Malaysian Music Augmented Reality (MMAR): Development of Traditional Musical Instruments Using Augmented Reality

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Abstract: ***The public music schooling course of study in Malaysia was brought in as a required subject into the primary schools since 1983 through the program of "Integrated Primary School Curriculum". The predominant intention of Malaysian music education is for pupils to improve an curiosity and an appreciation of music and songs of the Malaysian culture. In addition, the specific aim of music education in the Integrated Primary School Curriculum is to provide students who've a basic awareness then understanding of music, similarly as minimum skills in composing music. When comparing to traditional method (non-interactive), one of the drawbacks is the missing level of realism. Therefore, an Augmented Reality (AR) based approach may offer a way out to enhance the visual information. AR technology has been established and matured to the peak where the education sector can use it for effective teaching and learning especially to provide realistic learning experience to the students. In addition, the Ministry of Higher Education is strongly urging to get on board of the digital transformation since AR is one of the nine pillars that define Industry 4.0. The objectives of this research has two folds: (i) to promote Malaysian music education especially the traditional musical instrument to young generation by exploiting the technology from AR and (ii) to develop an AR application by enriching the digital content on top of the traditional musical instrument to help the students in the primary school to understand and learn the traditional musical instruments anywhere and at anytime. This research is found to be able to support interactions between students in the class, cultivating more interest in traditional music and instruments through the smooth transition between the reality and virtuality, as the interaction with a computer can improve the interest in learning and teaching.***

Index Terms: Augmented reality, Mobile learning, Randomized psychoacoustic model.

I. INTRODUCTION

Malaysia Music Curriculum for primary school has been carried out when we consider that 1983 and for secondary school in 1988. In addition, it has been more than 30 years since music was first introduced as an academic field of study in Malaysian public higher education institution. Since then, the number of institutions has increased to seven universities which offering music programs excluding those who may be on the way of starting such program. Several results have been represent which students who take tune as an optional subject had shown suitable performance within the national exam performed via Malaysian Ministry of Education on 2004 [1,2]. Additionally, there are plenty of advantages with the aid of studying the music, that allow a person to acquire fulfillment in his or her life-time.

In general, music education in Malaysia have been influenced by several factors such as 1) neighboring countries (Thailand and Indonesia), 2) history such as colonialists and 3) popular Western music. Therefore, music education in Malaysia has been developed and consists of traditional Malay music, traditional Chinese and Indian music, syncretic music, indigenous music as well as classical western music [3]. Unfortunately, lack of learning experience to study the traditional musical instruments becomes one of the challenging scenarios in the Malaysian music education. The current music education content material may be experienced through a huge style of media starting from non-interactive (books or interaction between teachers and friends) to highly interactive digital experience (e-books with full of multimedia, gamification, simulation) that fully engage the immersion from the students. However, the manner of interaction with learning experience is lacking in Malaysia education especially for the Malaysian music education.

AR has elevated its reputation in each enterprise and academia considering its creation 20 years in the past because AR is about the experience where it combines the real world with virtual world and it can be presented through various channels such as smartphones as well as PC and laptops. Besides, the display presentation could contain video, 3D modeling, images, animations and sounds where they are suitable for the development of educational material [4]. In addition, AR is part of the main pillar in Industry 4.0 where Malaysian's government is strongly urging the public and private sector to get on board the digital transformation through Industry 4.0 adoption.

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The particular goal of this study is to develop and evaluate a acceptance level in mobile application named as Malaysia Music Augmented Reality (MMAR) by utilizing the technology of AR to enrich the digital content on top of the current traditional musical instrument among the children.

II. LITERATURE REVIEW

Basically, AR takes the vision of the real world and adds virtual information on top of it. In different phrases, AR merges the real and partial virtual world together and offers each synthetic light as well as natural light bouncing off items within the actual world. In addition, AR is taken into consideration low value when comparison to Virtual Reality. A utilize of non-traditional interplay tool which include Head Mounted Display (HMD), data gloves, and Concave are not requited and usually these devices have an expensive cost. In AR, interactions happen with markers along with a camera from any device such as table and smartphone. In addition, AR does not require high technology webcam to operate and it make more accessible by a lot of users. Recently, AR has developed rapidly in the domain of music education [4,5,6,7,8,9,10, 11] as shown in Table 1.

