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Interactive Creation and Performance of Digital Music Based on Virtual Reality Technology

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Abstract: - It explores the application of Virtual Reality (VR) technology to the development and performance of digital music on the e-MARZ platform, which promotes Malaysian arts and culture. Following the ADDIE model's systematic approach, the emphasis is on the Design phase, which involves conceptualizing and realizing the goal for interactive digital music experiences. Through painstaking attention to user requirements and immersive design concepts, e-MARZ strives to provide entertaining and informative experiences that inspire creativity and enthusiasm for Malaysian music. Using VR technology, users are transported to virtual spaces where they can explore, compose, and play music in novel ways. By adhering to user-centred design principles and pedagogical effectiveness, e-MARZ seeks to give a transforming trip across the realms of digital music within a virtual landscape, enriching the cultural tapestry of Malaysian arts and music. The results of the usability show that the e-MARZ module effectively addressed the usability needs of both professionals and high school students, offering an immersive and engaging learning experience in Malaysian arts and music.

Keywords: Virtual Reality (VR), ADDIE Model, Music Appreciation, 360 media.

I. INTRODUCTION

In the ever-changing landscape of digital music production and performance, using Virtual Reality (VR) technology provides a revolutionary channel for artistic inquiry and expression. The e-MARZ platform, which promotes Malaysian arts and culture, notably music, uses virtual reality technology to provide users with immersive and interactive digital music experiences. The ADDIE model has the development and implementation of interactive digital music composition and performance within e-MARZ methodically planned. The ADDIE approach is divided into five separate phases: analysis, design, development, implementation, and evaluation, with each playing an important role in the iterative process of developing effective and engaging learning experiences [1].

This overview focuses on the Design phase of the e-MARZ project, where the idea for interactive creation and performance of digital music in VR is imagined and implemented. During this phase, meticulous attention is paid to identifying user requirements, creating immersive experiences, and assuring the seamless integration of VR technology to accomplish the desired learning objectives [2]. The Design part of e-MARZ's interactive digital music module entails envisioning virtual settings, creating intuitive user interfaces, and mapping out interactive aspects to increase user engagement. Using VR technology's immersive qualities, users are transported to virtual concert halls, studios, and interactive music labs where they may explore, compose, and play music in new ways [3].

Throughout the Design process, user feedback and input are critical in refining the interface, maximizing user engagement, and assuring alignment with learning goals. The e-MARZ platform strives to provide a unique learning experience that stimulates creativity, encourages musical exploration, and builds a deeper appreciation for Malaysian music and culture by adhering to the principles of user-centred design and pedagogical efficacy [4]. As e-MARZ progresses through the ADDIE model's Design phase, the subsequent phases of Development, Implementation, and Evaluation will further refine and enhance the interactive digital music module, resulting in a robust and immersive platform that allows users to embark on a transformative journey through the realms of digital music creation and performance within the virtual landscape of e-MARZ [5].

II. RELATED WORKS

VR technology immerses users in a 3D environment, creating a sense of presence and allowing them to act as they are in the actual world. Head Mounted Displays (HMD) allow users to feel immersed in virtual worlds, unlike desktop or cave-based apps. The relationship between presence and cybersickness poses obstacles to designing VR

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applications. To prevent cybersickness, consider decreasing sensory mismatch, avoiding stereoscopy and higher views, and improving interaction and navigation control [6].

VR applications achieve immersion through high-quality graphics and subjective user experience [7]. Graphics quality relies on creating a 3D environment with appropriate orientation and proportion of virtual items [8]. Immersive VR applications are classed by technology, with mobile VR and HMD being immersive and desktop VR and Cave Automated Virtual Environment (CAVE) being non-immersive [9].

Immersive VR applications are associated with a strong sense of presence in the virtual world, which is influenced by graphic quality, 3D artist abilities, and user preferences. The use of HMDs further enhances this experience. VRMIs provide more engaging experiences with diverse features [10]. When creating VRMIs, it's important to consider user interaction and feedback in visual, auditory, or haptic formats. While converting musical instruments into virtual formats isn't necessary, it's important to prioritize content enrichment of virtual features.

