objectives are:

1. To design a suitable programming that are can be use in various platform such as Windows, Linux, macOS and android.
2. To develop a high performance and efficiency software. C++ also allows low level manipulation of data and provides direct control over hardware resources.
3. To demonstrate the maximum level of understanding to users using software that is compatible with the latest programming.

1.3.2.4 Accessories & Finishing

The accessories and finishing are:

1. To design user can learn about flight instrument with the VR set which can visualize how the flight instrument working.
2. To develop virtual reality application superimposes actual data onto virtual models.
3. To demonstrate these technologies bridge the gap between the virtual world of design and learning and the real world of flight instrument working.

1.4 PURPOSE OF PRODUCT

The purpose of this project is to address the challenges associated with 6 basic flight instrument education by developing an interactive and immersive educational application. This application aims to enhance understanding and provide learners with a comprehensive understanding of flight instruments, including their principles, components, operational characteristics, and practical applications, through interactive multimedia content such as 3D models, infographics, notes, andquizzes. This project also serves as a valuable resource for both learners and professionals in the gas turbine industry, offering continuous learning opportunities, updates on industry advancements, and access to relevant educational materials. By catering to diverse learning needs and offering continuous learning opportunities, this project aspires to empower learners with the knowledge, skills, and confidence necessary to excel in the dynamic field of aircraft engineering.

1.5 SCOPE OF PROJECT

1.5.1 General Project Scopes

The project seeks to construct an immersive Virtual Reality (VR) training curriculum specifically tailored to flight instruments, melding interactive 3D models, gamified learning modules, exhaustive explanations, virtual simulations, challenges, missions, and a robust reward system. By crafting intricate 3D models, rich multimedia content, and lifelike virtual simulations, learners will be afforded hands-on exploration opportunities coupled with comprehensive explanations and demonstrations elucidating instrument functionalities. The incorporation of gamified modules will bolster engagement by presenting challenges and missions, while the reward system will incentivize progression and fortify knowledge through quizzes and assessments. This holistic approach is aimed at diploma students, affording them a dynamic and efficacious learning milieu within VR.

1.5.2 Specific Individual Scope

1.5.2.1 Product Hardware

This product uses advanced virtual reality hardware to deliver an immersive educational experience. Key components include head-mounted displays like the Oculus Quest 2, offering portability with standalone functionality, and the HTC Vive Pro, providing high-resolution visuals and precise tracking. VR controllers enable realistic interaction with flight instruments, enhanced by haptic feedback. Optional accessories, such as flight sim pedals, add to the realism, while spatial audio replicates cockpit sounds. The system is adaptable for standalone or PC-based setups, making it versatile and scalable for aviation training environments.

1.5.2.2 Product Mechanism

The critical aspect of the project will involve designing an intuitive and visually appealing user interface for the application. This will be achieved through userresearch to understand the preferences and needs of target audience, which includes engineers, technicians, students, and educators. Based on the insights gained from this research, wireframes and mock-ups will be created to visualize the layout and structure of the interface.

1.5.2.3 Software/ Programming

The heart of the application lies in its educational content, and the objective will beto develop comprehensive content covering fundamental principles, components related to gas turbine engines. This content will be presented in various formats, including multimedia elements such as 3D models, infographics, notes and quizzesensuring that users are provided with an engaging and immersive learning experience. The content is accurate, relevant, and based on Modul 11 –Turbine Aircraft System which aligns with industry standards. Integration of the content into the application will be seamless, with a focus on organizing it into logical sections for easy navigation and understanding.

1.5.2.4 Accessories & Finishing

Extensive user testing sessions to gather feedback from representatives of our target audience. Engineers, technicians, students, and educators will be invited to participate in these sessions, Qualitative and quantitative feedback through surveys will be collected, analyzing the data to identify strengths, weaknesses, and areas for improvement. Based on this feedback, the app will be iterated and refined, focusing on enhancing usability, addressing usability issues, and improving the overall user experience

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL LITERATURE REVIEW

2.1.1 Aviation Industry in Malaysia

Virtual reality (VR) technology has gained popularity worldwide, especially in Malaysia, when it comes to aviation instruction, particularly for learning the six fundamental flight instruments. Relatively little, meanwhile, has been written about VR-based flight instrument training in the Malaysian aviation sector. However, a more comprehensive grasp of the potential implications and difficulties in the Malaysian setting can be gained from the insights found in the broader literature on VR in aviation training and instrument performance.

The use of virtual reality (VR) in aviation training has been increasing in Malaysia due to technological developments [5] and a greater focus on safety and proficiency. Anecdotal data indicates that aviation training organisations and institutions are becoming more interested in investigating VR as an additional tool for pilot education, even though there may not be enough specific studies on VR-based flight instrument teaching.

However, there are obstacles and things to think about when integrating VR technology into the Malaysian aviation sector. Regulations, infrastructural needs, and the demand for instructors' and trainees' specific training are a few examples of these. Additionally, the acceptance and deployment of VR-based training methods within Malaysian aviation institutions may be influenced by organisational readiness and cultural variables.

In summary, although there is a dearth of research explicitly examining VR-based flight instrument instruction in the Malaysian aviation sector, insights from a larger body of literature on the subject provide insightful viewpoints. Further investigation and hands-on experiments investigating the use of virtual reality technology into pilot education and training programmes are necessary, as Malaysia persists in its pursuit of excellence in aviation safety and proficiency. Stakeholders in Malaysian aviation may improve the efficacy and efficiency of flight instrument training by utilising the advantages of virtual reality simulations, which would ultimately lead to safer skies and more skilled aviator.

2.1.2 Demand of E-Learning

The demand for e-learning has been steadily increasing in recent years due to several factors, including advancements in technology, changing learning preferences, and the need for flexible and accessible education options [3]. While eLearning offers numerous benefits, challenges related to the digital divide, quality assurance, and learner engagement need to be addressed to fully harness its potential. Virtual reality (VR) has emerged as a tool in meeting this demand as they offer interactive platforms for education [12]. Learning through Apps has become increasingly popular due to its accessibili ty and flexibility with the growth of remote and online education.

2.1.3 Type of E-Learning App in Aviation Studies

E-learning applications in aviation studies have become increasingly prevalent, offering flexible and accessible ways for individuals to acquire knowledge and skills relevant to the aviation industry. These applications leverage digital technologies to deliver educational content, simulations, and interactive modules tailored to the specific needs of aviation professionals and enthusiasts.

Here are a few varieties of e-mastering apps normally observed in aviation studies:

1. Virtual reality (VR) flight instrument comprehensive courses covering fundamental aviation such as air speed, vertical indicator and more instrument Research suggests that ground school training apps are effective tools for preparing individuals for pilot certification exams, such as the Federal Aviation Administration (FAA) written exams.
2. Learning kit virtual reality offer virtual environments where users can know about instrument. These apps feature realistic flight controls and cockpit instrumentation to simulate real-world flying scenarios.

2.1.4 Evaluation of Digital Learning in Aviation Industry

Digital learning, also known as e-learning or online learning, has become increasingly prevalent in the aviation industry as a means of delivering training and educational content to aviation professionals. With the advancement of technology, digital learning platforms offer flexible and accessible ways for individuals to acquire and enhance their knowledge and skills related to aviation. The evaluation of digital learning in the aviation industry is essential for assessing the effectiveness, efficiency, and impact of training programs on learners, organizations, and the broader aviation ecosystem.

2.1.5 App Specifications

E- applications have become an integral part of everyday life, offering users a wide range of functionalities and services on their smartphones and tablets. App specifications refer to the detailed requirements and features that define the functionality, design, performance, and user experience of an application. By carefully defining and documenting app specifications based on user needs, market analysis, technology trends, and regulatory requirements, app developers can effectively guide the development process and deliver successful mobile apps that meet user expectations and business objectives.

2.1.6 Lack of Conventional Teaching Method

As pointed out by Abah [8], Traditional teaching methods, often characterized by teacher-centered instruction, have long been the norm in educational settings. However, these methods have increasingly faced criticism for their limitations in engaging students and fostering deep learning.

Research has shown that conventional teaching methods can lead to passive learning, where students are primarily recipients of information rather than active participants in the learning process. This can result in a lack of motivation, critical thinking skills, and problem-solving abilities. Additionally, traditional methods often struggle to cater to the diverse learning styles and needs of individual students.

The rapid advancements in technology and the changing demands of the 21st-century workforce have further highlighted the need for innovative teaching approaches. Modernlearners require more interactive, experiential, and personalized learning experiences. Non- traditional methods, such as problem-based learning, project-based learning, and inquiry-based learning, have emerged as promising alternatives that can address the shortcomings of conventional teaching. These methods emphasize student-centered learning, active engagement,and real-world application, leading to improved student outcomes.

2.1.7 Education E-Training Kit

E-training kits are digital tools that provide a flexible and convenient way to learn new skills or knowledge [3]. They typically consist of online courses, interactive activities, and assessments. These kits are widely used in education, healthcare, and business to deliver training to many learners.

E-training kits offer several advantages. They are cost-effective as they eliminate the need for physical classrooms and travel expenses. They are also flexible, allowing learners to access training materials at their own pace and convenience. Additionally, e-training kits can ensure consistency in the delivery of training content and assessment standards.

However, there are challenges associated with e-training kits. Technical difficulties, lack of adequate internet access, and the potential for social isolation can hinder the effectiveness of online learning. To overcome these challenges, it is crucial to design e-training kits with clear learning objectives, engaging content, and robust technical support.

2.2 SPECIFIC LITERATURE REVIEW

2.2.1 Product Structure

Figure 2.1: Product Structure Illustration (thedailyguardian.c, n,d)

The basis of immersive equipment, which includes VR headsets like the Oculus Quest 2 [6] combined with suitable hand controllers to enable smooth user engagement with the virtual world, is where the VR educational software for aircraft flight instruments starts. The software foundation is formed by utilizing strong development platforms like Unity or Unreal Engine, which make it easier to create engaging and dynamic experiences. The experience revolves around painstakingly constructed 3D models of different aircraft, which authentically depict flight equipment such as attitude indicators and altimeters and carefully detail cockpit layouts. The educational content has been included and provides realistic scenarios for hands-on learning along with interactive tutorials explaining instrument functionalities.

An intuitive learning experience is promoted by an intuitive virtual reality (VR) interface that makes navigating menus and understanding instrument readings within the virtual cockpit easier. Additionally, by including accessibility features and guaranteeing compatibility with various VR installations, the software caters to a wide range of user demands, making it inclusive and accessible to a wider audience. A strong feedback mechanism built into the program allows users to receive prompt reactions to their activities and tracks performance metrics to measure improvement over time. The program also comes with extensive documentation that provides developers and users with precise instructions on how to utilize.

To ensure that users have a seamless learning experience, support channels are set up to handle any questions or problems they could run into. Additionally, the program is regularly updated and maintained to improve functionality, add new features, fix problems, and handle performance optimization requirements. This guarantees that the instructional tool for studying aircraft flying instruments in virtual reality is always evolving.

2.2.2 Product Mechanisms

Virtual Reality (VR) technology has made amazing improvements to aviation education, providing students with an unparalleled immersive learning experience. With a VR headset, students are transported into a virtual cockpit that is an exact duplicate of an aircraft's control environment, complete with all the flight instruments. This configuration creates a realistic sensation of presence within an aircraft, made possible by high-resolution displays that ensure every indicator and gauge is legible and exact to real-world specifications. The interactive surroundings of the virtual cockpit adapt smoothly to the students' motions, resulting in a constant and realistic experience that is critical for effective learning.

The ability to interact with the cockpit's instruments and controls enhances the VR experience even further. Using motion controllers or VR gloves, students can manipulate controls like the knob, obtaining tactile knowledge and a better understanding of flight instruments. Advanced VR setups improve this experience with haptic feedback systems, which deliver tactile sensations that mimic the physical feedback a pilot would receive in a real aircraft, assisting in the development of critical muscle memory for flying.

Underneath the immersive visuals and interactive equipment comes dynamic simulation software, which serves as the foundation for the VR flight experience. This software is designed to simulate the physical principles that control real-world flight, ensuring that the virtual instruments perform as they would in a real aircraft. This enables for an authentic learning experience because students may see the effects of their activities on flight dynamics in real time. Instructors can use the software's adaptability to simulate a variety of flight scenarios, from adverse weather to system failures, giving students the skills, they need to handle a wide range of flying conditions in a safe and controlled virtual environment.

Educational integration is an essential part of the VR flying training system. The simulations can be enhanced with educational guides or overlays that provide quick feedback, which is critical for students to fix errors and understand complex flight mechanics and the functioning of various instruments. Furthermore, VR technology allows for the customisation of learning experiences, including progress monitoring tools that adjust to individual students' learning rates and styles, resulting in a personalised progression through the training programme.

Figure 2.2 : Product Mechanism Illustration (linkedin.com, n.d.)

2.2.3 Software / Programming

Figure 2.3 : Software Application (unrealengine.com, n.d)

The VRFI platform is designed to make learning about flight instruments engaging and straightforward by focusing on the most important and relevant information [4]. Key topics, like understanding how different flight instruments work and their purposes, are presented through clear and concise notes, eye-catching infographics, and interactive tools. Notes provide simple explanations, broken into manageable sections, making it easy to follow along. Infographics use visuals to explain complex concepts in an easy-to-digest format, such as showing how instruments are arranged or how they interact with one another. To make the experience more immersive, users can explore 3D models of flight instruments, zooming in, rotating, and clicking on parts to learn how they function in real-time. Fun quizzes, like matching instruments to their purposes or labeling parts of an instrument panel, give instant feedback to help solidify learning.

The platform's main menu is organized in a way that feels natural and user-friendly, with sections like "Notes," "Infographics," "3D Models," and "Quizzes." This makes it easy to find what you need, whether you're diving into detailed notes, exploring interactive visuals, or testing your knowledge with a quiz. The 3D model section is especially engaging, letting users get hands-on with virtual instruments to see exactly how they work. Quizzes are designed to challenge you at the right level and even track your progress with rewards like badges to keep you motivated. To make the learning experience even richer, short videos or interactive scenarios can show how flight instruments are used in real-life flight situations. With this thoughtful design, VRFI becomes a practical and engaging tool for aviation students to confidently master flight instruments in an interactive and enjoyable way.

2.2.4 Accessories & Finishing

In the domain of virtual reality (VR) flight simulation, the six fundamental aircraft instruments are portrayed with exceptional precision, ensuring that students and trainees experience conditions that closely replicate real flying [17] . This level of detail and interactivity enhances the training effectiveness and realism, providing a comprehensive learning environment.

Figure 2.4 : Flight Instruments (instagram.com, n.d)

Airspeed Indicator (ASI): The ASI features a meticulously designed dial with interactive elements. Users can observe the needle move in response to changes in virtual airspeed, mirroring the behaviour of an actual airspeed indicator. This realistic movement helps trainees develop a keen understanding of speed management during flight.

Artificial Horizon (Attitude Indicator): Presented in a vivid 3D style, the Artificial Horizon dynamically responds to the aircraft's pitch and roll. This instrument provides pilots with immediate feedback on the aircraft's attitude, which is crucial for maintaining proper flight orientation, especially in instrument flight conditions.

Altimeter: Special attention is given to the altimeter, which includes a precise scale and an adjustable barometric pressure setting. Pilots can interact with these settings using VR controls to simulate real-world adjustments, enhancing their familiarity with altitude management and pressure settings.

Turn Coordinator: The Turn Coordinator is animated with an aircraft symbol to visually represent turn rate and coordination. Additionally, it includes a slip-skid indicator that moves realistically within the instrument, accurately replicating the lateral forces experienced during flight. This feature helps pilots understand the nuances of coordinated turns and yaw control.

Heading Indicator: The Heading Indicator features a smoothly moving card that indicates the aircraft's directional heading. In some advanced simulations, it may also include a simulated magnetic compass for added complexity, providing a more authentic navigational experience. This realism aids pilots in mastering precise directional control and navigation.

Vertical Speed Indicator (VSI): The VSI has a responsive needle that shows the rate of climb or descent. In advanced simulations, it may also display anticipated altitude trends, giving pilots additional insights into their vertical velocity and future altitude changes. This functionality is critical for managing altitude transitions and approach procedures.

The meticulous design and interactive nature of these instruments in VR flight simulations significantly enhance the training experience. By providing a realistic and immersive environment, these simulations help trainees develop the skills and confidence needed to operate real aircraft safely and effectively. The integration of these detailed accessories and finishing touches in VR systems underscores the importance of precision and realism in aviation training.

Figure 2.5 : Accessories & Finishing of Flight Instruments (aopa.org, Jun 22, 2021)

Aside from these visual representations, other VR accessories and finishes, such as haptic feedback, provide actual feelings connected with controlling the instruments, increasing the simulation's tactile component. Audio cues matching to various instrument actions enhance the auditory experience, while tutorial overlays provide step-by-step instructions for interpreting and controlling the instruments. Some VR systems go a step further, allowing the interface to be adjusted to specific training needs, so that each pilot can get the most out of their learning experience. Collectively, these features create a comprehensive and interactive learning environment that not only replicates but significantly improves the traditional way of familiarising pilots with critical flight equipment.

2.3 REVIEW OF RECENT RESEARCH AND RELATED PRODUCT

2.3.1 Related Patented Products

2.3.1.1 Patent A

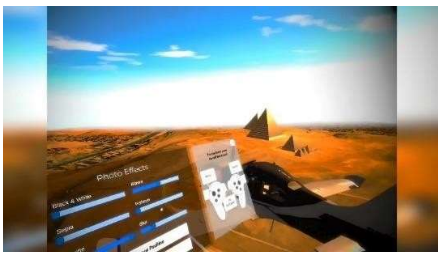
Bil.	Product	Description
1.		Title: World Flight Meta Quest 2 Published Date: September 30, 2020 Publisher: Zero Gravity Games Developer: Zero Gravity Games Space Required: 323.18MB Abstract: With the amazing virtual reality software World Flight, users can experience the world's marvels right at your fingertips. With breathtaking realism and depth, Meta Quest 2 allows users to travel the globe and discoverwell-known sites, untamed natural marvels, and undiscovered treasures [11] .

Table 2.1 : Patent A

2.3.1.2 Patent B

2..		Title: VR for Aircraft Maintenance Engineering Published Date: 2024 Publisher: HQSoftware Developer: HQSoftware Development Team Space Required: Varies with software configurations and hardware compatibility Abstract: HQSoftware provides VR-based training for aviation maintenance, simulating tasks like engine repairs, brake lining replacements, and de-icing procedures. The platform promotes collaboration and skills mastery through virtual practice, enhancing knowledge retention and operational readiness

Table 2.2 : Patent B

2.3.1.3 Patent C

3.		Title: CAE XR Training for Aircraft Technicians Published Date: 2024 Publisher: CAE Developer: CAE XR Division Space Required: Dependent on VR setup (headset and associated devices) Abstract: CAE's XR training offers virtual environments for technicians to practice maintenance procedures like engine diagnostics and repairs. It reduces physical equipment costs, minimizes downtime, and provides repetitive practice opportunities. These tools are tailored toadapt to new aircraft models, enhancing training efficiency and safety

Table 2.3 : Patent C

2.3.1.4 Patent D

4.		Title: Loft Dynamics eVTOL VR Simulator [2] Published Date: May 2024 Publisher: Loft Dynamics Developer: Loft Dynamics AG Space Required: Approximately 10–20 GB for software; VR hardware setup required Abstract: Loft Dynamics has introduced VR simulators for eVTOL aircraft, expanding from their established helicopter training systems. These simulators replicate real-world physics and scenarios, offering certified solutions for pilot training. They support tasks such as emergency operations and flight system adjustments, meeting growing pilot demand

Table 2.4 : Patend D

2.3.2 Related Product

2.3.2.1 Product A

Figure 2.6 : Flight Simulation Training Devices (loftdynamics.com, n.d)

VR Flight Simulation Training Devices (FSTDs) are intended to improve the accessibility and effectiveness of pilot training.