Table. 1 The Trends of Augmented Reality in the Domain of Music Education

Paper	Method / Model	Advantages and Disadvantages
[4]	Used Augmented Reality (AR) to promote the traditional folk musical instruments. The method allows the users to view the media in 2D modeling as well as equipped with sound by using a trigger image in a postcard via mobile device.	**Advantages:** 1) The approach is able to stimulate engagement in the classroom so that the students are eager to learn more during the class. 2) The approach also is able to elaborate the knowledge so that the students could develop their understanding and deepen their knowledge **Disadvantages:** 1) Needed to use Internet network. 2) The graphic is only in 2D modeling.
[5]	Presented an interactive learning system which is ChinaAR where utilizing the technology of Augmented Reality. ChinaAR combined the musical concept from Eastern and Western.	**Advantages:** 1) Help beginners to gain higher efficiency and better memorization. **Disadvantages:** 1) Lack of expressiveness of fingering by visualization and animation.
[6]	Adopted AR to create an immersive experience to improve the efficiency of learning for beginner piano students. To stimulate improvement in notation literacy and to create encouragement via providing as a game.	**Advantages:** 1) The method is able to breed the interest of the students in music and the process of learning the musical instrument. 2) Head mounted displays is able to convey instrument playing skills to a user. **Disadvantages:**) Lack of incorporating the performance analysis in the evaluation. 2) Lack of formal user study to determine the usability and effectiveness of the piano education.
[7]	Presented an Augmented Reality App for musical learning. The App works by verifying whether sequences of musical notes were correctly colored in a printed pentagram.	**Advantages:** 1) Augmented Reality is able to reduce the initial difficulties involved in learning music by reducing these barriers of traditional teaching materials. 2) It is a cheap and affordable technology **Disadvantages:** 1) The population size is only limited to six children.

[8]	Proposed to use Augmented Reality to enhance the experience of learning to play keyboard instruments. Used Google Cardboard to let users visualize a virtual character and instructions.	**Advantages:** 1) The interaction with an animated 3D character can help to keep the motivation in music learning. **Disadvantages:** 1) Lack of musical instruments and disallow the users to add their own songs and dance movements for the character.
[9]	Presented an Augmented Reality App to support musical learning of children. The application works by verifying whether sequences of musical notes of the melody are correctly colored in a printed pentagram (target).	**Advantages:** 1) Augmented Reality is able to reduce the initial difficulties involved in learning music by reducing these barriers of traditional teaching materials. **Disadvantages:** 1) Lack of evaluation in usability and learning assessments.
[10]	Presented MUSIC-AR which makes use the Augmented Reality generation for coaching of sound materials. MUSIC-AR consisted of 4 small applications which are 1) grant children to control virtual items liked to sounds, 2) focus on the concept of sound intensity, 3) related to duration of the sound and 4) related to timbre.	**Advantages:** 1) Children could understand through using Augmented Reality. 2) Children felt motivated to use the technology. **Disadvantages:** 1) Lack of more games in the application.
[11]	Proposed virtual reality may offer children with an alternative approach to acquiring musical skills.	**Advantages:** 1) Virtual Reality and Augmented Reality can be helpful tool in training musical skills, a task which is known to be usually tedious, repetitive and often also challenging. **Disadvantages:** 1) Lack of design consideration need to be taken into considerations.
[12]	Proposed three different learning modes which support the natural learning process, incorporate live feedback and performance evaluation, as well as the augmentation of the system with aspects of gamification to achieve early experiences of success.	**Advantages:** 1) Provided an assistance in learning to play piano without requiring any experience with traditional music notation. **Disadvantages:** 1) Lack of notation which cannot match the complexity and expressiveness of traditional sheet music notation. 2) Lack of extensive user studies to assess the learning support.

In a nutshell, we can conclude that AR is able to stimulate engagement [4,5,6] and increase the motivation [8,10] in the classroom as well as reduce the initial difficulties to learn the music [7,9].

III. SYSTEM OVERVIEW

The Malaysian Music Augmented Reality (MMAR) is Android applications which look for produce music studying greater interactive and entertaining particularly for the children. In short, MMAR provides another alternative for the children to learn the musical instrument. In addition, MMAR should be able to carry out two types of learnings, which are 1) inquiry learning and 2) experiential learning.

Inquiry learning is an instructional strategy that is used as the basis to design the active learning where the students are engaged in some kind of investigation that involves questions and require the student to find the answer based on the questions. Experiential learning is viewed as a process to create a new knowledge through transformation of the experience.