A stand-alone HMD is used to create a VR-based piano lesson system that is portable and easily accessible [11]. Video signal processing for HMDs is CPU-intensive and requires tolerance for data transport lags (latency) [12]. HMD technology, like as Oculus Quest 2, allows for high-quality graphics without delay. One solution to this issue is to create 3D objects using low-poly approaches.

A virtual reality museum is being constructed to preserve Chinese cultural heritage musical instruments, allowing users to perform performances in single or multiplayer modes [13]. The Oculus hand controller has been customized to include a mallet for playing the tsuridaiko drum, a traditional Japanese musical instrument, using 3D printing [14]. Using both physical and virtual forms to play VRMIs is an intriguing concept. The use of real tools enhances consumers' sense of presence when playing virtual instruments.

Several studies have explored Virtual Gamelan, but none have used VR technology. For instance, Smart Gamelan for smartphones used VR to simulate instrument placement and analyze frequency distribution for sound identification [15][16].

III. Methodology

A. ADDIE Model

This research uses a modified and improved version of the widely used ADDIE instructional design concept. The ADDIE model is widely used for product development because of its adaptability to different study needs. The model's architecture is represented by words, making it difficult for developers or students to determine the necessary tasks for each phase. This can lead to confusion as explanations vary between authors. This paper proposes a more specific development paradigm for multimedia products, m-ADDIE, which was chosen to guide the development of e-MARZ.

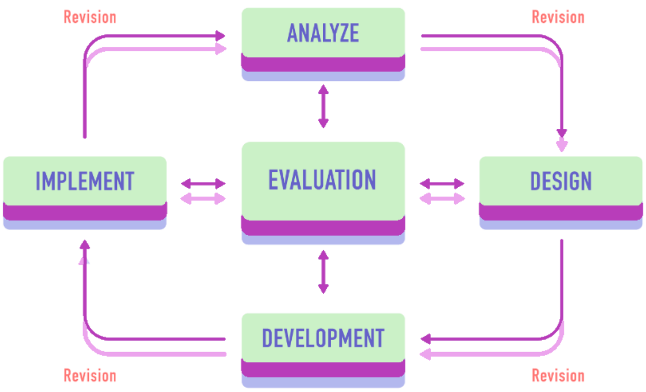

Fig 1: ADDIE model.

The m-ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation, is unique in that it includes sub-tasks within each phase to further explain its role, which is not typical in existing instructional design models. The "m" in m-ADDIE stands for instructional multimedia. Each step of the model includes subtasks that provide a full knowledge of the goal of each phase, with a concentration on instructional multimedia resources. In this study, the VR application e-MARZ was developed using the m-ADDIE model (see Fig 1) and validated using the classic ADDIE model.

The m-ADDIE model includes sub-tasks to clarify each phase's function, providing greater detail than traditional instructional design models. During the analysis phase, sub-tasks include objectives, users, content, methods, platforms, and software. In the design phase, sub-tasks include flowcharts, interfaces, and storyboards. The development phase includes principles, physical and intangible interactions, and instructions as subtasks. The implementation phase includes installation, configuration, training, and execution. The assessment phase focuses on information and efficacy as sub-tasks.

A 360° music ensemble film is one of the key components of the module to be built. The 360° video will be integrated into the e-MARZ module software, allowing users to see music ensemble performances in a more immersive first-person perspective. This approach allows for more exact interaction with virtual world items. 360° video is preferred over computer-generated visuals for successful VR-based teaching and learning. To create a 360° music performance film, the researcher will follow normal video production techniques, including pre-production, production, and post-production.

B. Virtual Reality

VR is a transformational technology that immerses users in virtual worlds, giving them a sense of presence and involvement in a computer-generated world. Users are transported to virtual environments that can be completely fictional or accurately imitate real-world settings using specialized hardware such as VR headsets and motion controllers. The ability of VR to follow users' motions and alter visual and aural stimuli accordingly is critical to its immersive experience, providing a seamless and convincing sense of reality. VR provides unparalleled options for enjoyment, learning, and adventure, whether you're exploring faraway planets, attending virtual concerts, or participating in instructional simulations. Beyond its entertainment appeal, virtual reality (VR) is quickly finding uses in industries such as healthcare, architecture, and training, where its capacity to replicate complicated events and surroundings can increase comprehension, skills, and experience learning. As VR technology advances and becomes more affordable, its potential to transform how we engage with digital information and perceive the world around us is virtually endless.