The Airbus H125 VR Training Device, an EASA-certified simulator, is one of their flagship products. With its completely equipped cockpit complete with force feedback controls, full motion platform, and 3D VR visuals, this gadget provides an incredibly realistic training experience. Within a small and affordable setup, pilots can rehearse a variety of scenarios, such as emergency procedures, night flying, and instrument flight instruction. For competency evaluations and type ratings, this simulator is quite helpful (dynamic, n.d.)

2.3.2.2 Product B

Aircraft Inspection by Digital Asia Engineering

Figure 2.7 : Asia Digital Engineering (newsroom.airasia.com, n.d)

Background

Digital Asia Engineering's VR for Aircraft Inspection

Digital Asia Engineering's VR tool helps technicians perform virtual inspections of aircraft [10] . Users can conduct walk-arounds, inspect different parts of the aircraft, and identify issues without any real-world risks. The tool features high-quality graphics and interactive elements that replicate actual inspection processes, improving the accuracy and efficiency of maintenance work.

VR for Flight Instrument System Education

This educational VR tool provides a detailed learning environment for understanding flight instruments. Users can explore a virtual cockpit, interact with various instruments, and learn about their functions and operations. The tool enhances traditional learning methods by allowing users to engage with virtual instruments and receive instant feedback.

Methodology

This study uses a comparative analysis approach, focusing on the following aspects:

- Features and Capabilities: Evaluating the main functionalities and technological aspects of each VR application.
- User Experience: Assessing how easy and enjoyable the VR tools are to use.
- Impact on Training and Operations: Analysing how effective and beneficial the VR tools are in real-world training and operational settings.
- Implementation and Integration: Reviewing how easily the VR tools can be deployed and integrated with existing systems.

Analysis

Features and Capabilities

1. Digital Asia Engineering's VR Tool: Offers detailed 3D models of aircraft, interactive checklists, and scenarios to simulate issues like wear and tear. It focuses on providing a realistic environment to enhance inspection accuracy.
3. VR for Flight Instrument System Education: Features detailed virtual instruments, interactive tutorials, and flight scenarios to demonstrate instrument use. It focuses on delivering comprehensive knowledge about each instrument's role in flight operations.

User Experience

1. Digital Asia Engineering's VR Tool: Designed for professional technicians, it emphasizes realism and practical application. Users report high engagement and improved understanding of inspection protocols.
2. VR for Flight Instrument System Education: Aimed at students and aviationprofessionals, it offers easy navigation and interactive elements that make learning complex concepts more accessible.

Impact on Training and Operations

1. Digital Asia Engineering's VR Tool: Reduces time and cost associated with physical inspections and training, minimizes human error, and enhances safety.
2. VR for Flight Instrument System Education: Improves traditional learning methods, leading to better-prepared pilots and aviation personnel by providing a more engaging and effective way to learn about flight instruments.

Implementation and Integration

- Digital Asia Engineering's VR Tool: Easily integrates with existing maintenance systems and can be scaled for different aircraft types and inspection scenarios.
- VR for Flight Instrument System Education: Can be incorporated into existing training programs and adapted for various levels of expertise, from beginners to experienced professionals.

Conclusion

Both VR applications by Digital Asia Engineering and the VR tool for flight instrument system education represent significant advancements in aviation training. Digital Asia Engineering's VR tool excels in providing a practical, immersive environment for aircraft inspection, enhancing maintenance efficiency and safety. On the other hand, the VR educational tool offers an innovative approach to learning about flight instruments, improving comprehension and retention. Both tools serve different purposes but demonstrate the transformative potential of VR technology in aviation. Future developments should focus on expanding the capabilities of these tools and integrating VR further into aviation training and operations.

Recommendations

- Increase Interactivity: Both applications could benefit from more interactive features, such as dynamic scenarios and real-time problem-solving tasks.
- Cross-Functional Training Modules: Combining elements of aircraft inspection and flight instrument education could provide a more comprehensive training experience.
- Integration with Augmented Reality (AR): Combining VR with AR could offer even more immersive and practical training solutions by blending virtual and real-world environments.
- Regular Updates and User Feedback: Updating the tools regularly based on user feedback and new technological advancements will ensure they remain effective and relevant.

2.3.2.2 Product C

Advancements in Virtual Reality Revolutionizing Flight Training

Recent advancements in virtual reality (VR) technology have paved the way for significant developments in flight instruments and flight training [15]. A standout product showcased at CES 2024 is the Pimax Crystal 60G Airlink VR headset, which offers high-speed, low-latency, wireless VR experiences. This headset features inside-out tracking and glass lenses, greatly enhancing the realism and immersion of flight simulations. Additionally, Pimax previewed their 12K EVT0 prototype, promising even higher visual fidelity and an expanded field of view, which is ideal for complex flight training scenarios.

Innovations in VR Flight Training Technology

Pimax Crystal 60G Airlink VR Headset

The Pimax Crystal 60G Airlink VR headset is a cutting-edge device that significantly improves the quality of flight simulations. Its high-speed, low-latency wireless capabilities ensure seamless and uninterrupted VR experiences. The inside-out tracking allows for precise motion detection without the need for external sensors, while the glass lenses provide clear and sharp visuals. These features collectively enhance the sense of realism and immersion, making it an invaluable tool for flight training.

Pimax 12K EVT0 Prototype

The 12K EVT0 prototype by Pimax represents the next leap in VR technology for flight training. It boasts an unprecedented level of visual fidelity and an expanded field of view, which are crucial for realistic and comprehensive flight training scenarios. This advanced headset can simulate more intricate and dynamic environments, providing trainees with a more thorough and practical training experience.

Integration of VR in Traditional Flight Training Programs

Flight Safety International's VR Training Modules

Flight Safety International, a leading provider of flight training, has integrated VR into their training modules. This incorporation offers a cost-effective solution, especially for university-level programs. VR allows pilots to virtually experience their own aircraft's controls and instrumentation, which enhances their confidence and familiarity with the equipment. This hands-on virtual experience is invaluable in preparing pilots for real-world scenarios.

Challenges and Future Prospects

While the advancements in VR technology present numerous benefits, challenges remain. One significant challenge is matching the performance fidelity of real aircraft. The virtual simulations must accurately replicate the behaviour and response of actual aircraft to be truly effective. Additionally, adherence to Federal Aviation Administration (FAA) regulations is crucial to ensure that VR training modules meet the necessary standards for pilot training.

Conclusion

The innovations in VR technology showcased at CES 2024 illustrate the transformative potential of VR in flight training. Devices like the Pimax Crystal 60G Airlink VR headset and the 12K EVT0 prototype offer immersive and realistic training experiences. These advancements make flight training more accessible and cost-effective while reducing logistical constraints. As VR technology continues to evolve, it holds the promise of revolutionizing the field of flight training, providing pilots with unparalleled training tools that prepare them more effectively for real-world flying.

2.3.2.4 Product D

VRpilot's VRflow Cockpit Procedure Trainer

Virtual Reality (VR) technology has become a transformative tool in the aviation industry, particularly in pilot training. Among the many advancements in this field, VRpilot's VRflow Cockpit Procedure Trainer stands out as an innovative solution designed to enhance the learning process for pilots [16]. Developed by VRpilot, this trainer offers a state-of-the-art, immersive experience that simulates real-life cockpit environments, allowing pilots to practice a variety of essential tasks in a safe and controlled virtual setting.

The VRflow Cockpit Procedure Trainer is specifically designed to assist pilots in mastering standard operating procedures, emergency scenarios, and cockpit familiarization. By using advanced VR technology, the system provides an interactive and engaging platform that allows trainees to repeatedly practice complex tasks without the risks or costs associated with using actual aircraft. This approach not only improves skill acquisition but also boosts knowledge retention, making it easier for pilots to recall procedures during real-world operations.

One of the key features of VRflow is its ability to replicate realistic scenarios, which help pilots prepare for various challenges they may face during their careers. For example, emergency scenarios can be simulated to train pilots on how to respond effectively under pressure. Similarly, the platform allows for extensive practice of standard procedures, ensuring that pilots are thoroughly prepared before operating an aircraft. The immersive nature of the VR experience accelerates the learning process and helps users build confidence in their abilities.

The VRflow system is compatible with popular VR hardware setups, requiring only standard devices such as VR headsets and controllers to operate. This makes the trainer highly accessible and cost-effective compared to traditional training methods. Its flexibility also allows for integration into existing training programs, providing an adaptable solution for aviation schools, airlines, and individual trainees.

In conclusion, VRpilot's VRflow Cockpit Procedure Trainer exemplifies how VR technology is revolutionizing pilot training. By offering a realistic, interactive, and risk-free training environment, it enhances learning outcomes and prepares pilots to handle real-world challenges with greater competence and confidence. This innovation represents a significant step forward in the aviation industry, demonstrating the potential of VR to improve the efficiency and effectiveness of pilot training.

2.4 COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT

2.4.1 Patent A vs. Product A vs. Your Product

World Flight Meta Quest 2 vs. VR Flight Simulation Training Devices (FSTDs) vs. VRFI

Aspect	World Flight Meta Quest 2	VR Flight Simulation Training Devices (FSTDs)	VRFI
Focus	Interactive VR flight experience for entertainment and basic training.	Realistic flight simulation for pilot training.	Immersive 3D exploration and training of Cessna 172N flight instruments [19].
Technology	Offers basic VR interactivity in a simulated flight environment.	Uses physical controls and screens for realistic flight simulation.	Combines immersive VR with interactive tutorials, quizzes, and adaptive learning paths.
Limitations	Limited focus on professional aviation training and lacks specialized content for flight instruments.	Expensive, requires extensive setup, and focuses primarily on flight rather than detailed instrument training.	Affordable and focused on aviation students, emphasizing hands-on instrument learning in VR.

Table 2.5 : Comparison A

2.4.2 Patent B vs. Product B vs. Your Product

VR for Aircraft Maintenance Engineering vs. Aircraft Inspection by Digital Asia Engineering vs. VRFI

Aspect	VR for Aircraft Maintenance Engineering	Aircraft Inspection by Digital Asia Engineering	VRFI
Focus	VR for learning and performing maintenance tasks on aircraft.	Application of VR for efficient aircraft inspection.	Specialized VR training focused on Cessna 172N flight instruments for aviation students [18] .
Technology	Uses VR to simulate maintenance scenarios and workflows.	Utilizes VR to streamline inspection processes and improve accuracy.	Focuses on interactive explanations, real-time feedback, and in-depth exploration of flight instruments.
Limitations	Primarily targets maintenance operations and lacks training content for specific cockpit instruments.	Geared towards operational efficiency rather than educational purposes.	Tailored for educational use with specific focus on the six primary flight instruments in aviation.

Table 2.6 : Comparison B

2.4.3 Patent C vs. Product C vs. Your Product

CAE XR Training for Aircraft Technicians vs. Advancements in Virtual Reality Revolutionizing Flight Training vs. VRFI

Aspect	CAE XR Training for Aircraft Technicians	Advancements in Virtual Reality Revolutionizing Flight Training	VRFI
Focus	Advanced VR and AR solutions for technician training [7].	Enhances aviation training using virtual reality for flight and maintenance scenarios.	Comprehensive VR platform for understanding flight instruments and their functionality.
Technology	Integrates extended reality (XR) for technical skills development.	Employs VR for immersive flight scenarios and basic technician training.	Combines VR with quizzes, video tutorials, and detailed 3D models for flight instrument training.
Limitations	Primarily targets technicians and maintenance roles; limited focus on cockpit instruments.	Focuses on generalized aviation training without emphasis on instrument specifics.	Targets specific educational needs of aviation students for flight instrument comprehension.

Table 2.7 : Comparison C

2.4.4 Patent D vs. Product D vs. Your Product

Loft Dynamics eVTOL VR Simulator vs. VRpilot's VRflow Cockpit Procedure Trainer vs. VRFI

Aspect	Loft Dynamics eVTOL VR Simulator	VRpilot's VRflow Cockpit Procedure Trainer	VRFI
Focus	High-fidelity VR simulator for eVTOL aircraft training.	VR-based cockpit procedure training for pilots.	VR training for flight instruments focusing on the Cessna 172N cockpit.
Technology	Simulates eVTOL aircraft flight dynamics and controls using VR.	Provides VR-guided cockpit procedure training with checklist assistance.	Offers an immersive learning environment with quizzes, video tutorials, and real-time feedback.
Limitations	Specific to eVTOL aircraft; not generalizable to other aircraft types or student training.	Limited to procedural training; lacks focus on individual flight instrument functionality.	Comprehensive coverage of flight instrument knowledge with interactive exploration and adaptive learning.

Table 2.8 : Comparison D

CHAPTER 3

RESEARCH METHODOLOGY

3.1 PROJECT BRIEFING AND RISK ASSESMENT

3.1.1 UTILIZATION OF POLYTECHNIC'S FACILITIES

The facilities of the Polytechnic, in particular its Wi-Fi infrastructure and the flight instrument, were extremely important contributors to the successful creation of our educational application. Through the efficient utilization of these resources, we were able to maximize our productivity, our ability to collaborate, and our access to many important tools and information. In light of this experience, it is clear that it is essential to make effective use of institutional resources in order to maximize the results of projects and improve educational opportunities.

3.1.2 PROJECT COLLABORATION & TRANSFER OF TECHNOLOGY

This product was brought to life through the invaluable collaboration with Asia Digital Engineering (ADE) and Otaiz Solution Enterprise, two key partners who have helped shape its success and innovative features. ADE, as a leader in aviation maintenance and digital solutions, shared their industry expertise to ensure the virtual reality simulations are realistic, practical, and aligned with real-world aviation standards. Their involvement has made the product an excellent tool for enhancing safety, building confidence, and giving students and trainers a hands-on way to understand and interact with flight instruments.

On the other hand, Otaiz Solution Enterprise, our developer consultant, brought their technical expertise to the table. They played a crucial role in designing a system that is not only reliable but also easy to use. Thanks to their work, the product includes exciting features like interactive simulations and real-time feedback, making the learning experience more dynamic and engaging for users.

The collaboration with ADE and Otaiz Solution Enterprise has had a profound impact on the product's development, ensuring it is innovative, effective, and beneficial for aviation education. Together, we've created something that doesn't just teach it transforms how students learn about flight instruments, setting a new benchmark for training in the aviation industry.

3.2 OVERALL PROJECT GANTT CHART

Week / Process	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
Briefing And Group Formation	■														
Project Registration Form		■	■												
Assignment 1 (Design Requirement)			■	■											
Assignment 2 (Design Generation)				■	■	■									
Assignment 3 (Establishing Datum)					■	■									
Pre-Proposal Presentation (Assignment1,2&3)							■	■							
Write-Up Chapter 1								■	■						
Write-Up Chapter 2									■	■	■	■			
Write-Up Chapter 3/Final Proposal (Compile)											■	■	■		
Final Proposal Presentation (Chapter 1,2 & 3)														■	■