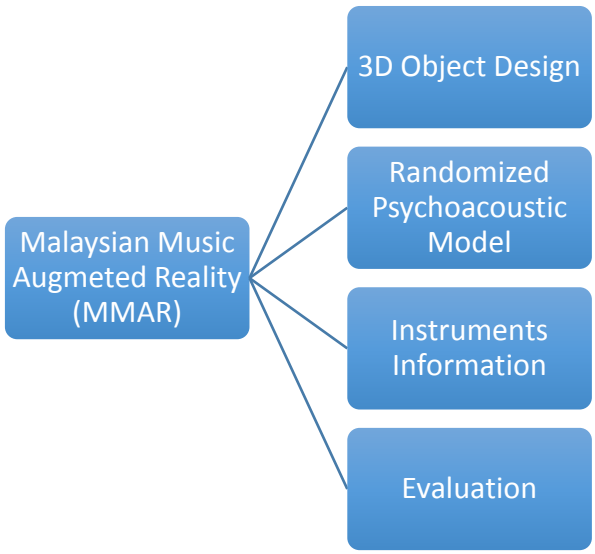

Fig. 1 Overview of MMAR

In general, MMAR, consist of four modules such as 1) 3D Object Design, 2) Acoustical Model, 3) Information about Instruments and 4) Evaluation as shown in Figure 1. 3D Object Design is one the most important modules to store all the 3D modeling for the traditional musical instrument. Blender (Version: 2.79) is utilized to sketch the difficult shapes like cone and torus shape. Then, these 3D shapes are important to Unity (Version: 2017.2.1) to sketch and assemble the remainder of the three-dimensional shapes to create a whole three-dimensional object. Furthermore, SketchUp (Version: SketchUp Make 2017) could be wide utilized within sketching the three-dimensional objects for less for fewer difficult shapes. Randomized Psychoacoustic Model was used in MMAR [12] because person interaction using multi-gesture faucet is important in handing over the psychoacoustic consequences to children. In addition, a Randomized Psychoacoustic Model consists of the modifications in acoustical traits consisting of amplitude to consist of the modifications in acoustical traits consisting of amplitude to let the user have the immersive feeling by using the hand gesture tochange the amplitude in MMAR. Instruments Information module is a vital in giving constructive information to the user on the traditional musical instruments. It is designed in table views in order to communicate long lists of information to the user effectively and efficiently as shown in Figure 2 where Figure 2 (a) showed the information about membranophone while Figure 2 (b) showed the list of membranophones instrument music. The module allows the user to obtain the information and provides the flexibility of viewing at anytime and anywhere. Lastly, the Evaluation module consists of two types of evaluation which are 1) guess the musical instruments (in image form) based on the sound and 2) guess the name of the musical instruments based on multiple choices by scanning the maker.

Fig. 2 The Interface of Membranophone (a) Information about Membranophone and (b) List of Membranophone Instrument Music

IV. EVALUATION AND DISCUSSION

This part describes 2 kinds of assessment which are 1) evaluation with capacity end users and 2) evaluation with musical instructors. For evaluation with capability end users, a set of ten (10) children of each gender (seven girls and three boys) and two musical teachers were elected. The average age of the children is 7.9 and all of the children have never in contact with AR. All the participants reported using tablets and smartphones from parents or family members to play with moderate frequency (1 to 2 per day), but none of them had ever interacted with AR technology. As for musical knowledge, none of the children had contacted with traditional musical instruments.

During the evaluation, all of the children used the same smartphone, which is the Samsung Galaxy J3 model. The specification of the smartphone is shown as below:

- Display: 5.00-inch
- Resolution: 720 x 1280 pixels
- Rear Camera: 13-megapixel
- OS: Android 7.0

The subsequent technique became implemented for the tests with potential end users. First, we need to get the permission from the parents before allowing the children to to take part in this assessment. Some questions about their profile were asked.

As mentioned before, all of the children have never contact with AR. Therefore, explanation of the AR in layman terms is a must and small demonstration turned into accomplished before the evaluation. Subsequently, each child was asked to use the application by following the instructions given in MMAR. Lastly, some questions had been requested approximately usability. The physical surroundings used for the evaluation was not a managed surroundings (also known as critical surroundings). The evaluation took place in the children's accommodation so as now not to motive nuisance to the youngsters's regular environment. The youngsters had been then asked to run the MMAR application by themselves as shown in Figure 3.

Fig. 3 Example of Augmented Reality Effect in one of the Traditional Musical Instrument during the Evaluation

During the evaluation sessions, observation techniques have been applied and certain information about the use of MMAR as shown below:

- Six (6/10) children had some difficulty performing the activities.
- The difficulty is not related to the lack of musical education, and neither to the lack of interest.
- The difficulty is related to the problems of usability of MMAR, such as the children faced difficulty to scan the marker due to inadequate of light.
- All (10/10) of the children felt impressed when they played sound (psychoacoustic effects) based on different types of traditional musical instruments.
- Based on the observation, all (10/10) of the children could understand and differentiate various type of traditional musical instruments by using MMAR.