C. Video Recording Concept

Developing a video concept before taping helps streamline production, improve team communication, and simplify post-production. Having a clear concept improves production efficiency and creates a coherent message that resonates with the intended audience. Having a clear vision helps plan and organize resources, money, and timelines for a successful video project.

Fig 2: Actual camera and object placement for Caklempong.

The video concept positions the viewer in the centre, surrounded by musicians. This concept aims to deliver immersive audio experiences, including the use of Ambisonic formats. Ambisonic is the most effective spatial audio recording technology in terms of the sound field depending on the position of the sound source. The listener can hear dynamic audio based on the sound source's position. If the audience looks straight at the chosen performer, their sound will be heard louder and more balanced than the other musicians. Figure 2 displays the actual recordings made in this investigation.

D. Audio Recording Equipment

Ambisonic audio can provide a more immersive auditory experience. For this investigation, a handheld Ambisonic microphone was employed for audio recording alongside video. Ambisonic technology is supported by web platforms like Google, YouTube, and Facebook, as well as post-production tools for audio and video editing and VR gaming. Ambisonic technology allows the microphone to record surrounding audio across four channels. This feature allows for audio rotation via headphones, VR head-mounted displays, and mobile devices. The Zoom H3-VR microphone was used during the recording session.

Fig 3: Zoom H3-VR Ambisonic Audio Recorder.

This microphone is affordable and can record in ambisonic, binaural, stereo, and mono audio formats. This microphone is designed for immersive VR audio in an Ambisonic format. This microphone allows researchers to use a variety of audio formats during post-production. The 360° camera has a microphone for recording audio. Figure 5 depicts the type of microphone utilized for recording purposes.

IV. Result And Discussion

A. Analysis Phase

The VR e-MARZ program uses VR technology to teach students traditional Malaysian and popular music. It provides an immersive learning experience in which students can study numerous areas of music using interactive exercises. The target users are music stream students in Forms 1 and 2, as well as Malaysian Music Education Teachers. The program was created using 3DVista Virtual Pro software, which is noted for its no-coding approach, making it user-friendly for developers.

Fig 4: 3D Vista Software.

This software allows for the production of immersive and interactive music appreciation experiences by integrating 360° performance footage, audio, text, and graphics into the virtual world. This multimedia method promotes a deeper understanding of musical principles, techniques, and historical settings, resulting in a greater respect for the art form.

B. Design Phase

The design phase consists of creating flowcharts, interfaces, and storyboards for the development process. The prototype software and VR e-MARZ app start with an introduction screen, after which users select the music kind they want to explore. In non-immersive mode, interaction is done through a touch screen, whereas in immersive mode, it is done by motion gaze. Following choosing, viewers are sent to various main menu panels that include interactive buttons for watching ensemble performances, accessing instrument information, and more. Both linear and non-linear navigation patterns are used, with linear offering sequential progression and non-linear allowing users to return to the main menu or select new alternatives.

C. Development Phase

The VR e-MARZ application's development begins with a thorough analysis of multimedia principles to ensure accurate design. During the development process, screen design should prioritize text, graphics, music, video, and colour, among other multimedia concepts. Consistently reference the flowchart, interface, and storyboard sketches from the design phase when presenting content in education software development.

D. Implementation Phase

The implementation phase consists of four major steps: installation, configuration, instruction, and use. Initially, the program is made available online by a hyperlink or QR code scan for ease of use by educators and students. Next, the VR Head Mounted Display or compatible smartphones are configured, with gyroscope-equipped devices recommended for best performance. Educators are given extensive platform usage rules, allowing students to participate independently or with teacher supervision. Finally, the software is linked to the teaching process, allowing students to review information outside of class hours. These processes ensure that the system runs smoothly and effectively, providing students with an immersive learning experience.