■ **: EXECUTED**

Table 3.1: Overall Project Gantt Chart

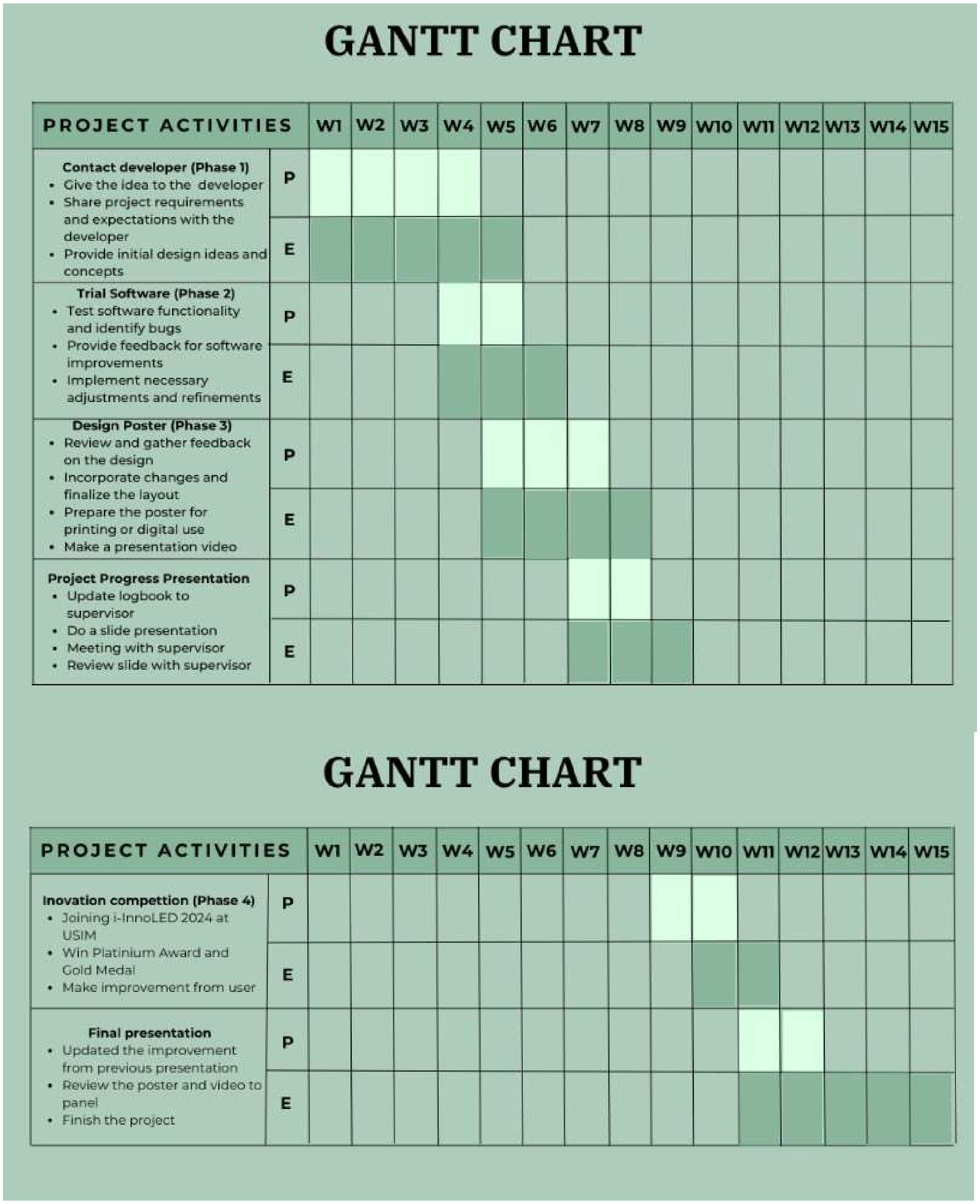
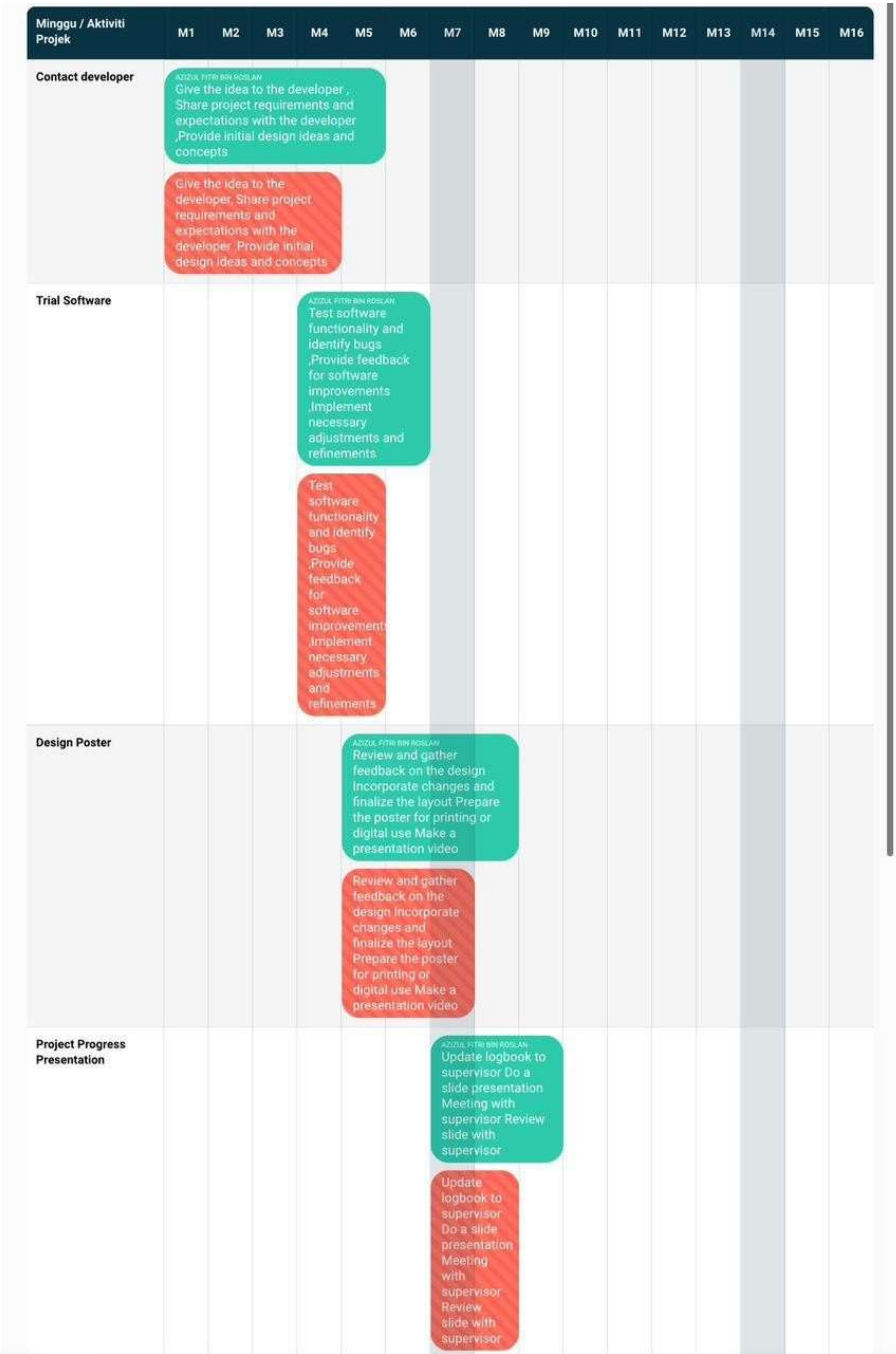
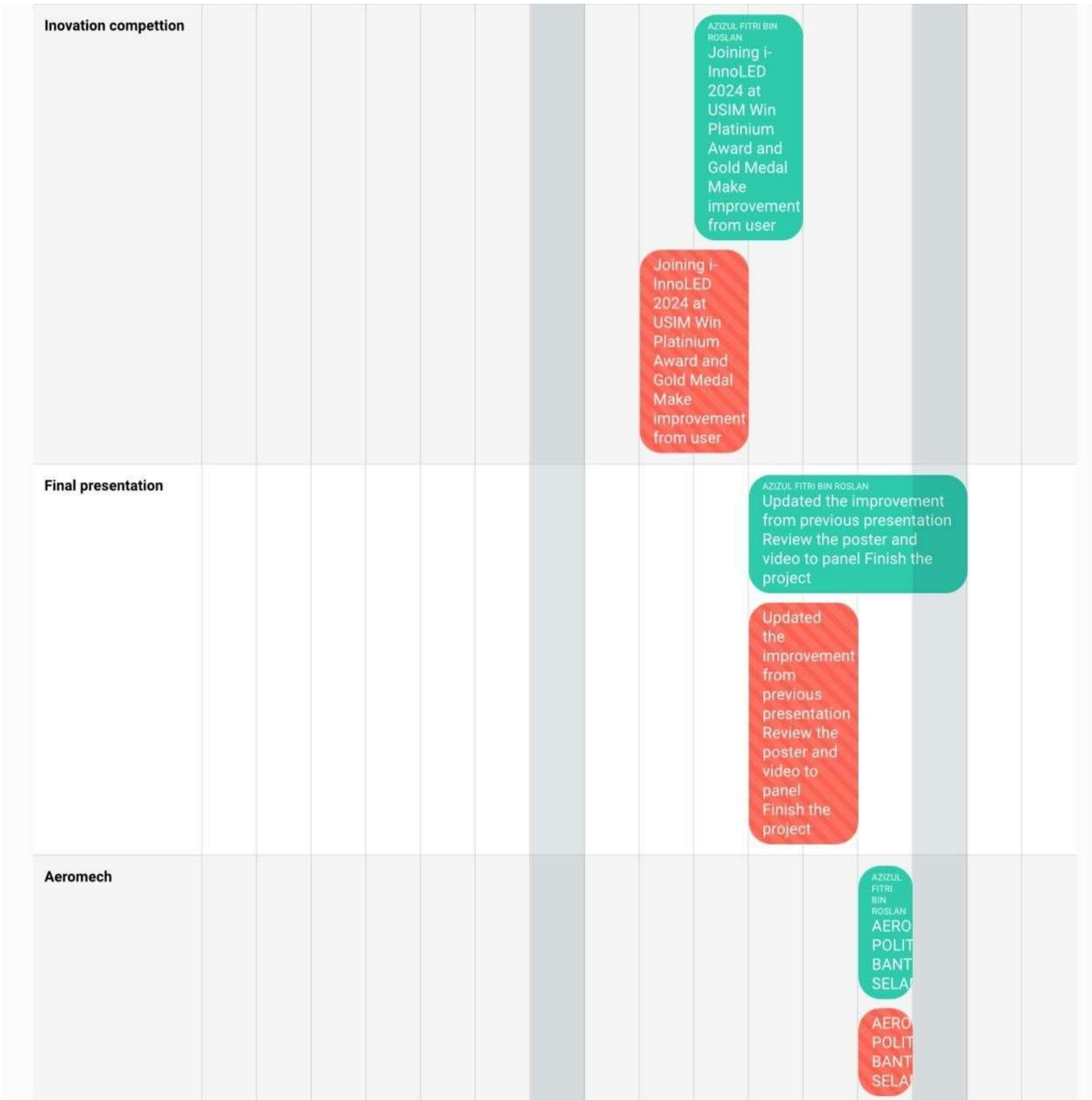


Table 3.2 : Project Gantt Chart



Minggu / Aktiviti Projek
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
M11
M12
M13
M14
M15
M16
Contact developer
AZIZUL FITRI BIN ROSLAN
Give the idea to the developer , Share project requirements and expectations with the developer ,Provide initial design ideas and concepts
Give the idea to the developer, Share project requirements and expectations with the developer. Provide initial design ideas and concepts
Trial Software
AZIZUL FITRI BIN ROSLAN
Test software functionality and identify bugs ,Provide feedback for software improvements ,Implement necessary adjustments and refinements
Test software functionality and identify bugs ,Provide feedback for software improvements ,Implement necessary adjustments and refinements
Design Poster
AZIZUL FITRI BIN ROSLAN
Review and gather feedback on the design Incorporate changes and finalize the layout Prepare the poster for printing or digital use Make a presentation video
Review and gather feedback on the design Incorporate changes and finalize the layout Prepare the poster for printing or digital use Make a presentation video
Project Progress Presentation
AZIZUL FITRI BIN ROSLAN
Update logbook to supervisor Do a slide presentation Meeting with supervisor Review slide with supervisor
Update logbook to supervisor Do a slide presentation Meeting with supervisor Review slide with supervisor


Inovation competition
AZIZUL FITRI BIN ROSLAN
Joining i-InnoLED 2024 at USIM Win Platinium Award and Gold Medal Make improvement from user
Joining i-InnoLED 2024 at USIM Win Platinium Award and Gold Medal Make improvement from user
Final presentation
AZIZUL FITRI BIN ROSLAN
Updated the improvement from previous presentation Review the poster and video to panel Finish the project
Updated the improvement from previous presentation Review the poster and video to panel Finish the project
Aeromech
AZIZUL FITRI BIN ROSLAN
AERO POLIT BANT SELA
AERO POLIT BANT SELA

3.3 PROJECT FLOW CHART

3.3.1 OVERALL PROJECT FLOW CHART

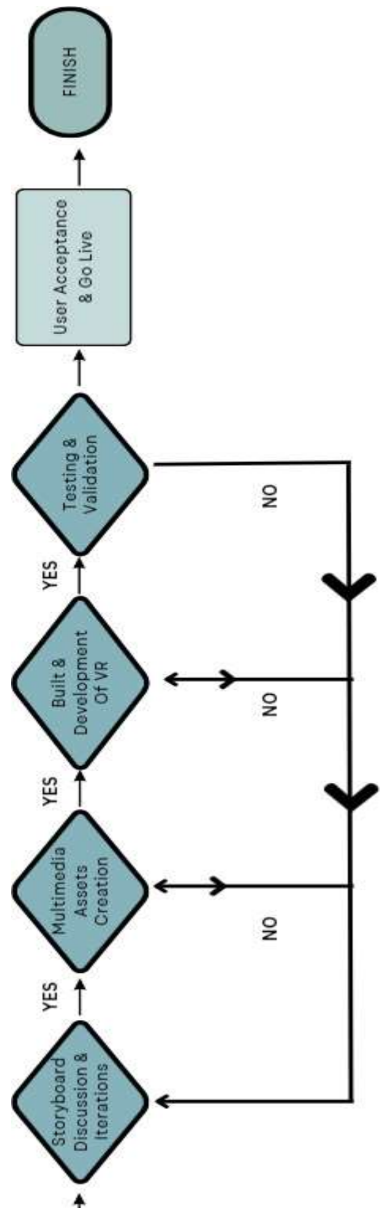


Figure 3.1: VRFI Flow Chart

3.3.2 SPECIFIC PROJECT DESIGN FLOW

3.3.2.1 Product Structure

The design process for the product structure focuses on creating the physical and virtual framework necessary for the development and integration of flight instruments in a virtual reality (VR) environment. The product structure consists of the following stages:

1. **Hardware Framework:** The system includes hardware components such as VR headsets, motion sensors, and haptic devices. These devices form the physical infrastructure for simulating the cockpit environment. Selection of VR-compatible hardware with high resolution and low latency. Design of cockpit replicas for an immersive experience, incorporating control panels, joystick, and throttle replicas.
2. **VR Environment Setup:** Development of a 3D VR cockpit model using tools like Blender or Unity. Structuring the cockpit with accurate placements of flight instruments, including altimeter, airspeed indicator, and attitude indicator. Ensuring ergonomic arrangement for ease of user interaction.

3.3.2.2 Product Mechanism

The product mechanism ensures functional operation and interaction between virtual instruments and the VR system. The steps involved include:

1. **Instrumentation Mechanism:**
    - Virtual flight instruments are programmed to reflect real-time data based on simulation parameters.
    - Integration of motion tracking for head and hand movement to enhance interaction with virtual instruments.
2. **Data Flow Mechanism:**
    - Simulation data is transmitted from a central flight simulation engine to the VR system.
    - Implementation of algorithms to update instrument readings in real-time, ensuring accuracy in navigation and control.

3. **User Interaction Mechanism:**

   - Hand gesture recognition or controller-based inputs to manipulate flight instruments within the VR cockpit.
   - Feedback systems (audio or visual) to guide user actions, creating an intuitive interface.

3.3.2.3 Software/programming

The software design focuses on the development and implementation of programs that support the VR system and simulate flight instruments effectively. The process includes:

1. **Platform and Engine Selection:** Using Unity or Unreal Engine for creating an interactive VR environment. Open-source flight simulation engines, such as X-Plane or FlightGear, for accurate flight dynamics.
2. **Programming Languages and Frameworks:** Utilization of C#, Python, or C++ for simulation logic, data transmission, and VR controls.Application of APIs like OpenXR or SteamVR SDK for integrating hardware devices with the VR environment.
3. **Simulation Logic:** Programming virtual flight instruments to display altitude, airspeed, attitude, heading, and vertical speed. Implementing real-time physics-based calculations to simulate realistic flight behavior.
4. **Testing and Debugging:** Testing for real-time synchronization between the flight simulation engine and VR cockpit. Debugging software for latency reduction and ensuring accurate user feedback during interaction.

3.3.2.4 Acessories/finishing

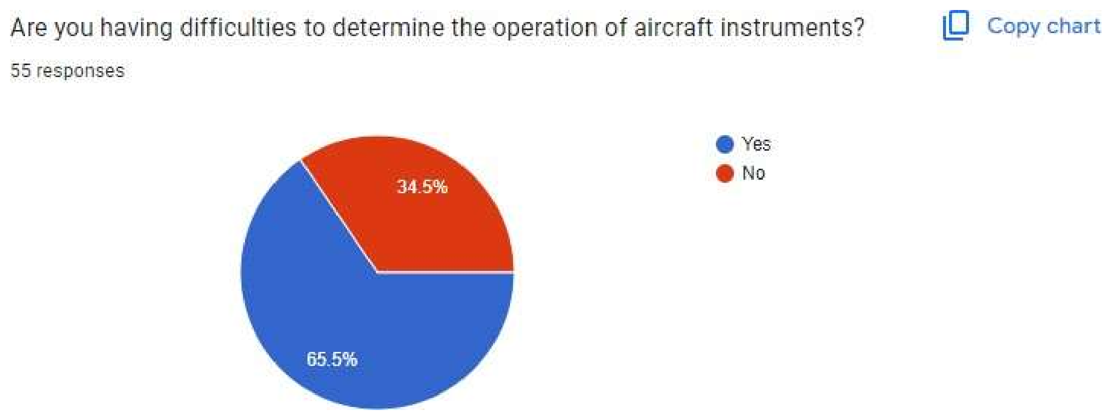
The final step involves enhancing the product's usability, aesthetics, and user experience. Key aspects include:

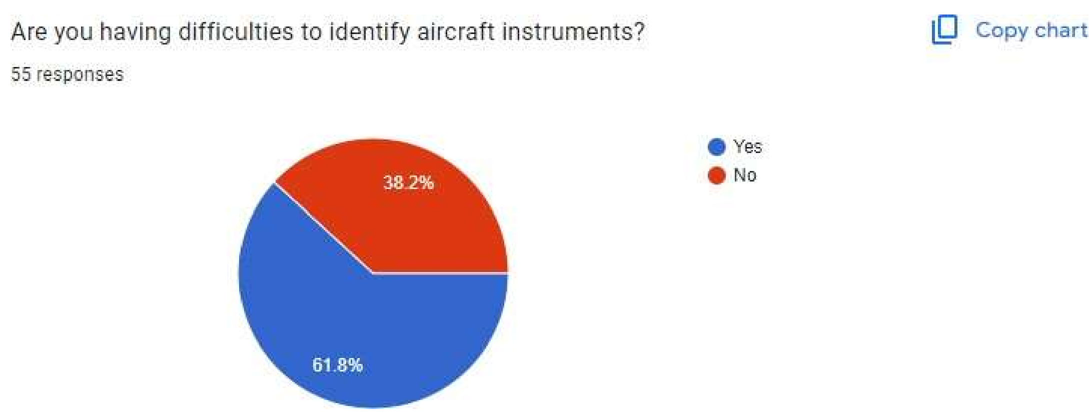
1. **Accessories:**
    - Integration of comfortable and adjustable VR headsets to suit various users.
    - Addition of tactile controls such as knobs, buttons, and switches that mimic real-life cockpit interactions.
    - Use of headphones for immersive audio feedback.
2. **Finishing Touches:**
    - Optimizing the VR environment with realistic textures, lighting, and sounds to improve the sense of immersion.
    - Ensuring durability and ease of use for physical components, such as controllers and haptic feedback devices.
    - Polishing the user interface (UI) to ensure a seamless and intuitive user experience.
3. **Packaging and Presentation:**
    - Creating user manuals and guides for operating the VR system effectively.
    - Structuring the setup in a professional and compact manner for ease of transport and storage.

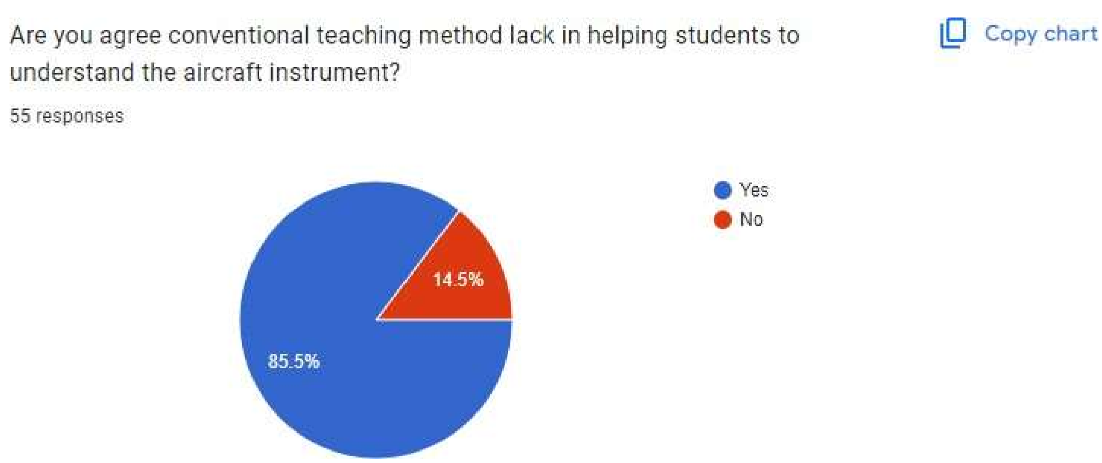
3.4 DESIGN ENGINEERING TOOLS

3.4.1 Design Requirement Analysis

3.4.1.1 Questionnaire Survey

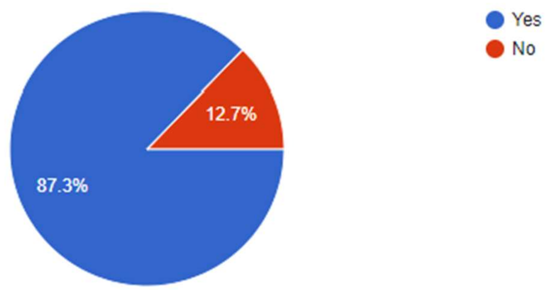






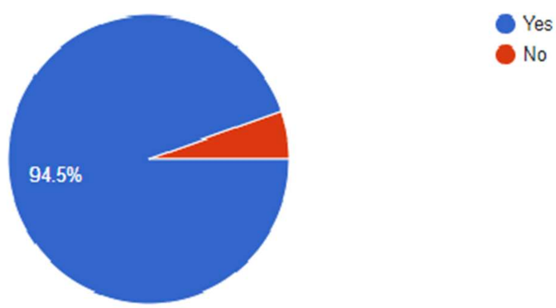
Do you think the 6 basic instruments is important? Copy chart

55 responses



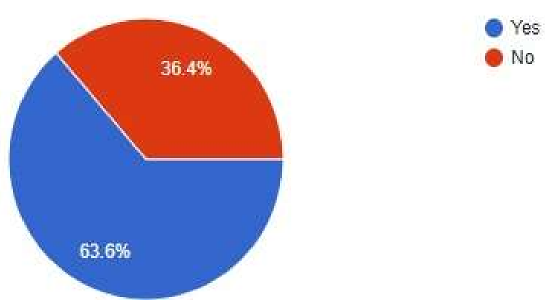
Do you feel this virtual reality (VR) relevent for educational purpose? Copy chart

55 responses



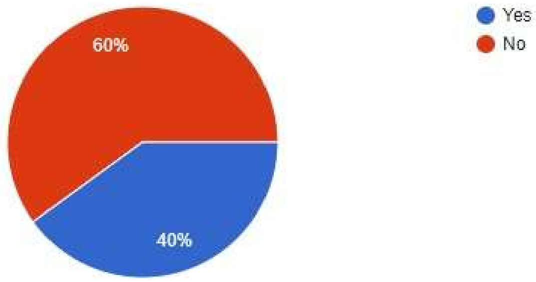
Are you familiar with virtual reality ? Copy chart

55 responses



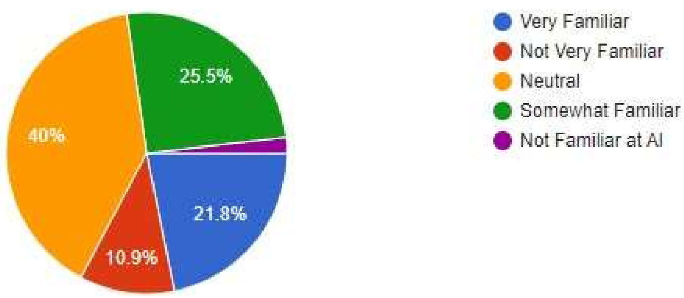
Have you ever used a virtual reality (VR) aircraft instrument learning kit? Copy chart

55 responses



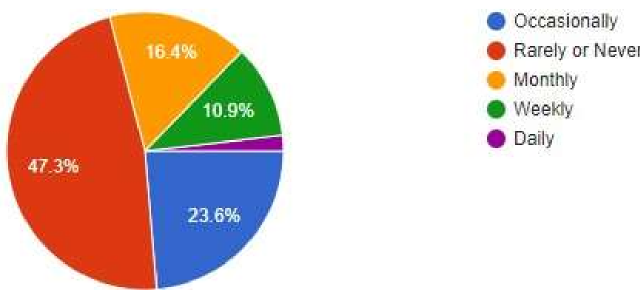
How familiar are you with the concept of virtual reality (VR) technology? Copy chart

55 responses



How often do you use the VR aircraft instrument learning kit? Copy chart

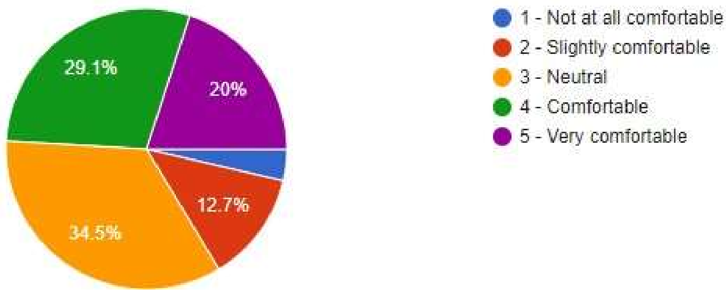
55 responses



On a scale of 1 to 5, how comfortable are you using virtual reality (VR) technology?