About the usability questions, the children answered as shown below:

- All (10/10) of the children have confidence in the design of MMAR as appropriate and attractive.
- Four (4/10) of the children have to try more than two times in order to view the 3D objects.
- All (10/10) of the children were able to change the amplitude (psychoacoustic effects) from MMAR.
- All (10/10) of the children agreed to use this type of technology which are AR and psychoacoustic effects in other applications.

The following results are based on the interview with the music teachers as shown below:

- The teachers did not know the technology of AR, but considered Augmented Reality and psychoacoustic effects are important to use in the area of music education.
- The teacher considered MMAR is incredibly fascinating then able to give entertaining to the children, which could help in teaching music.
- The teacher proposed to use tablet rather than smartphone due to the screen size.

In the nutshell, MMAR used the three-dimensional modelling then gives offline mode that resolved the shortage during [4]. Additionally, the entire range of sample size for this analysis is 12 where 10 from students and 2 from musical teachers to solve the constraints from [6,7,9].

V. CONCLUSION & FUTURE WORKS

In this paper, we presented an overview of the MMAR by utilizing the technology of Augmented Reality for teaching traditional musical instruments. In conclusion, it can be concluded that MMAR has met the objectives of this research which majority of the children agreed to use MMAR as a beginning to learn music education. Furthermore, it is possible to conclude that children could know the traditional musical instruments and is able to research and examine the contrast for different forms of sounds from the traditional musical instruments. Although this application is prospering and totally developed, however there are still small lacking criteria during application. These lacking criteria may be improved to generate a much better and more economical application. Longer term works is to supply additional musical instruments and deploy the MMAR in a bigger screen, which is tablet. In addition, further evaluation such as deployment in primary school can be executed to collect more comments.

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REFERENCES

1. Shahanum, M. S., Mohd, N. H., Hasnizam, A. W., Chan, C. J., Mohd, H. A., Andrew, P. (2014). Future direction of music education in Malaysia public higher education institutions, PenerbitUniversitiKebangsaan Malaysia.
2. Mubin, M. N. (2011). Develop human capital through music education in Malaysia, Academic Research International, vol. 1(2), pp. 220-227.
3. Shahanum, M. S. (2006) Popular music in Malaysia: Education from the outside, International Journal of Music Education, vol. 24(2), pp. 132-189.
4. Suwichai, P. (2014). Applying augmented reality technology to promote traditional Thai folk musical instruments on postcards, International Conference on Computer Graphics, Multimedia and Image Processing, pp. 64-68
5. Zhang, Y. X., Liu, S., Tao, L., Yu. C., Shi, Y., Xu, Y. (2015). ChinAR: facilitating Chinese guqin through interactive projected augmentation, International Symposium of Chinese CHI, pp. 23-31.
6. Chow, J., Feng, H., Amor, R., Burkhard, C. W. (2013). Music education using augmented with a head mounted display, International Conference on Australasian User Interface, pp. 73-79.
7. Ana, G. D. C., Bruno, H. V. L., Marilena N., Roseli, D. L. (2016). AR musical app for children's musical education, International Symposium on Consumer Electronics, pp. 125-126.
8. Carlos, T. F., Pujana, P., Chu, C. Y., Ruck, T. (2016). Piano learning application with feedback provided by an AR virtual character, Global Conference on Consumer Electronics, pp. 1-2.
9. Bruno, L., Ana G. D. C., Marilena, N., Roseli, D. L. (2017). Augmented reality musical app to support children's musical education, Journal of Computer Science and Information Technology, vol. 5(4), pp. 121-127.
10. Martins, V. F., Gomez, L., Ana, G. D. C. (2015). Teaching children musical perception MUSIC-AR, EAI Endorsed Transaction on e-Learning, vol. 15(2), pp. 1-8.
11. Serafin, S., Adjorlu, A., Nilsson, N., Thomsen, L., Nordahi, R. (2017). Consideration on the use of virtual and augmented reality technologies in music education, IEEE Virtual Reality Workshop on K-12 Embodied Learning through Virtual & Augmented Reality, pp. 1-4.
12. Lim, C. K., Tan, T. P., Tan, K. L., Abdullah, Z. T. (2012). Randomized psychoacoustic model for mobile, panoramic, heritage-viewing application, International Conference on Virtual-Reality Continuum and Its Applications in Industry, pp. 315-322.