E. Evaluation phase

The usability of the e-MARZ module was assessed using the System Usability Scale (SUS) and the Post Study System Usability Questionnaire (PSSUQ), which were given to both experts and high school students. Initially, five experienced music teachers were chosen, followed by 82 secondary school students who used the curriculum for four weeks. Students provided input on the usability of using cell phones in both immersive and non-immersive modes. A team of specialists used the Content Validity Index (CVI) to ensure the questionnaire's validity and reliability, yielding an average ICVI rating of 1. The PSSUQ, noted for its dependability, conducted a pilot test with 30 non-participants to establish applicability and evaluate Cronbach's Alpha coefficient (α). The PSSUQ instrument has a robust overall reliability value with a coefficient (α) of 0.89, which coincides with the assumption that a coefficient (α) $\geqslant$ 0.7 indicates excellent reliability in educational research. The SUS instrument's dependability was not assessed due to its small sample size of five respondents and its use of percentiles. The PSSUQ was used with students to assess the usability of the e-MARZ through descriptive statistics. Five music education and technology specialists evaluated the e-MARZ module's application system using a SUS questionnaire. The expert panel evaluated the usability of the e-MARZ program (see Fig 5 for SUS results) and found it commendable.

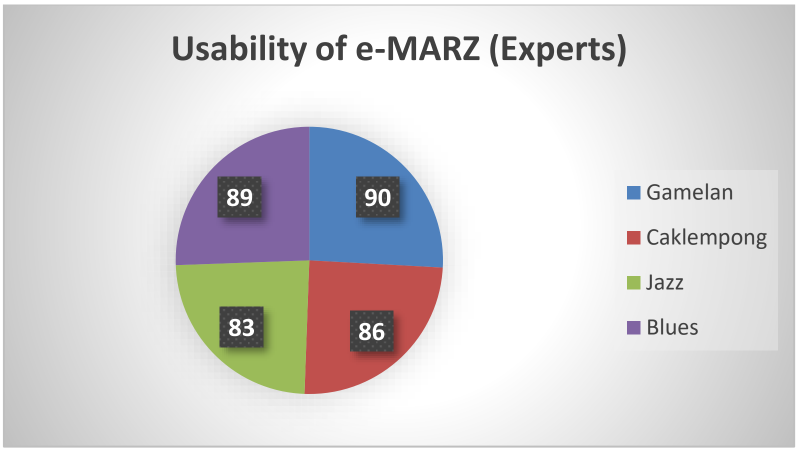

Fig 5: The study of the total SUS score findings.

The expert panel's replies for each sub-module were analyzed thoroughly, yielding the following results: Gamelan (90), Caklempong (86), Jazz (83), and Blues (89). Fig 6 summarizes the SUS usability tests for each sub-module.

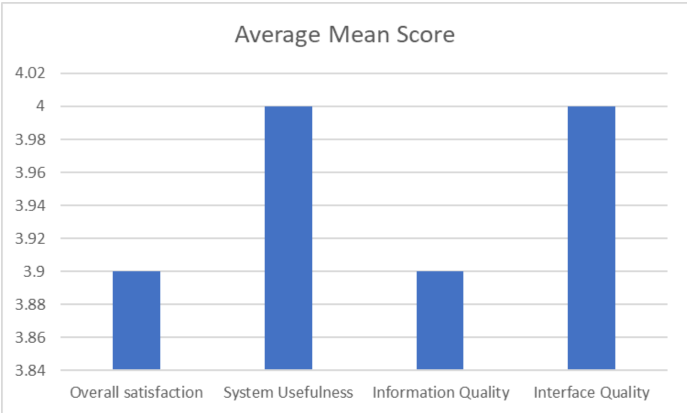

Fig 6: Overall analysis of PSSUQ mean score findings.

The PSSUQ questionnaire was used to assess the usability and satisfaction of the e-MARZ app on smartphones among 82 students.

V. Conclusion

The use of Virtual Reality (VR) technology in the development and performance of digital music on the e-MARZ platform is a big step forward in promoting Malaysian arts and culture. e-MARZ has created immersive and engaging digital music experiences that cross traditional boundaries by applying the ADDIE model methodically, notably during the Design phase. By integrating VR technology, e-MARZ allows users to explore, create, and perform music in immersive and interactive virtual worlds. Using user-centred design concepts and painstaking attention to educational efficacy, e-MARZ intends to stimulate creativity, foster musical exploration, and build a greater appreciation for Malaysian music and culture in its users. Moving forward, the ADDIE model's development, implementation, and assessment phases will refine and improve the digital music experiences provided by e-MARZ. By constantly iterating and refining its products, e-MARZ hopes to position itself as a prominent platform for immersive and educative digital music experiences.

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