Copy chart

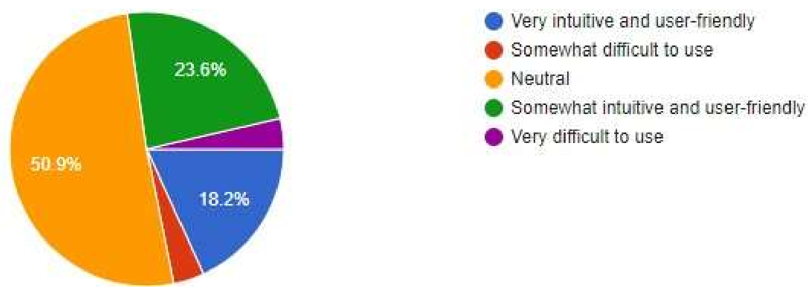
55 responses



How intuitive and user-friendly do you find the interface of the VR learning kit?

Copy chart

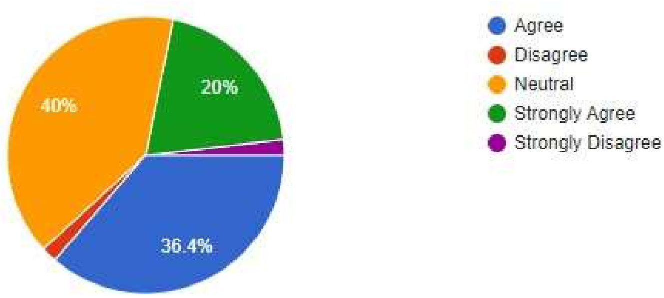
55 responses



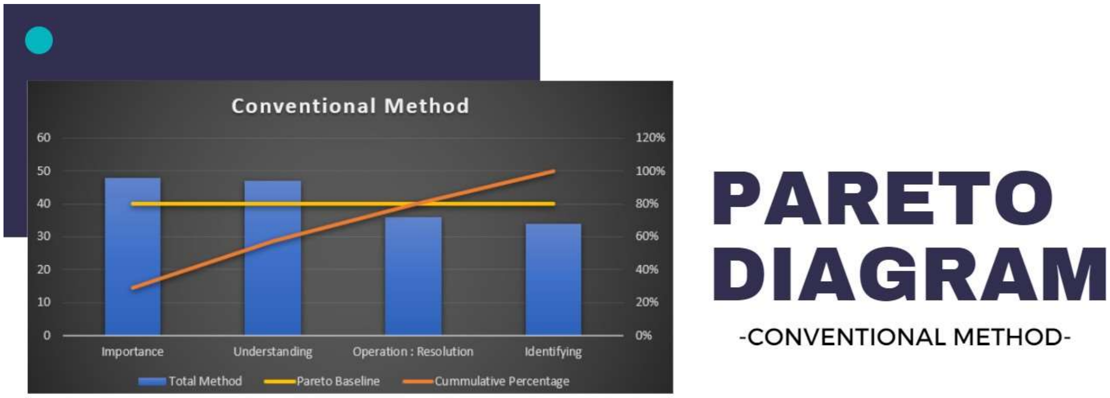
Do you think the VR learning kit adequately prepares users for real-world scenarios involving aircraft instruments?

Copy chart

55 responses

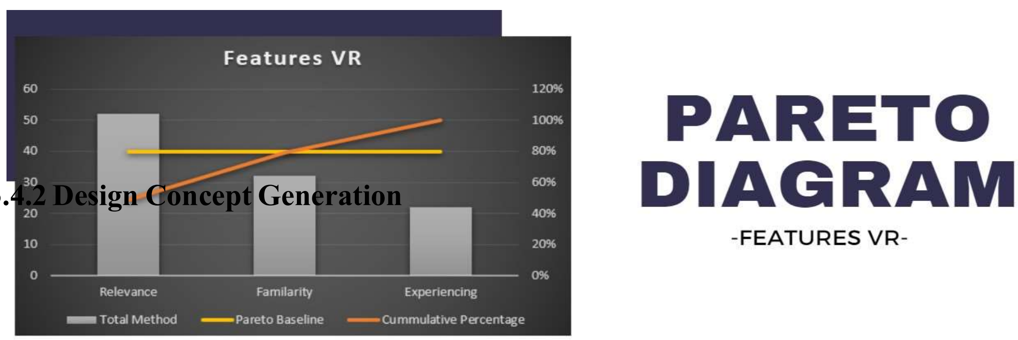


3.4.1.2 PARETO DIAGRAM



Conventional Method	Total Method	Total Percentage	Cummulative Percentage	Pareto Baseline
Importance	48	29.09%	29.09%	80%
Understanding	47	28.48%	58%	80%
Operation : Resolution	36	21.82%	79%	80%
Identifying	34	20.61%	100%	80%

Figure 3.2 : Conventional Method Pareto Diagram



3.4.2 Design Concept Generation

Features VR	Total Method	Total Percentage	Cummulative Percentage	Pareto Baseline
Relevance	52	49.06%	49%	80%
Familiarity	32	30.19%	79%	80%
Experiencing	22	20.75%	100%	80%

Figure 3.3 : Features VR Pareto Diagram

3.4.2 DESIGN CONCEPT GENERATION

3.4.2.1 FUNCTION TREE

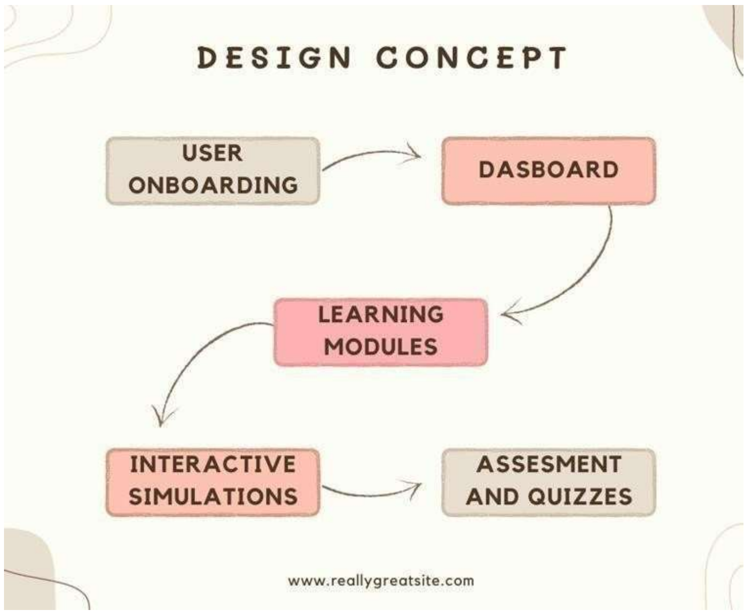


Figure 3.4 : Function Tree

3.4.2.2 MORPHOLOGICAL MATRIX

FUCTION (SUB-FUCTION)	IDEA 1	IDEA 2	IDEA 3	IDEA 4
TYPE	Game	Game	Explore	Game
SOFTWARE	Unity	Unreal engine	Unity	Unreal Engine
HARDWARE	Motion Controller	Motion controller	Oculus Quest 2	HTC vive pro
PROGRAMMING LANGUAGE	Java	C++	C++	C#
INTERACTION	Hand movement	Hand movement	Hand tracking	Full body tracking and motion controllers

Figure 3.5 : Morphological Matrix

3.4.2.3 PROPOSED DESIGN CONCEPT 1

FUNCTION	CONCEPT 1	JUSTIFICATION
TYPE	Game	Learning process while playing the game
SOFTWARE	Maya	Software development tool from Autodesk. With Maya, you can create 3D animations, motion graphics, and VFX software
HARDWARE	Motion controller	Hardware accessories that allow users to take action in mixed reality
PROGRAMMING LANGUAGE	Java	High-level, class-based, object-oriented programming language that is designed to have as few implementation dependencies as possible
INTERACTION	Hand movement	Users begin with their hand at a given starting point and reach to select a target location somewhere in the virtual environment

Figure 3.6 : Design Concept 1

3.4.2.4 PROPOSED DESIGN CONCEPT 2

FUNCTION	CONCEPT 2	JUSTIFICATION
TYPE	Game	Its more interesting and playful while learning
SOFTWARE	Unreal engine	Mobile, console, and PC platforms are all supported by Unreal Engine. This implies that a large audience may be reached by VR experiences created using Unreal Engine.
HARDWARE	Motion controller	Motion controls allow users to interact with virtual environments more intuitively, mimicking real-world movements
PROGRAMMING LANGUAGE	C++	C++ allows for low-level manipulation of system resources and provides direct access to hardware, making it suitable for applications that require high performance and efficiency.
INTERACTION	Hand movement	The ability to see and manipulate virtual hands in synchronisation with actual hand movements enhances one's feeling of presence inside a virtual environment.

Figure 3.8 : Design Concept 2

3.4.2.5 PROPOSED DESIGN CONCEPT 3

FUNCTION	CONCEPT 3	JUSTIFICATION
TYPE	Explore	Users can explore and study about digital versions of 6 basic instruments
SOFTWARE	Unreal engine	Provide advanced graphic capabilities, making it suitable for creating realistic virtual instruments and high quality
HARDWARE	Oculus Quest 2	All in one VR headset with built in tracking and controllers, offering wireless and immersive VR experience
PROGRAMMING LANGUAGE	C++	Primary programming language used for unreal engine development
INTERACTION	Hand tracking	Users can navigate the movement using hand tracking, allowing them to move their hands naturally

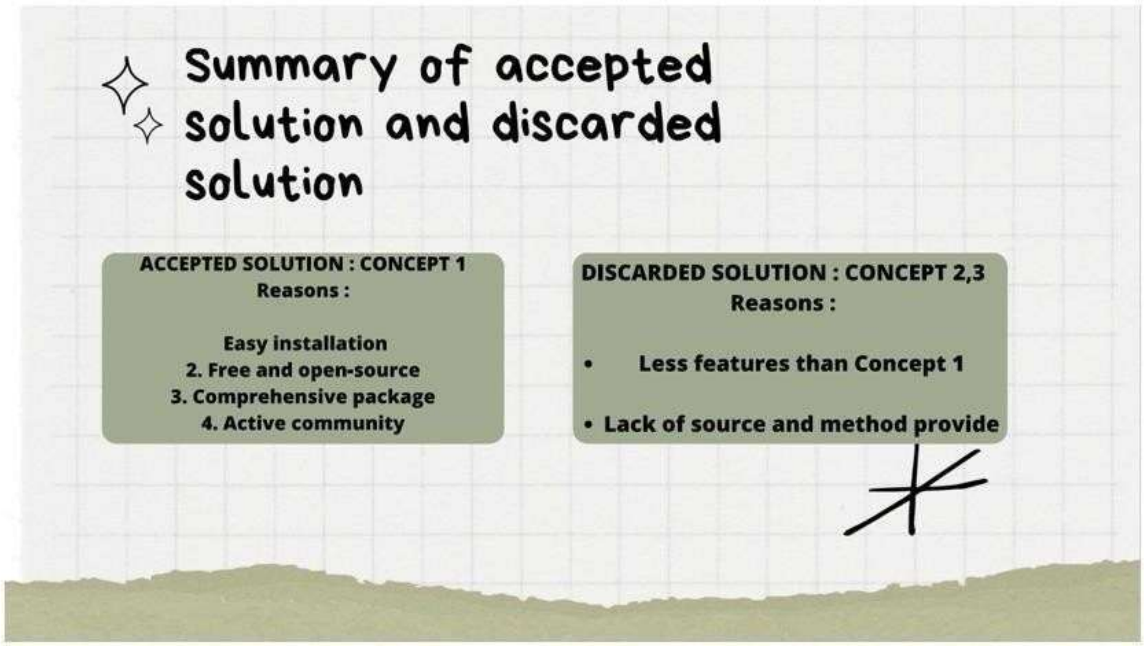
Figure 3.9 : Design Concept 3

3.4.2.6 PROPOSED DESIGN CONCEPT 4

FUNCTION	CONCEPT 4	JUSTIFICATION
TYPE	Game	More interesting and able to attract the attention of users
SOFTWARE	Unity	Unity is versatile game engine that supports VR development and offers a wide range of tools and resources for creating interactive experiences
HARDWARE	HTC Vive pro	Is a high-end VR headset with precise tracking and motion controllers, providing users with a realistic and immersive VR experiences
PROGRAMMING LANGUAGE	C#	Is the primary programming language used for Unity development, offering a balance of performance and productivity
INTERACTION	Full body tracking and motion controllers	Users can enjoy using full body tracking and motion controllers. Full body tracking sensors can capture user's movement

Figure 3.9 : Design Concept 4

3.4.2.7 ACCEPTED VS DISCARDED SOLUTION



Concept 1 was selected as the accepted solution due to its strong alignment with the project's requirements. This solution stands out for its easy installation, which simplifies the integration process, and its free and open-source nature, which not only reduces costs but also provides flexibility for customization to suit the specific needs of the project.

Additionally, Concept 1 offers a comprehensive package with a wide range of tools and functionalities essential for simulating and implementing flight instruments within a VR environment. Another key advantage is the active community supporting this solution, which ensures continuous access to resources, troubleshooting, and updates, making it highly adaptable for ongoing development.

On the other hand, Concepts 2 and 3 were discarded because they lacked critical features present in Concept 1, and they provided insufficient documentation or support, making them unsuitable for the project's requirements. These limitations would have hindered the ability to develop a robust and realistic flight instrument system in VR. As a result, Concept 1 was chosen as the most effective and reliable solution for achieving the project's goals.

3.4.3 EVALUATION & SELECTION OF CONCEPTUAL DESIGN

3.4.3.2 PUGH MATRIX

CRITERIA	CONCEPT 1	CONCEPT 2	CONCEPT 3	CONCEPT 4	CONCEPT 5
TYPE	D	3	2	1	3
SOFTWARE	A	2	1	3	3
HARDWARE	T	1	3	1	3
PROGRAMMING LANGUAGE	U	1	3	1	3
INTERACTION	M	1	3	1	3
TOTAL SCORE	-	8	12	7	15
RANKING		3	2	4	1

Legend = 3(+}, 2(=), 1(-)

Figure 3.10 : Pugh Matrix

3.5 PRODUCT DRAWING / SCHEMATIC DIAGRAM

3.5.1 General Product Drawing

After entering into the app, there will be an interface layout which contains three main options for the user for using the app. It contains notes, video, infographics, 3D model, Cessna 172N and quiz.

3.4.4 Specific Part Drawing / Diagram

3.5.2.1 Product Structure

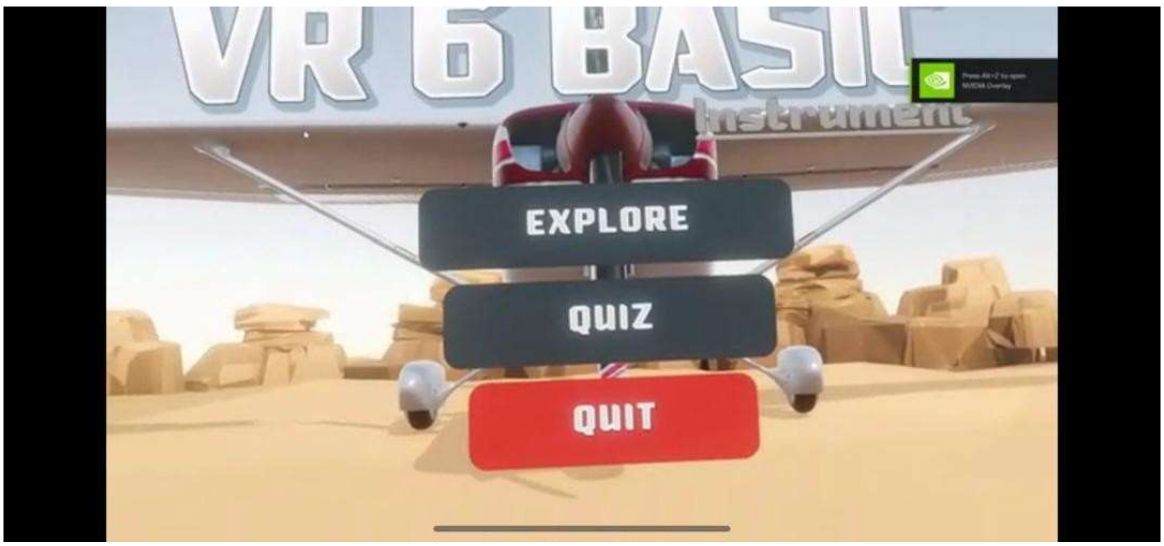


Figure 3.11 : Interface

3.5.2.2 Product Mechanism

Figure 3.12 : Cockpit

3.5.2.3 Software/ Programming

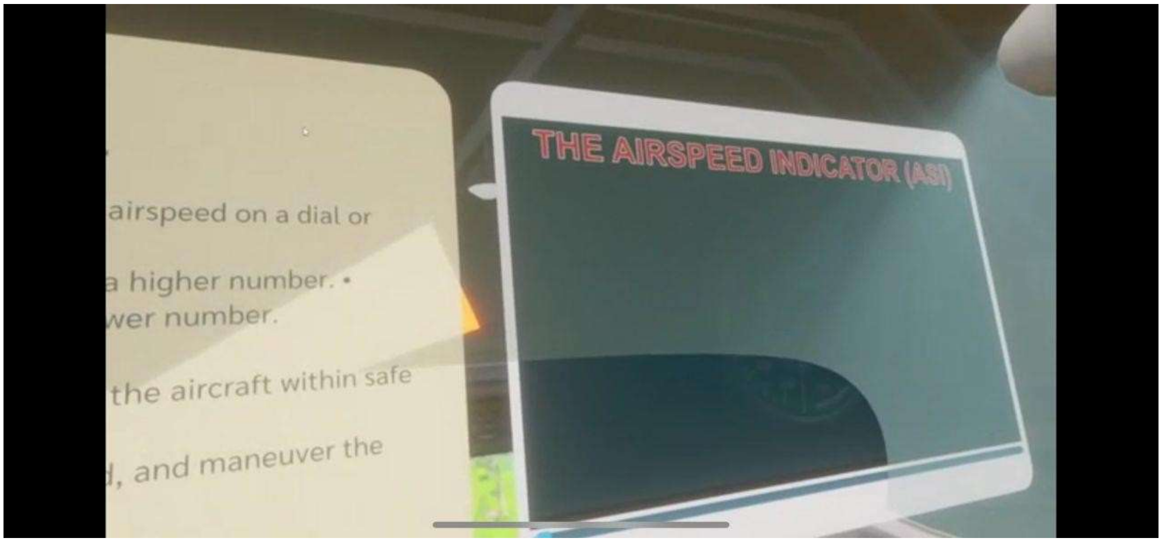


Figure 3.13 : Cockpit And Pop Up

3.5.3.4 Accessories & Finishing

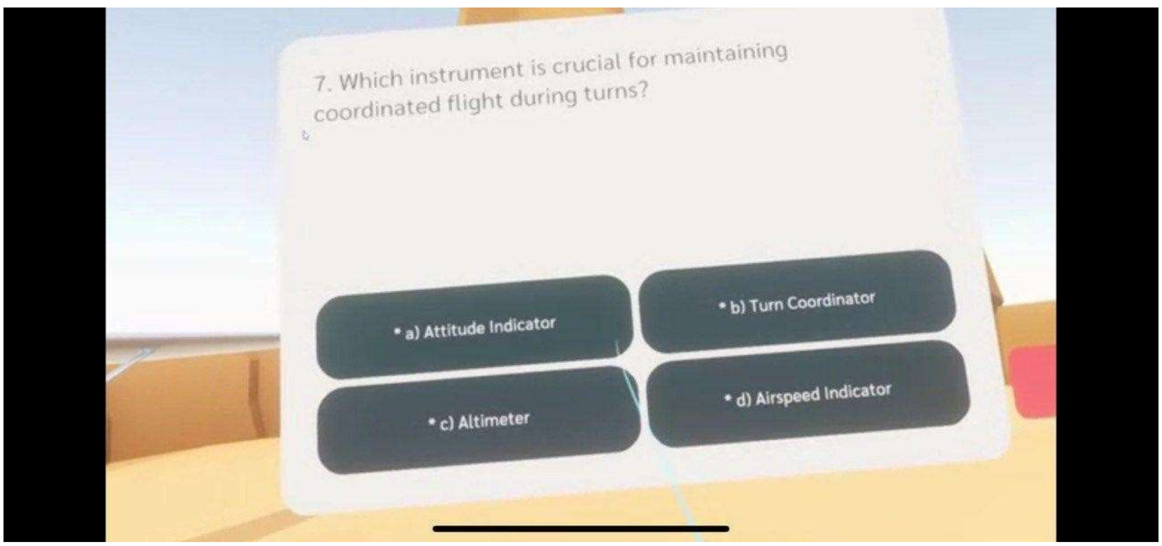


Figure 3.14 : Horizontal Situation Indicator Quizzes

Once you press into the explore option, it will directly bring us to the Cessna 172N, after that we can walk around the Cessna 172N and can get into the aircraft which is have 6 basic instrument and the explanation. For every explanation there will be a quiz to test the knowledge.

3.6 PROTOTYPE / PRODUCT MODELLING

3.6.1 Prototype / Product Modelling

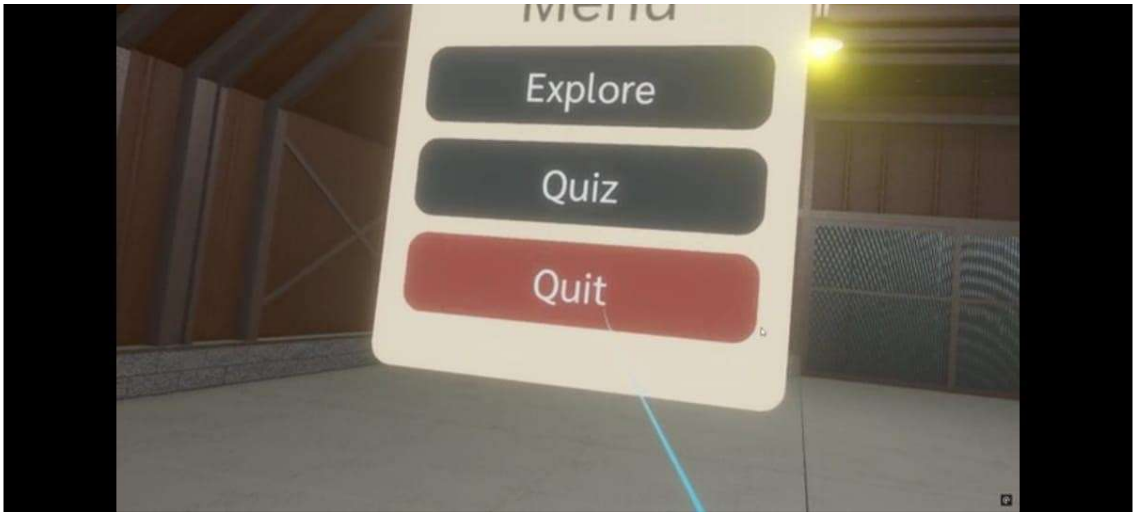


Figure 3.15: Menu Page Prototype

The menu page is integrated into the game environment, avoiding additional interfaces or dimensions. It allows users to navigate options like starting the game or exiting without disrupting the immersive VR experience.

Figure 3.16: Cockpit Design Prototype

The cockpit is a simplified but realistic representation, designed to simulate a flight environment. While not fully accurate to real-world standards, it provides an engaging and functional space for users to interact with basic flight instruments.

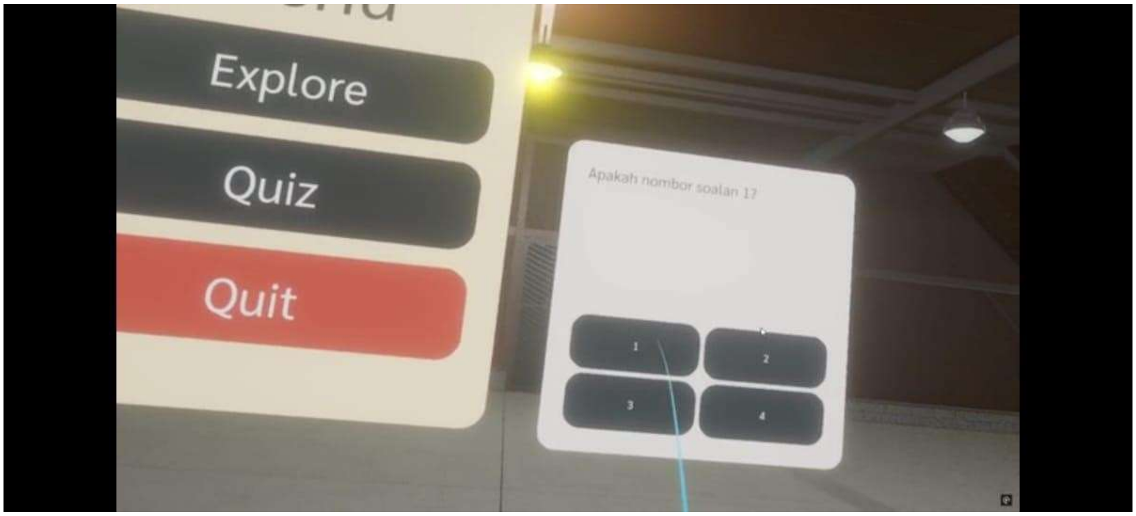


Figure 3.17: Quiz Section Prototype

The quiz section is embedded directly into the game, presented within the same dimension as the primary gameplay. It tests users' understanding of flight instruments through interactive questions, ensuring continuity in immersion.

3.6.2 Prototype Development

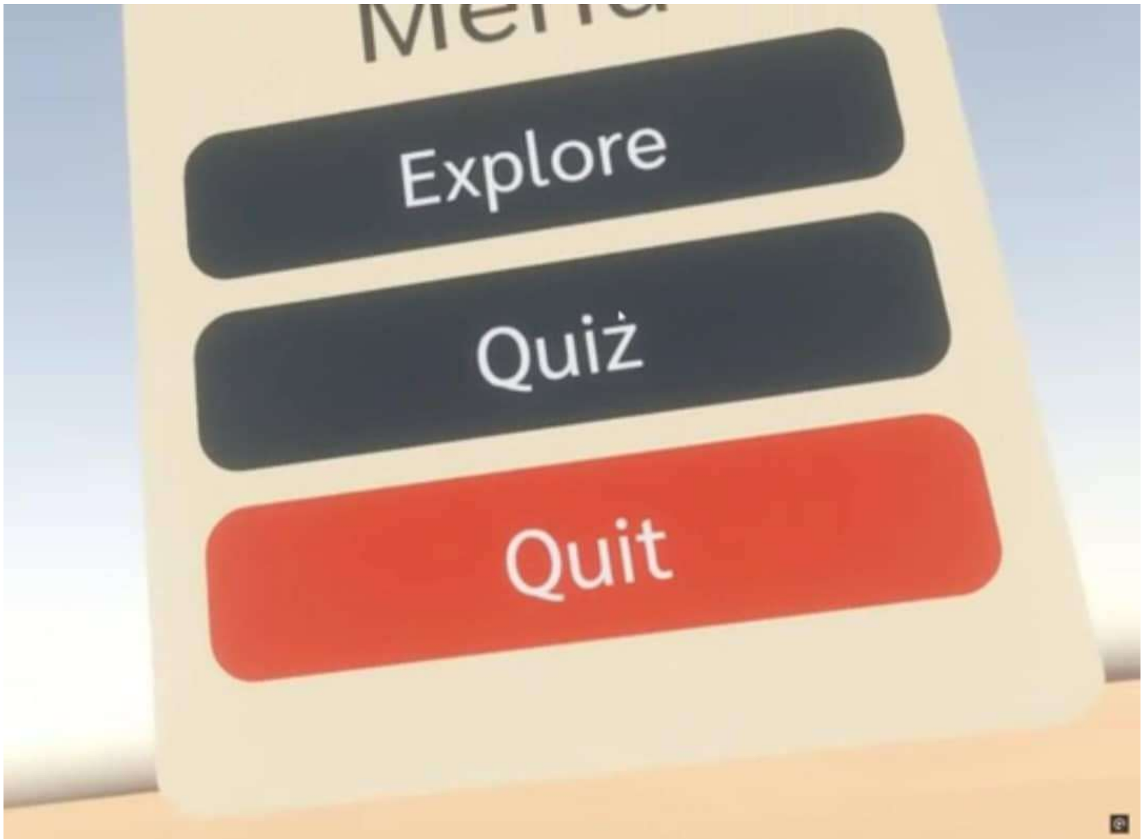


Figure 3.18: Menu Page Development

The menu page is redesigned to exist in a separate dimension, offering a more interactive and visually distinct experience. Users navigate the options through an engaging interface that enhances immersion.

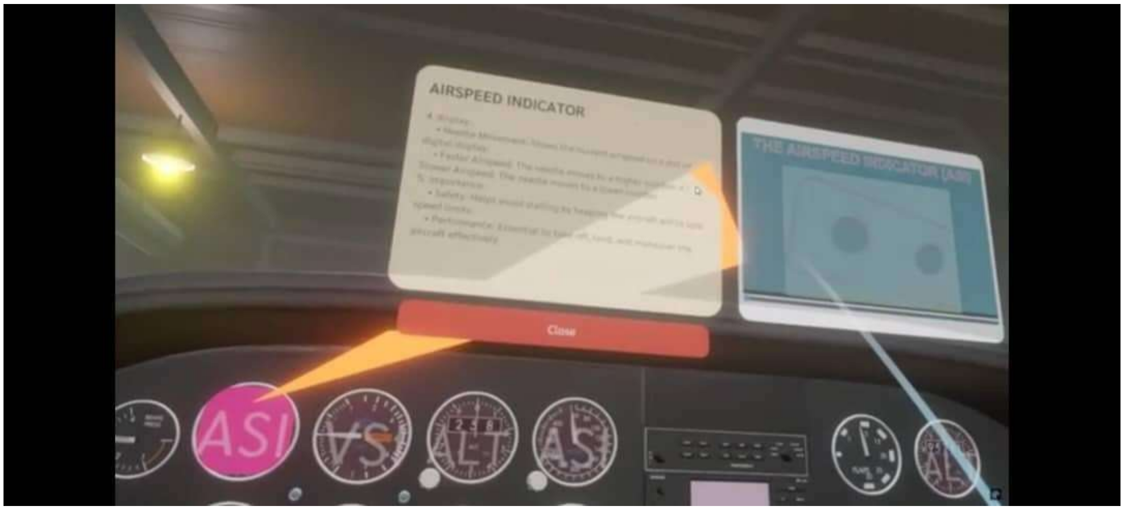


Figure 3.19: Cockpit Design Development

The cockpit now includes interactive elements that provide explanations for each flight instrument, allowing users to learn about their functions and importance directly within the simulation.

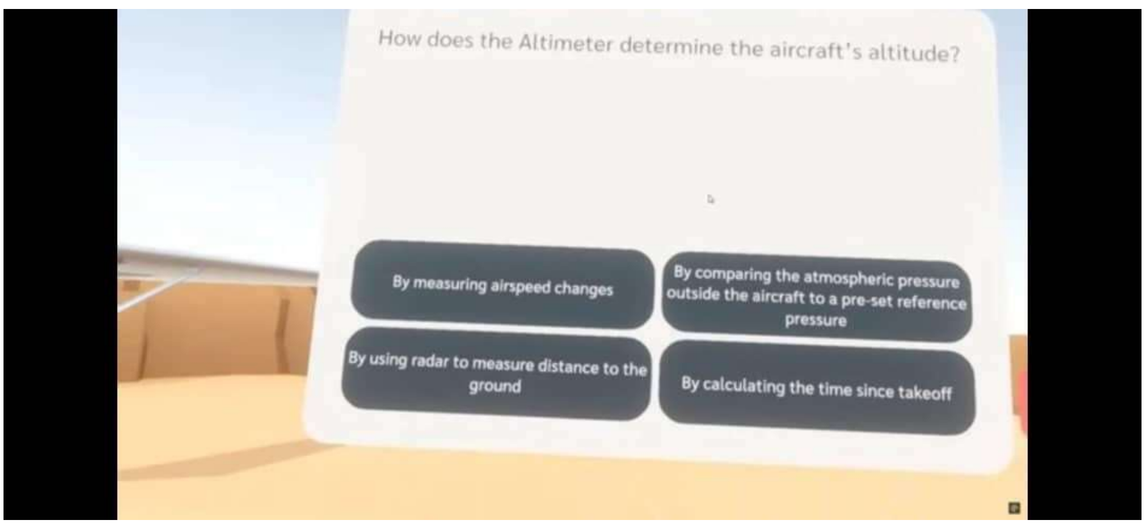


Figure 3.2: Quiz Section Development

The quiz section is moved to a separate dimension, creating a focused environment for users to answer questions and test their understanding away from the exploratory gameplay mode.

3.7 DEVELOPMENT OF PRODUCT

3.7.1 Material Acquisition

Description	Material
Using Unity software to create the apps	Unity
A platform that we used to take notes for our app	
A platform that we used to create infographics	Canva
A platform that we used to make quiz for every chapter	W
To develop the 3D model	Sketchfab

Table 3.3 : Material Acquisition

3.7.2 Material and Tools

Figure 3.21 : Microsoft laptop (jbhifi.com, n.d)

To develop this app, we used this laptop for designing, editing, entering 3D model and notes that we collected because it is more flexible that smartphone and much easier to do our job. Besides that, we use this device to access website such as UNITY, Cidos, Canva, word and chat GPT. Those websites that we've used to create notes, quizzes and 3D model. We can tell that this device is one of the main reasons behind developing this VRFI.

Figure 3.22 : VR Set (walmart.com, n.d)

We have used VR set to using this app so we can use it to run our app and check for any improvement. It is more flexible to bring anywhere. VR setis also very easy to use and easy to access.

3.8 PRODUCT TESTING / FUNCTIONALITY

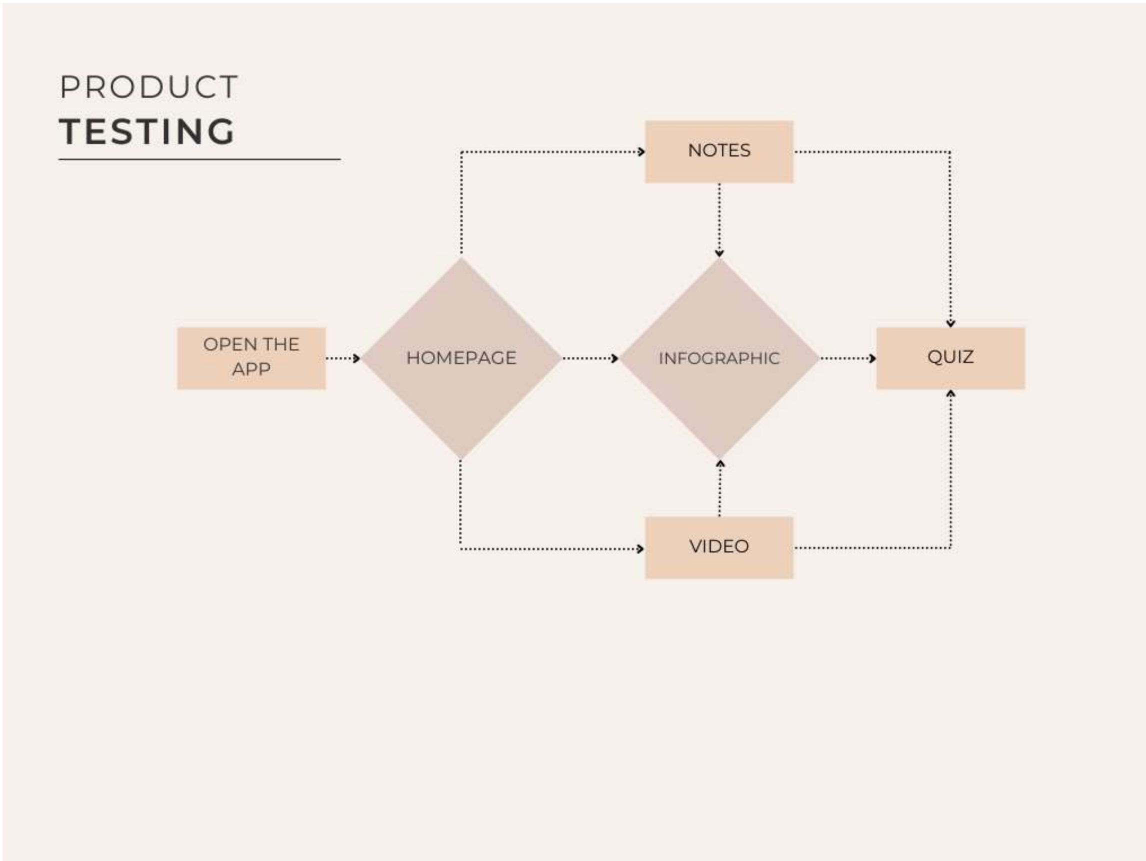


Figure 3.23 : Product testing

3.9 LIST OF MATERIALS & EXPENDITURES

	Items	Unit	Price/Unit	Total
1.	UNITY package (student)	1	RM 0.00	RM 0.00
2.	Canva	1	RM 0.00	RM 0.00
3.	Cidos	1	RM 0.00	RM 0.00
4.	Word	1	RM 0.00	RM 0.00
5.	TV (POLYTECNIC asset)	1	RM 0.00	RM 0.00
6.	VR set (POLYTECNIC asset)	1	RM 0.00	RM 0.00
7.	Sketchfab	1	RM 785.00	RM 785.00
Total				RM 785.00

Table 3.4 : List of material & expenditures

CHAPTER 4

RESULT AND DISCUSSION

4.1 PRODUCT DISCRIPTION

4.1.1 General Product Features and Functionalities

Our commitment to transforming the way Politeknik Banting students explore and comprehend crucial flight instruments is at the core of the Virtual Reality Flight Instrument project. Students can completely immerse themselves in a Cessna 172N Skyhawk cockpit with a dynamic, interactive virtual reality experience. The software has two modes: "Quiz" to test users' knowledge and encourage learning, and "Explore" to allow users to explore the aircraft, sit in the pilot's seat, and receive comprehensive explanations and tutorials for each of the six fundamental flight instruments. Our goal is to provide a contemporary approach to experiential learning by making the study of aviation instruments both approachable and interesting.

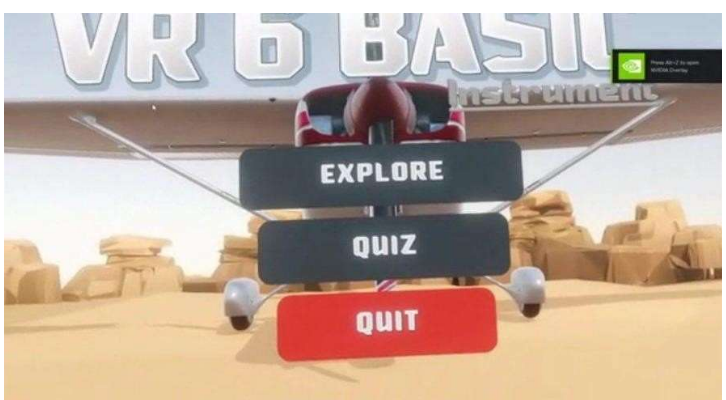


Figure 4.1 : App Home Screen

4.1.2 Specific Part Features

4.1.2.1 Product Structure

Key elements of the Virtual Reality Flight Instrument (VRFI) program are intended to improve aviation students' educational experiences. The software's primary component, an immersive 3D replicating of a Cessna 172N Skyhawk cockpit, connects theoretical research with practical uses. Complex subjects are made easier to understand through interactive components, video lectures, and clear explanations. Students can evaluate their knowledge at any moment thanks to the integrated quizzes, which offer a thorough and practical learning experience.

1) Explanation

We offer easily understandable explanations that are suited to different learning styles to improve the VRFI application's usability. Each flight instrument's extensive yet straightforward explanations are readily available to students, allowing them to examine crucial information whenever they need to, whether for brief recaps or in-depth research.

2) Video Explanation

Video tutorials integrated into the VRFI program give aviation students a dynamic and exciting approach to comprehending difficult ideas. By providing thorough explanations of every flight instrument, these clips enhance the interactive and visually instructive nature of the learning process and help students understand technical content more naturally.

3) 3D Model

Students can examine the Cessna 172N Skyhawk's flight instruments in depth due to the VRFI software's 3D model function, which immerses them in a realistic virtual cockpit. By simulating a cockpit setting, this interactive representation improves comprehension and aids students in grasping both the basic ideas and the specifics of each instrument.

4) Quiz

There are several benefits to the VRFI application's quiz feature, which was created especially for aviation students. Through quizzes, students may assess their comprehension, solidify their knowledge, and get immediate feedback. Students gain the ability to take to manage their educational path in learning flight instruments due to these self-assessment tools, which promote active involvement.

4.1.2.2 Product Mechanisms

1) Real-Time Knowledge Checkpoints

Real-time "knowledge checkpoints" might be incorporated into the VRFI app's exploring mode. These checkpoints challenge students' learning in the moment by posing context-sensitive questions or mini-quizzes while they engage with various flying instruments. This makes the content feel immediate and relevant while promoting active learning and aiding in knowledge boost in real time.

2) Adaptive Learning Paths

The VRFI app might include guided walkthroughs in addition to free exploration, in which students are led step-by-step through the roles and functions of each instrument in flight operations by virtual instructors or interactive prompts. For inexperienced who are still establishing their core knowledge, this method can be particularly helpful as it blends a structured learning path with practical involvement.

3) Guided Interactive Walkthroughs

Flexible learning pathways that change according to quiz results and user interactions may be included in the VRFI app. For example, the app might offer more materials, clarifications, or practice relevant to the altimeter if a student finds it difficult to use. By preparing the experience to each student's unique learning demands, this adaptive approach enhances retention.

4) Immersive Feedback System

By associating the quiz answers with particular areas of the 3D cockpit, an immersive feedback system could improve the quiz experience. An explanation and a visual representation of the right response might be provided by the app if a student answers a question incorrectly by zooming in on the important instrument in the virtual cockpit. By connecting information to visual cues, the distribution between the quiz's content and the virtual cockpit layout aids in memory reinforcement.

4.1.2.3 Software/Programming

To provide an innovative, engaging, and immersive experience for students, the VRFI app utilizes cutting-edge technologies that prioritize ease of use, deep learning integration, and an adaptable platform. The app is designed to be user-friendly, allowing students to learn in a dynamic and interactive environment. With a focus on enhancing the learning experience, the VRFI app combines immersive features with intuitive interactions, making it easier for students to understand complex flight concepts.

A key feature of the app is its **Immersive User Interface (UI)**, which is designed to feel like an extension of the virtual cockpit. This interface replicates real-world flight dynamics, allowing students to interact naturally with flight instruments. Using gestures, students can manipulate the instruments, and the app provides real-time feedback through audio-visual cues. Visual elements such as changing colors or highlighted instruments enhance the learning process by offering clear feedback, making it more intuitive and reinforcing the connection between actions and outcomes.

The core of the VRFI app lies in its **3D simulation of the Cessna 172N cockpit and aircraft interior**. This simulation provides students with a detailed and immersive environment to explore, unlike generic flight simulators. The focus on the **Cessna 172N**, a widely used light aircraft, ensures that students are learning in a context that is relevant and practical. By interacting with the cockpit and instruments, students can better understand how each component operates and how they influence flight dynamics.

In addition to the cockpit, the app allows students to explore the **aircraft's interior**, including elements like seating, windows, and the layout of the aircraft. This comprehensive view of the Cessna 172N helps students gain a deeper understanding of the aircraft environment. Students can visualize and familiarize themselves with the real-world setting they would encounter during a flight, making the learning experience more realistic and immersive, and providing a holistic view of the aircraft beyond the cockpit alone.

4.1.2.4 Accessories and Finishing

The VRFI app is designed to offer a seamless, professional, and immersive learning experience with attention to both function and aesthetic detail. To complement the core features and enhance usability, a range of **accessories and finishing touches** have been integrated into the app, ensuring that the virtual environment is not only educational but also visually appealing and engaging.

1. **Customizable Cockpit Environment**

   The virtual cockpit allows users to customize certain aspects of their environment, such as the lighting and weather conditions, providing an added layer of realism. Students can adjust lighting to simulate different times of day or weather scenarios, enhancing their understanding of how environmental factors affect flight operations. This level of customization ensures that learners experience various flight conditions and scenarios in an interactive and dynamic way.

2. **High-Quality Visuals and Textures**

   To ensure a visually immersive experience, the app includes high-resolution textures and detailed models of the aircraft interior and cockpit. Every component, from the flight instruments to the cockpit seats and controls, is meticulously crafted to replicate the real-world Cessna 172N. The detailed textures and accurate visual representation of the aircraft create a lifelike and engaging atmosphere that aids in the learning process by making the virtual environment as realistic as possible.

3. **Ergonomic Interface Design**

   The user interface is designed with ergonomic principles in mind, ensuring that interactions feel natural and intuitive. Buttons, sliders, and gestures are optimized for ease of use, making navigation through the app simple and fluid. This thoughtful design eliminates confusion and allows students to focus entirely on learning, while the layout ensures a clear, organized, and visually appealing experience.

4. **Interactive Audio Feedback**

   In addition to the visual cues, the app includes **interactive audio feedback** to further enhance the learning experience. Sound effects such as engine noise, instrument alerts, and cockpit sounds create an immersive atmosphere that replicates real-world flight. Audio cues are also used to guide students when interacting with different instruments, providing further assistance in learning the functionality of the cockpit instruments and adding to the overall realism of the app.

These accessories and finishing touches work together to provide a rich, engaging, and realistic learning experience, ensuring that students have access to both the essential tools and the immersive details needed to succeed in mastering the operation of flight instruments.

4.1.3 General Operation of The Product

The general operation of the VRFI app is designed to provide students with an intuitive and immersive learning experience, seamlessly integrating theoretical knowledge with practical application. Upon launching, users are presented with an interactive menu offering two primary modes: Explore and Quiz. In Explore mode, students can navigate the 3D virtual environment of the Cessna 172N cockpit and interior, interact with the flight instruments, and view tutorial videos explaining their functions. This hands-on exploration allows students to manipulate instruments like the altimeter, heading indicator, and attitude indicator, observing the effects in real time. In Quiz mode, users test their knowledge with multiple-choice and interactive questions based on the six primary flight instruments, receiving immediate feedback on their performance. The app also tracks user progress, providing analytics that summarize quiz scores, interaction times, and areas of focus, allowing students to assess their learning and track improvement. This integrated system of interactive exploration, self-assessment, and progress monitoring ensures a comprehensive and flexible learning experience for students, reinforcing their understanding of flight instruments and the operation of the Cessna 172N cockpit.

4.1.4 Operation of The Specific Parts of The Product

4.1.4.1 Product Structure

The product structure includes both physical and digital components that form the foundation of the VRFI application. On the hardware side, the system requires a VR headset, controllers, and a compatible computer to run the software smoothly. These devices are selected to ensure compatibility and provide users with a responsive and comfortable VR experience. The VR headset offers an immersive view, while the controllers or hand-tracking devices allow interaction with the virtual environment.

On the digital side, the software is divided into four main sections: the menu interface, cockpit simulation, quiz section, and learning tools (explanations, videos, and 3D models). Each section is designed to serve a specific purpose and is interconnected for seamless navigation. The menu serves as the entry point, allowing users to access different features. The cockpit simulation recreates the instrument panel of a Cessna 172N, the quiz tests users' knowledge, and the learning tools provide detailed explanations and visual demonstrations. Together, these components form a structured, user-friendly system.

4.1.4.2 Product Mechanisms

The product mechanisms describe how each feature of the VRFI application functions. The menu system operates by placing users in a virtual space where they can select options such as “Start Simulation,” “Learn Instruments,” and “Take Quiz.” Interaction is achieved through head tracking or controller inputs, making navigation intuitive and efficient.

The cockpit simulation is programmed to allow users to interact with flight instruments. For example, users can adjust controls to simulate changing altitude, speed, or heading. Each action produces a realistic response, such as the artificial horizon tilting or the altimeter needle moving. These mechanisms are designed to give users a practical understanding of how the instruments work in real flight situations.

The quiz section operates by presenting users with multiple-choice or situational questions. Each question is linked to specific flight instruments or scenarios, testing the user’s knowledge and understanding. Immediate feedback is provided for each answer, with explanations for both correct and incorrect responses, helping users learn from their mistakes.

The learning features, including explanations and videos, are triggered through interactive elements within the app. For example, clicking on an instrument in the cockpit brings up a text-based description or a video demonstration, ensuring users can learn about each instrument in detail [17] .

4.1.4.3 Software / Programming

The software development for the VRFI application uses Unity 3D as the primary development platform, with C# scripting for functionality. Each feature is programmed to respond to user inputs in real-time, ensuring smooth interaction. For example, scripts are written to detect user actions, such as selecting an option in the menu or interacting with an instrument, and trigger the appropriate response.

To integrate VR hardware, the application uses software development kits (SDKs) such as Oculus SDK or OpenXR, which enable features like head tracking, hand tracking, and spatial awareness. These integrations ensure that the user's movements and actions are accurately reflected in the virtual environment.

Data handling is a critical aspect of the software. Scripts manage the flow of information, such as tracking user progress in the quiz or saving their preferences in the menu. The app is also optimized to reduce latency and maintain high frame rates, ensuring an immersive and comfortable VR experience without motion sickness or lag.

4.1.4.4 Accessories & Finishing

Accessories and finishing focus on enhancing the usability and aesthetics of the VRFI application. Optional accessories such as hand-tracking gloves or replica flight controls (joystick, throttle) can be integrated to provide a more realistic experience. These accessories help users feel like they are interacting with an actual cockpit, improving the sense of immersion.

The visual design of the application is polished with high-quality textures, realistic lighting, and smooth animations. Each instrument in the cockpit is labeled clearly, with accurate placement and dimensions to mimic the layout of a real Cessna 172N cockpit. This attention to detail ensures that users can easily identify and interact with each component.

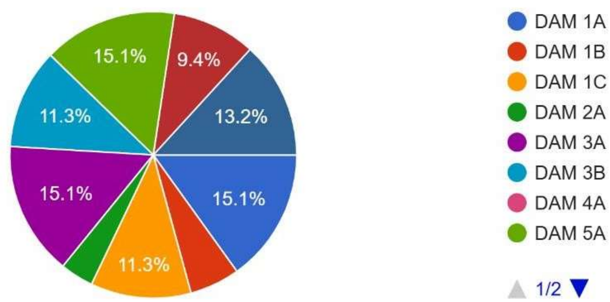
User comfort is also prioritized in the finishing stage. The menu interface is designed to be accessible, with options placed within easy reach. The overall environment is tested multiple times to ensure smooth transitions between features, bug-free interactions, and an engaging user experience. These refinements ensure the final product meets educational goals while delivering a professional and polished VR application.

4.2 PRODUCT OUTPUT ANALYSIS

4.2.1 Survey Questions

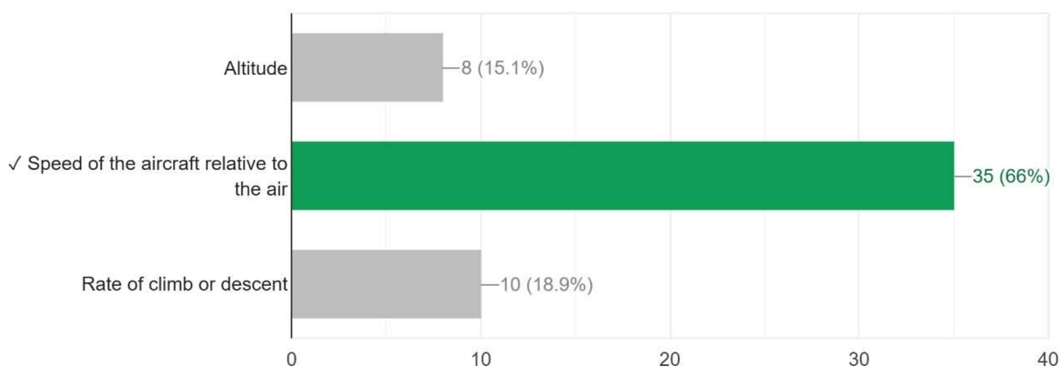
Class

53 responses



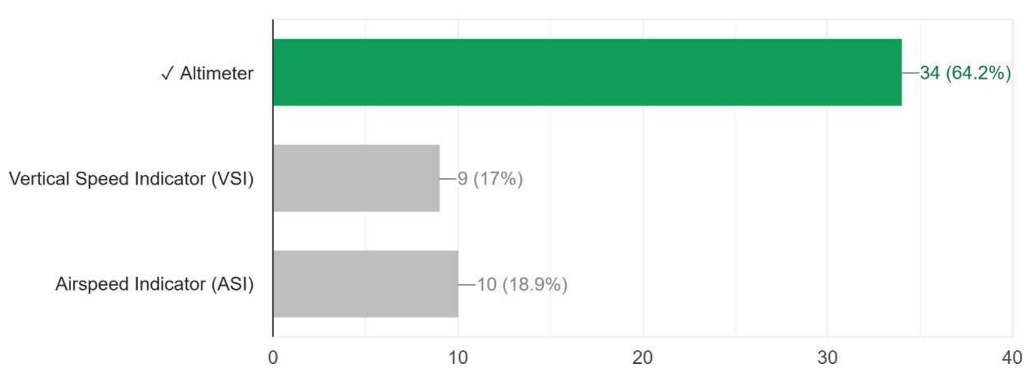
1. What does the Airspeed Indicator (ASI) measure?

35 / 53 correct responses



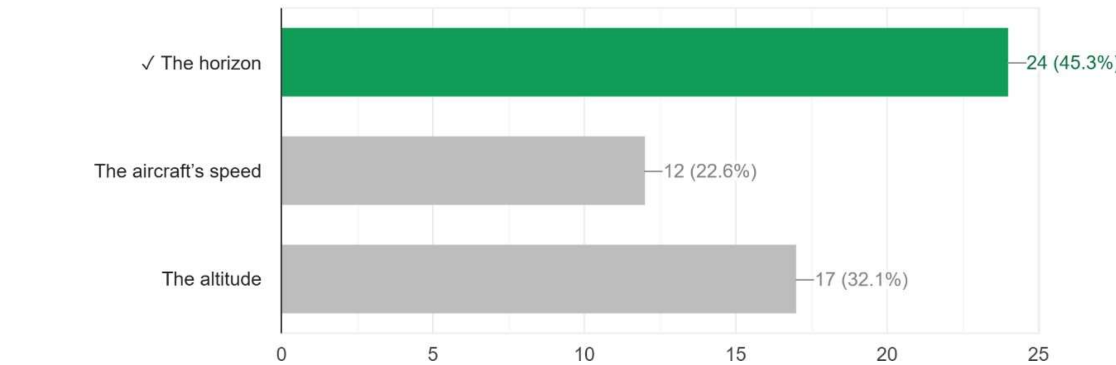
2. Which instrument displays the aircraft's altitude?

34 / 53 correct responses



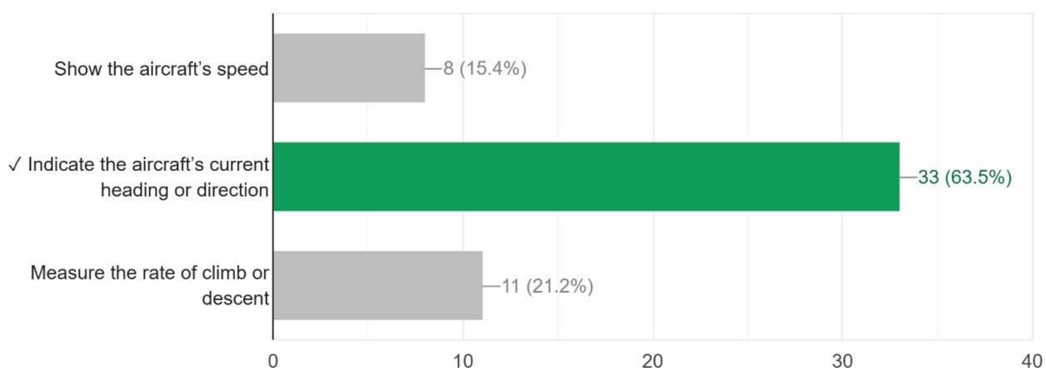
3. The Attitude Indicator shows the aircraft's position relative to which reference?

24 / 53 correct responses



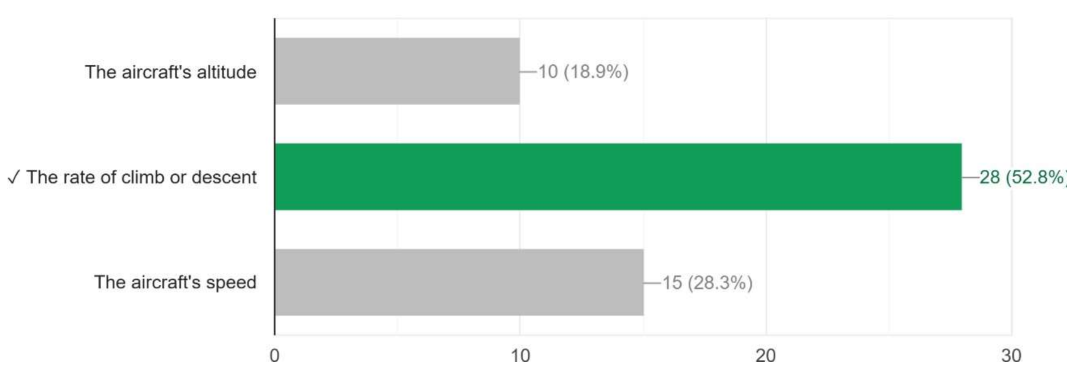
4. What is the primary function of the Heading Indicator?

33 / 52 correct responses



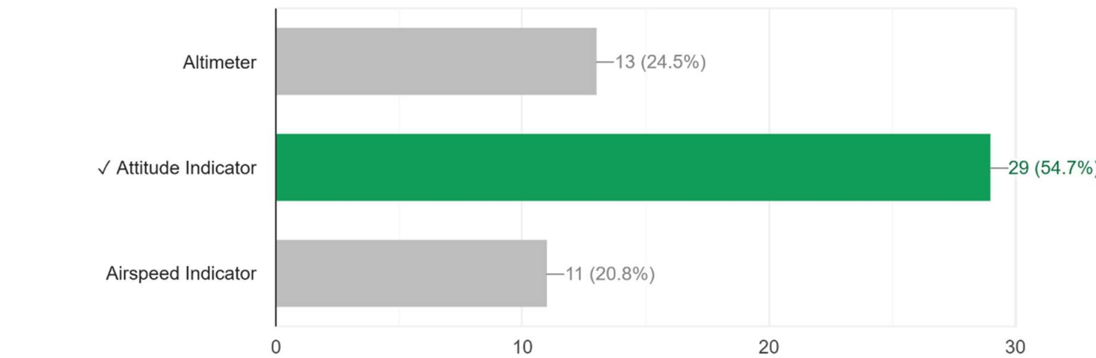
5. The Vertical Speed Indicator (VSI) shows what information?

28 / 53 correct responses



6. Which flight instrument is often referred to as the "artificial horizon"?

29 / 53 correct responses

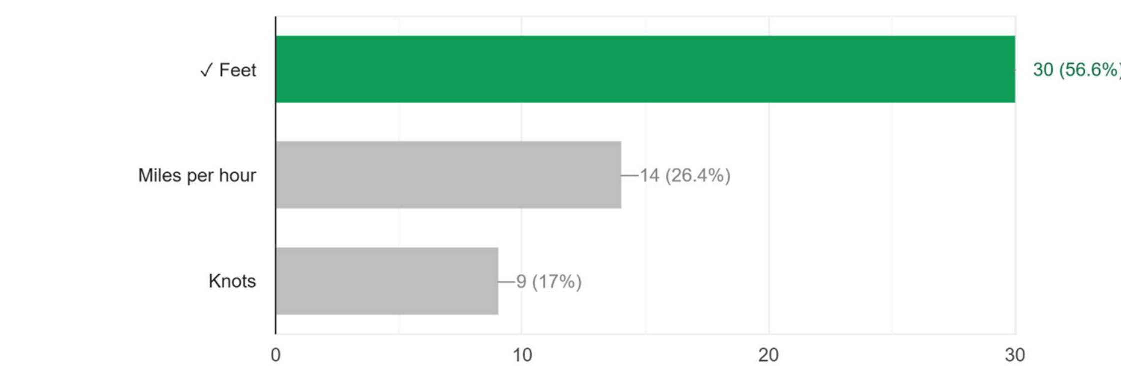


7. What does the Heading Indicator help a pilot to maintain?

20 / 53 correct responses

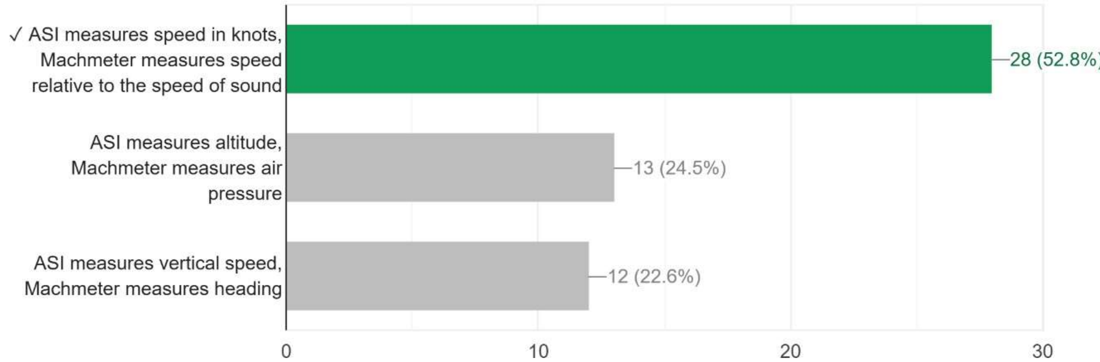
8. What unit is typically used to measure the altitude on an Altimeter?

30 / 53 correct responses



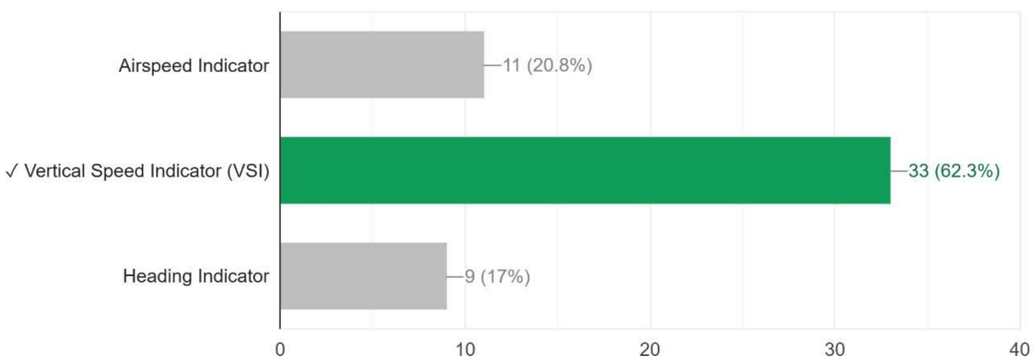
9. How does the Airspeed Indicator (ASI) differ from the Machmeter?

28 / 53 correct responses

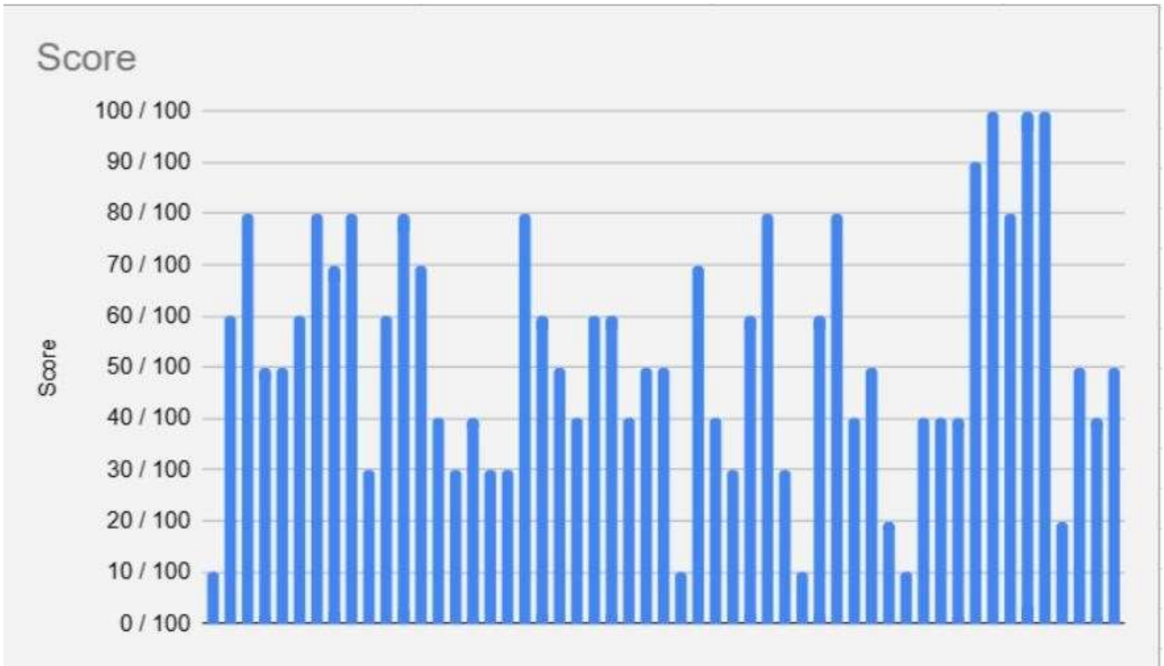


10. Which instrument provides information on how fast the aircraft is climbing or descending?

33 / 53 correct responses



4.2.2 Pre-Test Survey Mean Mark



The **pre-test** was administered before students used the VRFI app to gauge their baseline knowledge of flight instruments in the Cessna 172N. The pre-test questions, identical to those found in the VRFI app's quiz section, covered identification, function, interpretation, and application of flight instruments. The mean score of **52%** reflects a moderate understanding among students, revealing several common areas where knowledge was lacking. For example, many students struggled with interpreting complex instruments like the attitude indicator and turn coordinator. Furthermore, questions related to instrument limitations and combined readings were particularly challenging, highlighting gaps in both theoretical and applied knowledge. This initial assessment indicated a clear need for instructional tools that go beyond traditional learning to improve comprehension and retention.

4.2.2 Post-Test Survey Mean

After engaging with the VRFI app, students completed the **post-test**, which assessed the same set of questions. The mean score increased significantly to **94%**, showcasing an impressive improvement in understanding. The VRFI app's immersive 3D models, interactive explanations, and audio-visual guides likely contributed to this enhanced comprehension. The increase in scores suggests that students not only improved their ability to identify and interpret each instrument but also gained a deeper understanding of how these instruments function in real flight scenarios. Notably, questions on interpreting combined instrument readings and understanding instrument limitations saw the most significant improvements, demonstrating the app's effectiveness in bridging theory and practice.

4.3 EVALUATING THE IMPACT OF VRFI APP ON FLIGHT INSTRUMENT KNOWLEDGE: A PRE-TEST AND POST-TEST ANALYSIS

The analysis of the 10-question survey conducted as pre-test and post-test assessments shows significant improvement in user understanding of flight instruments. The questions in this survey are identical to those in the quiz section of the VRFI app, designed to assess students' knowledge of the six primary flight instruments and their functions. Before interacting with the VRFI project, students completed the pre-test, which provided a baseline measure of their initial understanding of these instruments.

The pre-test results yielded a mean score of 52%, indicating a moderate level of familiarity with the subject matter among participants. This score reflects that, while some students had foundational knowledge of flight instruments, there were considerable gaps in their understanding of the specifics related to the Cessna 172N cockpit layout and instrument functions. The pre-test results suggest that most students would benefit from additional instruction, especially in areas requiring a deeper understanding of instrument operation and flight dynamics.

After completing the VRFI project, students took the post-test, which consisted of the same set of questions. The post-test mean score rose dramatically to 94%, demonstrating a substantial increase in comprehension and retention. This improvement reflects the effectiveness of the VRFI app in enhancing students' understanding, as they could interact directly with 3D models, access detailed explanations, and view video tutorials within the virtual environment. These immersive tools appear to have played a crucial role in bridging knowledge gaps identified in the pre-test.

The results of this analysis reveal the VRFI project's strong impact on learning outcomes. The 42% increase from the pre-test to the post-test mean score indicates that the VRFI app successfully provided students with a deeper and more accurate understanding of flight instruments. This notable improvement underscores the effectiveness of interactive, immersive learning tools in aviation education and highlights the VRFI app as a valuable resource for mastering flight instrument concepts.

4.3.1 Product Structure

The aim of the VR Flight Instrument (VRFI) project's product structure is to produce an ergonomic, durable, and realistic design that aviation students may use frequently. The product's structure, which was designed to achieve a balance between comfort and strength, guarantees that students can participate completely in the virtual reality experience in a realistic environment. Material selection, modular design, and user comfort are all critical factors considered in the structural design of the VRFI.

1. Material Selection

The VRFI product structure is designed with lightweight yet robust materials that can endure regular use. Options like ABS plastic or carbon fiber are selected for their durability and comfort, helping to minimize user fatigue during long sessions while ensuring the VR system remains resilient and reliable.

2. Modular Design

The modular design of the VRFI structure facilitates easy maintenance and component replacement, reducing downtime. By allowing individual parts to be swapped out, the VRFI system guarantees consistent functionality and cost-effectiveness, enabling both students and instructors to utilize the product without interruptions.

3. User Comfort

To improve user comfort, the VRFI structure incorporates ergonomic designs tailored for extended use. A strong emphasis on physical ergonomics ensures that aviation students can interact with the VR controls and components comfortably for longer periods, enhancing their overall learning experience.

4.3.2 Product Mechanism

The VRFI's product mechanisms aim to provide an interesting, realistic experience with flight instruments, with a focus on tactile feedback and control precision. Ensuring smooth, accurate reactions from dials, switches, and levers is critical for establishing an authentic cockpit experience that improves practical learning for aviation students.

1. Haptic Feedback

Integrating haptic feedback into the VRFI boosts the realism of virtual flight controls by mimicking the resistance and weight of actual cockpit instruments. This feature allows students to feel the physical dynamics of each control, enhancing their understanding and muscle memory related to real-world flight operations.

2. Precision Controls

The VRFI incorporates high-quality components like potentiometers and encoders to guarantee smooth and precise control movements. These mechanisms enable students to make accurate adjustments to the instruments, which are reflected accurately in the VR environment, promoting a more practical and skill-focused learning experience.

3. Calibration Consistency

Consistent calibration of VRFI controls is crucial to ensure that movements in the physical world correspond perfectly with actions in the virtual environment. This calibration consistency is vital for immersive training, enabling students to interact naturally and accurately with virtual flight instruments, thereby building confidence in their skills.

4.3.3 Software/Programming

VRFI's software development focusses on creating a stable, responsive virtual environment that closely resembles real-world flight instruments. The software must run smoothly, manage real-time interactions, and provide a visually engaging experience for aviation training.

1. Real-Time Responsiveness

The VRFI software is designed for real-time responsiveness, ensuring that any input from physical controls is immediately reflected in the VR environment. By utilizing high-performance VR engines like Unity, the system provides a responsive and immersive experience for students, enhancing their interaction with virtual instruments.

2. Performance Optimization

To prevent lag or performance issues in the VRFI, various optimization techniques, such as level of detail (LOD) adjustments and optimized shaders, are implemented. These methods help maintain frame rates and visual clarity, ensuring that the VR environment remains stable and engaging for students learning about flight instruments.

3. Continuous Testing

Ongoing testing of the VRFI software under various conditions guarantees stability and responsiveness. This testing process allows developers to identify and fix any inconsistencies or bugs, resulting in a reliable learning platform that students can depend on for accurate and immersive training experiences.

4.3.4 Accessories & Finishing

The accessories and finishing of the VRFI enhance usability, immersion, and comfort. Accessories like VR controllers need to be intuitive and seamless, while the finishing of the system contributes to a professional, realistic appearance that supports the VRFI's educational objectives.

1. Accessory Integration

VR controllers are selected for their ergonomic, wireless designs, allowing students to engage with flight instruments without bulky attachments. These accessories ensure seamless compatibility with the VRFI, providing students with an intuitive and immersive way to manage virtual controls in the cockpit setting.

2. Battery Life and Charging

The accessories are crafted with extended battery life and rapid charging capabilities, guaranteeing that both students and instructors can enjoy uninterrupted sessions. The wireless design minimizes clutter, while dependable power options improve the usability and accessibility of the VRFI system during practical training sessions.

3. Finishing and Realism

Top-quality materials and lifelike textures are utilized in the finishing of the VRFI to elevate its professional appearance and feel. Anti-glare and matte coatings enhance visual clarity, while realistic instrument labels and soft-touch surfaces contribute to a refined, immersive experience that feels genuine for aviation training.

CHAPTER 5

CONCLUSION AND RECCOMENDATION

5.1 ACHIEVEMENT OF AIM & OBJECTIVES OF THE RESEARCH

5.1.1 General Achievements of the Project

- **Enhanced Learning Experience**: The VR flight instrument project offers an immersive learning environment for aviation students, allowing them to explore and interact with flight instruments in a realistic, hands-on manner. This provides an advantage over traditional learning methods by facilitating practical, interactive experience.

- **Improved Knowledge Retention**: By simulating real-world scenarios, students can learn the functions and purposes of each flight instrument more effectively. This interactive experience is shown to improve knowledge retention and understanding, helping future aircraft engineers gain a more comprehensive grasp of instrument operations.

- **Accessible Training Tool**: The VR application makes complex flight instruments accessible without the need for costly hardware or real aircraft. Students can repeatedly practice and familiarize themselves with instruments without risks, creating a safer learning environment.

5.1.2 Specific Achievement of Project Objectives

5.1.2.1 Product Structure

VRFI is successfully designed a realistic virtual cockpit environment that mirrors actual flight instruments used in aircraft. Achieved accurate scaling and positioning of virtual instruments within the VR environment to maintain realism and user engagement. The structure accommodates multiple instruments, enhancing the educational potential of the simulation. Created an accessible, navigable VR space that gives users a spatially accurate sense of an aircraft's instrument panel.

5.1.2.2 Product Mechanisms

Implemented interactive mechanisms that allow users to operate and manipulate various flight instruments as they would in a real cockpit. Developed functionalities like dial rotations, button presses, and switch toggling, simulating real-life instrument behavior to reinforce hands-on learning. Provided a dynamic, hands-on learning experience where users can see real-time responses of the instruments, such as altitude adjustments or speed indicators, based on simulated input.

5.1.2.3 Software and Programming

Developed software using Unity creating a stable and responsive VR application. Programmed accurate animations and data representations for various instruments, like the altimeter and airspeed indicator, ensuring each function as expected in real-world scenarios. Created a reliable software system that delivers an immersive VR experience with minimal latency, enhancing user immersion and accuracy in understanding instrument functions.

5.1.1.1 Accessories and Finishing

Completed the project with accessories and finishing touches that add realism and polish to the VR experience. Integrated additional elements like realistic textures, sound effects, and lighting within the virtual cockpit, contributing to an immersive, professional feel. Delivered a complete and refined VR product that aligns visually and functionally with the real-world environment of an aircraft cockpit, creating a seamless learning tool for students.

5.2 CONTRIBUTION OR IMPACT OF THE PROJECT

VRFI brings a cutting-edge virtual simulation of flight instruments directly to aviation training schools, giving students access to an immersive, interactive environment that enhances traditional learning methods. With VRFI, aviation schools can offer hands-on training without needing expensive, physical aircraft or simulators. This virtual setup supports effective learning for students, regardless of an institution's budget or access to real aircraft, making high-quality training more achievable across a range of schools.

Second, VRFI enables aviation training schools to incorporate advanced instrument training without investing heavily in physical simulators or aircraft, thereby reducing costs and making quality training more widely accessible. Schools can offer enhanced learning experiences even in regions with limited access to training aircraft or simulators, helping bridge the gap in educational resources. This affordability allows smaller training schools to remain competitive and deliver professional-grade training to their students.

Lastly, The VRFI system's interactive experience facilitates deep learning by allowing students to engage with instrument operations and scenarios in a controlled, immersive setting. Students at aviation training schools can practice and repeat tasks to improve proficiency, increasing knowledge retention and skill levels. This prepares students to transition smoothly into real-world environments, giving aviation training schools a reputation for producing skilled, job-ready graduates.

5.3 IMPROVEMENT AND SUGGESTIONS FOR FUTURE RESEARCH

5.3.1 Product Structure

Enhance the virtual environment to simulate a broader range of aircraft models and cockpit layouts. This could allow users to gain experience with different instrument panel configurations, improving their adaptability. Investigate how the accuracy of spatial dimensions and ergonomic positioning impacts user immersion and learning outcomes. This research could lead to insights on optimizing the VR environment for different types of aircraft, including commercial and military variants.

5.3.2 Product Mechanisms

Expand the range of interactive features to include more advanced instrument behaviors, such as response to simulated weather changes, turbulence, and other environmental conditions. Explore ways to simulate complex instrument behaviors, such as multi-step processes and system malfunctions. Research could also focus on developing haptic feedback for more realistictactile experiences when interacting with virtual instruments, enhancing hands-on engagement.

5.3.3 Software and Programming

Optimize the VR software for multi-platform compatibility, ensuring that VRFI can run smoothly on various VR headsets and computer systems. This would make the product more accessible to a wider audience of training schools and users. Study the potential of integrating artificial intelligence (AI) to create adaptive learning paths based on user performance. Additionally, research could focus on improving real-time graphics rendering and reducing latency to provide a more seamless user experience.

5.3.4 Accessories and Finishing

Add finishing touches that increase immersion, such as ambient cockpit sounds, environmental lighting adjustments, and realistic textures for all instruments and surfaces. Investigate the impact of these finishing elements on user focus, learning speed, and retention. Research could also consider user feedback on visual and audio enhancements to determine the most effective sensory elements for VR-based learning.

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DEPARTMENT OF AIRCRAFT MAINTENANCE

APPENDIX A: DECLARATION OF TASK SEGREGATION

SUB-CHAPTERS	DESCRIPTION
AHMAD NAQIB BIN MOHD ZAIDI	
1.3.1	General Project Objectives
1.3.2.1	Product Hardware
1.5	Project Impact
2.1.2	Demand Of E-Learning
2.2.1	Product structure
2.2.4	Accessories & Finishing
2.3.3	Recent Product
3.2.1.1	Function Tree
3.2.1.3	Proposed Design Concept 1
3.2.2.1.1	Pugh Matrix: Concept 1 As A Datum
3.2.3.1	Cockpit layout Cessna 172
3.4.1	Overall Project Flow Chart
3.4.2.3	Challenges
3.6.1	Prototype/ Product Modelling
3.6.2	Prototype Development
3.7	Development of Product
4.1.1	General Product Features and Functionalities
4.1.2.1	Product Structure
4.1.4.1	Product Structure
4.3.1	Product Structure
5.1.1	General Achievements of The Project
5.1.2.1	Product Structure
5.3.1	Product Structure

MUHAMMAD HARRAZ BIN OTHMAN	
1.3	Project Objective
1.3.2.2	Product Mechanisms
2.1.3	Type Of E-Learning App in Aviation Industry
2.2.2	Product Mechanism
2.3.1	Related Product
3.2.1.2	Morphological Matrix
3.2.1.5	Proposed Design Concept 3
3.2.1.7	Proposed Final Concept
3.2.2.1.3	Concept 3 As A Datum
3.2.3.1	Interface
3.31	General Product Features & Functionalities
3.4.2.2	Tutorial/ Practice
3.7.2	Machines And Tools
4.1.2.2	Product Mechanism
4.1.3	General Operation of The Product
4.1.4.2	Video Explanation
4.2.2	Pre-test Survey Mean
4.3	Evaluating The Impact of VRFI App On Flight Instrument Knowledge: A Pre-test And Post-test Analysis
4.3.2	Product Mechanism
5.1.2.2	Product Mechanism
5.2	Contribution or Impact of The Project
5.3.2	Product Mechanism

AZIZUL FITRI BIN ROSLAN	
1.1	Background Of Study
1.2	Problem Statement
1.3.2.3	Software / Programming
1.4	Scope Of Project
2.1.1	Aviation Industry in Malaysia
2.1.5	App specification
2.2.3	Software / Programming
2.3.2	Recent market Product
3.2.1.4	Proposed Design Concept 2
3.2.2.1.2	Pugh Matrix: Concept 2 As A Datum
3.2.3.3	Pop Up Information
3.4.2.4	Conclusion
3.9	List of Materials and Expenditures
4.1.2.3	Software / Programming
4.1.4.1	Explanation
4.1.4.3	3D Model
4.2.1	Survey Question
4.2.2	Post-test Survey Mean
4.3.3	Software / Programming
5.1.2.3	Software / Programming
5.3.3	Software / Programming

NUR ALYAA MAISARAH BINTI JASNI	
1.3	Objective Project
1.3.2.4	Accessories & Finishing
2.1.4	Evaluation Of Digital Learning in Aviation Industry
2.2.4	Accessories & Finishing
2.3.4	Recent Advancements in Virtual Reality Technology
3.2.1.6	Proposed Design Concept 4
3.2.2.1.4	Pugh Matrix: Concept 4 As A Datum
3.2.3.4	Quizzes Section
3.4.1	Overall Flow Chart
3.4.2.1	Introduction
3.5	Overall Project Gantt Chart
3.8	Product Testing/Functionality
4.1.2.4	Accessories And Finishing
4.1.4.4	Quiz
4.3.4	Accessories & Finishing
5.1.2.4	Accessories & Finishing
5.3.4	Accessories & Finishing

APPENDIX B: SUMMARY OF SIMILARITY REPORT (Turnitin)

FINAL THESIS VRFI.pdf

ORIGINALITY REPORT

7%	3%	2%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Jabatan Pendidikan Politeknik Dan Kolej Komuniti Student Paper	3%
2	www.coursehero.com Internet Source	<1%
3	Yaser Mohammed Al-Worafi. "Handbook of Complementary, Alternative, and Integrative Medicine - Education, Practice, and Research, Volume 1: Education, Training, Assessment, and Accreditation", CRC Press, 2024 Publication	<1%
4	"Extended Reality", Springer Science and Business Media LLC, 2024 Publication	<1%
5	Submitted to Taylor's Education Group Student Paper	<1%
6	Hazell, Lynne Janette. "A Study to Assess the Ability of Radiographers to Apply Pattern Recognition Criteria and Interpret Radiographs", University of Johannesburg (South Africa), 2021	<1%

Publication

7	ir.canterbury.ac.nz Internet Source	<1 %
8	Submitted to Solihull College, West Midlands Student Paper	<1 %
9	Submitted to Universiti Teknikal Malaysia Melaka Student Paper	<1 %
10	José Llanes Jurado. "Affective computing framework for social emotion elicitation and recognition using artificial intelligence", Universitat Politecnica de Valencia, 2024 Publication	<1 %
11	Andreas Marougkas, Christos Troussas, Akrivi Krouska, Cleo Sgouropoulou. "How personalized and effective is immersive virtual reality in education? A systematic literature review for the last decade", Multimedia Tools and Applications, 2023 Publication	<1 %
12	Submitted to RMIT University Student Paper	<1 %
13	Dennis Vincenzi, Mustapha Mouloua, P. A. Hancock, James A. Pharmer, James C. Ferraro. "Human Factors in Simulation and Training - Theory and Methods", CRC Press, 2023 Publication	<1 %

14	Submitted to Embry Riddle Aeronautical University Student Paper	<1%
15	Submitted to Florida Institute of Technology Student Paper	<1%
16	umpir.ump.edu.my Internet Source	<1%
17	Submitted to Curtin University of Technology Student Paper	<1%
18	www.etas.com Internet Source	<1%
19	Submitted to Aviation Management College Student Paper	<1%
20	Submitted to Republic Polytechnic Student Paper	<1%
21	Prana Ugiana Gio. "Repeated-Measures ANOVA and Friedman Test Using SPSS and STATCAL", INA-Rxiv, 2019 Publication	<1%
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APPENDIX C: RESEARCH OF VIRTUAL REALITY-BASED LEARNING APPS

I.S.S.N.: 1138-2783

A Review of Virtual Reality-Based Language Learning Apps

(Una revisión de apps de realidad virtual para el aprendizaje de idiomas)

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Salvador Reyes-Sánchez
Universidad de Cádiz, UCA (España)

DOI: http://dx.doi.org/10.5944/ried.24.1.27486

How to reference this article:
Berns, A., & Reyes-Sánchez, S. (2021). A Review of Virtual Reality-Based Language Learning Apps. *RIED. Revista Iberoamericana de Educación a Distancia, 24*(1), pp. 159-177. doi: http://dx.doi.org/10.5944/ried.24.1.27486

Abstract

Research in the area of mobile-assisted language learning (MALL) has shown that the use of mobile devices such as smartphones may offer multiple opportunities for supporting foreign language learning. In addition, the development and increasing accessibility of emerging technologies such as virtual reality (VR) has opened new perspectives in the area of MALL, paving the way for a new research field called virtual reality assisted language learning (VRALL). In this context, the present study aims to identify the trends as well as challenges of VRALL by analyzing the most popular of the currently available VR apps that can be downloaded from commercial platforms such as *Google Play Store* and *App Store*. However, results suggest that most of the retrieved apps are not specifically designed for foreign language learning, although they can be used for such a purpose. Furthermore, very few of the apps explore the real potential of VR, either providing novel teaching and learning approaches and new types of interaction, or offering novel learning scenarios that could allow the learner to experience a greater sense of immersion and thus facilitate the process of language immersion and language acquisition.

Keywords: educational software; language teaching; telecommunications; multimedia system.

Resumen

La investigación en el área del aprendizaje de lenguas asistido por dispositivos móviles (MALL) muestra que el uso de dispositivos móviles como los smartphones ofrecen una gran

APPENDIX D: RESEARCH OF PROGRAMING SOFTWARE

A Study On A Gaming Software As the Virtual Reality Tools

Sing Hong Ting and Shahrol Mohamaddan

Abstract— **Virtual Reality (VR) is becoming a cheap technology with potentially widespread applications in many professions including education, medicine and industry. This kind of technology consists of human-machine interface devices that are used to present multimodal information and sense of virtual world. In engineering, VR commonly used as a toolkits to trains the technician that needs to perform a complex task which can result in dangerous effect such as aircraft piloting ability and handle a radioactive chemical material. However, the practicality of using a gaming software to simulate the 3-dimension VR environment for any training purposes need to be investigate. Through the testing of the hypothesis, the gaming software is justified suitable for VR training purposes. By providing the VR training session for an individual escape from an unacquainted places, that individual can directly recognize the route when they come the real-world.**

Keywords: Virtual Reality (VR), Virtual Environments (VEs), Serious Games (SGs), Gaming Software, Training Tools

I. INTRODUCTION

'Virtual Reality' or sometime also called as 'Virtual Environment' is a technology develop by VPL, an American company during the late 20 century. The word 'Virtual' denoted that something existing in essence or effect though not in actual fact, while the word 'Reality' meant that the state of being actual or real. Most popular definitions of VR make reference to a particular technological system. [1] define that VR, virtual cockpits, and virtual workstations were used to describe specific project. The term VR therefore typically refers to three-dimensional realities implemented with stereo viewing goggles and reality gloves. This definition is insufficient to describe what really VR is because it only refer to the mean that access to the VR. Latest definition of VR by [2] further describe the VR by introducing the concept of presence which focus on human experience rather than technological hardware. In unmediated perception, presence is taken for granted. However, when perception is mediated by a communication technology, human sense is forced to perceive two different environments at once, that is the physical environment in which one is actually present, and the environment presented through the medium. At this point, the sense of this phenomenon can be called as telepresence [3].

A. Previous Research on VR as A Training Tools

[5] investigated the use of gaming software for generating virtual environments (VEs) for evacuation drills (Figure 1). The aim of the research is to determine the human behavior during in emergency situation. They found that the computer game technology supported rapid development of VEs, with one developer building a virtual representation of a university building in three weeks. They tested 12 participants in the VEs in three different scenarios to investigate evacuation time and behavior through a verbal protocol approach and a post-trial questionnaire. The authors concluded that while the time to evacuate followed a similar pattern to that in real life, it was generally longer in the virtual environment. No inferential statistics were provided, however. Time to evacuate was also affected by computer gaming experience, with self-reported experts taking less time to evacuate than non-gamers.

Figure 1: VEs Simulated by using Gaming Software [5].

[7] explores discusses the educational theories explaining why virtual simulations and serious games (SGs) are an important training tool, and finally suggests how to assess their value within an educational context. The tasks being trained span several levels of abstraction, from kinematic and dynamic aspects to domain knowledge training. The evaluation of the trainee at each level of this hierarchy necessitates objective metrics. [6] also argue that after the game has been designed, it needs to be evaluated and study the

APPENDIX E: COMPARISON OF VR EDUCATION AND CONVENTIONAL TEACHING METHOD

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BMC Medical Education

RESEARCH **Open Access**

Comparison of the effectiveness of virtual reality-based education and conventional teaching methods in dental education: a systematic review

Hossain Koolivand[1], Mohammad Mahdi Shooreshi[2], Roya Safari-Faramani[3], Milad Borji[4], Meysam Siyah Mansoory[5], Hedaiat Moradpoor[6*], Masoud Bahrami[7] and Seyyed Mohsen Azizi[8]

Abstract

Background and objectives Virtual reality dental simulators as an educational tool may create specific training conditions for dental students, allowing them to practice dental skills in a safe and controlled condition. This study aimed to investigate the effectiveness of virtual reality-based education in dental education compared to traditional education approaches.

Methods In this systematic review, four databases (PubMed, Scopus, Web of Science, and Science Direct) were searched until 2023 following PRISMA guidelines. The Quality assessment and risk of bias were assessed by the Cochrane Collaboration Tool for RCTs and GRADE, respectively. Inclusion criteria were restricted to randomized or quasi-randomized trials about virtual reality efficacy in dental education. Two authors independently evaluated the data and reviewed the overall risk of bias for all selected studies. Study design, sample size, hardware, onset time of intervention, duration, and number of procedures performed were among the data extracted.

Results From the 703 titles, 48 full texts were chosen for review, yielding 14 articles for final inclusion. The review of these articles indicated the effective role of virtual reality dental simulators in improving students' knowledge and practical skills.

Conclusions Based on our findings, adding haptic technology to virtual reality can improve students' practical skills, hand skills, theoretical knowledge, self-confidence, and learning environment. Although a fair amount of research needs to be done, notably on cost-effectiveness, student satisfaction, and other potentially adverse effects, virtual reality is a growing phenomenon with immense potential.

Keywords Dental education, Virtual reality, Conventional teaching methods, Systematic review

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APPENDIX G: RECOGNITION LETTER FROM OTAIZ SOLUTION

Otaiz.Com

OTAIZ SOLUTION

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herwanotaiz@gmail.com

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To:
Mr. Muhammad Azmin bin Zainal
Politeknik Banitng Selangor,
Persiaran Ilmu, Jalan Sultan Abdul Samad,
42700 Banting, Selangor

20th March 2024

RECOGNITION OF VIRTUAL REALITY OF FLIGHT INSTRUMENT (VRFI)

I hope this message finds you well. On behalf of Otaiz Solution, I am pleased to officially confirm our acceptance of your proposal to collaborate on the Virtual Reality Flight Instruments (VRFI) project.

This project represents a significant step forward in enhancing aviation training by utilizing virtual reality technology to simulate flight instruments. We are excited about the opportunity to apply our expertise and resources to this innovative venture, which not only improves the effectiveness of training but also ensures a higher level of safety and precision in operating flight instruments.

We look forward to working closely with you and are confident that our collaboration will lead to a successful and rewarding outcome. Thank you for presenting us with the opportunity to be part of this groundbreaking initiative.

Thank you,

Regards,

Herwan bin Samsuddin
Director
Otaiz Solution

APPENDIX H: RECOGNITION LETTER FROM ADE

ASIA DIGITAL ENGINEERING

(+60)3-8660 4333
abdulfatah@airasia.com
REDQ, Jalan Pekeliling 5, Kuala Lumpur International Airport, 64000 Sepang, Selangor

To:

Mr. Mohammad Azmin bin Zainal

Politeknik Banting Selangor,
Persiaran Ilmu, Jalan Sultan Abdul Samad,
42700 Banting, Selangor

7th October 2024

CONFIRMATION OF RECOGNITION OF VIRTUAL REALITY OF FLIGHT INSTRUMENT (VRFI)

I hope this letter finds you well. On behalf of Asia Digital Engineering, I would like to express our sincere gratitude for your approval of the project integrating virtual reality (VR) technology into the training of aviation students and trainers.

Your support is crucial as we work to enhance aviation education and skill development through immersive simulations. By allowing students and trainers to engage with realistic VR environments and interact with flight instruments, we foster a deeper understanding of their functions and real-world applications. This innovative approach not only enhances learning outcomes but also promotes safety and confidence in handling aviation systems.

With VFRI, we can simulate complex flight situations and instrument readings, giving students the opportunity to practice and refine their skills in a controlled, risk-free environment. We are confident that this will contribute significantly to producing well-prepared, competent aviation professionals.

We look forward to collaborating with you on this groundbreaking initiative and raising the standards of aviation training.

Regards,

Fatah Hashim
Digital and Innovation
Asia Digital Engineering (ADE)

APPENDIX I: PWC STUDY ON EFFECTIVENESS OF VIRTUAL REALITY TRAINING

APPENDIX J: CERTIFICATE OF ACHIEVEMENTS

MARNet

CERTIFICATE OF ACHIEVEMENT

This is to certify that

MOHAMMAD AZMIN BIN ZAINAL, AHMAD NAQIB BIN MOHD ZAIDI, MUHAMMAD HARRAZ BIN OTHMAN, AZIZUL FITRI BIN ROSLAN, NUR ALYAA MAISARAH BINTI JASNI

Are awarded

PLATINUM MEDAL

For the project entitled

THE DEVELOPMENT OF FLIGHT INSTRUMENTS ON VIRTUAL REALITY (VR)

at the

i-INNOLED 2024 (15-16 October 2024)

organized by

FACULTY OF MAJOR LANGUAGE STUDIES, USIM

ASSOC. PROF DR. ZAINUR RIJAL ABDUL RAZAK
DEAN
FACULTY OF MAJOR LANGUAGE STUDIES

ASSOC. PROF DR. HAZLINA ABDULLAH
DIRECTOR
i-INNOLED 2024

MARNet

CERTIFICATE OF ACHIEVEMENT

This is to certify that

MOHAMMAD AZMIN BIN ZAINAL, AHMAD NAQIB BIN MOHD ZAIDI, MUHAMMAD HARRAZ BIN OTHMAN, AZIZUL FITRI BIN ROSLAN, NUR ALYAA MAISARAH BINTI JASNI

Are awarded

GOLD MEDAL

For the project entitled

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DEAN
FACULTY OF MAJOR LANGUAGE STUDIES

ASSOC. PROF DR. HAZLINA ABDULLAH
DIRECTOR
i-INNOLED 2024

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Sekalung tahniah kepada

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AHMAD NAQIB BIN MOHD ZAIDI	**040825-11-0279**
AZIZUL FITRI BIN ROSLAN	**040511-10-0385**
MUHAMMAD HARRAZ BIN OTHMAN	**040116-02-0203**

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**PERTANDINGAN PROJEK AKHIR
PELAJAR AEROMECH SESI I 2024/2025**

dengan tajuk projek

THE DEVELOPMENT OF VIRTUAL REALITY OF FLIGHT INSTRUMENT

pada

5 NOVEMBER 2024

bertempat di

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TS. IBRAHIM BIN BURHAN
PENGARAH
POLITEKNIK BANTING SELANGOR

No. Siri:PBS/UPIK/AN_0030

APPENDIX K: CONSTRUCTION OF FLIGHT INSTRUMENTS ON CESSNA 152

Study, design, construction and validation of a flight director for VFR flights for en-route operation of a Cessna C-152


Bachelor's thesis

Study, design, construction and validation of a flight director for VFR flights for en-route operation of a Cessna C-152

View/Open

- Memòria (5,324Mb)
- BUDGET.pdf (138,6Kb)
- Memòria (amb dades confidencials) (5,370Mb) (Restricted access)

Olivella i Martí, Guillem

Author's e-mail: olivella.guillem@gmail.com

Tutor / director: Pérez Llera, Luis Manuel

Document type: Bachelor thesis

Date: 2019-07-15

Rights access: Open Access

Abstract

A flight director for a Cessna 152 (single engine, fix propeller aircraft) for en-route operation has been designed, implemented and tested. The hardware, totally independent of the aircraft instruments and systems, was an iOS platform with GNSS capabilities (iPhone XR). The path following law employed has been a pure pursuit algorithm in the horizontal path; and, the flight technique used consisted on reaching the desired altitude at the same time that the aircraft was established in the correct course to cross the target point with levelled wings. The algorith mused involved two parallel... [+]

Subjects: Navigation (Aeronautics), Flight control, Flight navigators, Navegació aèria, Sistemes de control (Vol)

Degree: GRAU EN ENGINYERIA EN TECNOLOGIES AEROESPACIALS (Pla 2010)

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