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Mobile Augmented Reality Coloring Sheets Development for Dengue Awareness

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Abstract
Many of the tropical and subtropical regions of the world are facing significant socioeconomic concerns. In relation to this they face the spread of dengue fever. From the populations of Southeast Asia and Western Pacific regions, Asia remains disproportionately affected by 75% of the dengue infection. Thus, it has become a major challenge to the public health because of the worldwide spread and the dramatic increase in dengue cases particularly in the Asian region. Even though, action has been taken by the government and community, to combat the diseases through media campaign and other activities, the lack of knowledge such as understanding the life cycle and breeding of a mosquito may result in less effective mosquito control measures. Taking the advantages of augmented reality (AR) technology using marker-based will be able to facilitate the visualization and integration of information by displaying it directly to the user's view. This study aims to edutain school aged children about the mosquito breeding. The total participants involved in this survey were 86 standard 6 students from public schools. The results show that the scores for all scales in UEQ tools represent a positive evaluation describing a pragmatic quality aspect (efficiency, perspicuity, dependability) with a value of 1.26, hedonic quality (stimulation and novelty) with a value of 1.50 and attractiveness with a value of 1.57. Alpha coefficients are 1.570 for attractiveness, 1.302 for perspicuity, 1.279 for efficiency, 1.186 for dependability, 1.750 for stimulation and 1.244 for novelty. The value of attractiveness and stimulation give the highest scale in the results. This showed that users have found that the overall impression of the application is attractive, exciting and motivate them to use it. This suggested that the use of AR application can assist students understanding because it provides a dynamic visualization to support learning. Thus, able to create awareness in the early prevention of dengue control.

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I. INTRODUCTION

Augmented Reality (AR) is a technology that allows users' interaction between virtual and the real worlds in real time, where they become engage with the learning. This has created an interesting way in bridging the real within virtual worlds, thus create a magical feeling to capture the user's attention during learning. AR has been used in many disciplines and not limited to fields such as education, health and marketing [1]. Compared to the traditional way in raising awareness through radios, handheld displays or campaign, AR provides more meaningful method to create personal awareness of the surrounding context [2].

Taking the advantages of AR technology, which will be able to facilitate the visualization and integration of information by displaying it directly to the user's view[3]this study aims to develop mobile AR coloring sheets for dengue awareness to educate school aged children about the mosquito breeding as a complimentary to printed

booklet information. Whilst reading the printed materials, user are enable to view a dynamic visualization using the AR application and assists their understanding to support the comprehension, meanwhile the coloring features creates the enjoyment feeling [4] because they can view 3D animation of the coloring objects covered by the painted colors. Hence, the dynamic 3D viewing, and coloring features are able to create awareness in the early prevention of dengue as well as enable them to interact with the booklet content for knowledge information. This study has also assessed the users' experience of application quality.

The research question of this study is framed to develop the mobile AR marker-based and coloring features, which increase users' knowledge about mosquito breeding and may affect their understanding on the importance of early prevention in mosquito control and habitat. Therefore, using the users' experience questionnaires (UEQ) tools, a quantitative measurement and analysis methods were done to evaluate the quality of AR Aedes Alert application. Thus, this study demonstrates that the used of AR has the potential to support conceptual knowledge, which is essential to user's understanding and visualizing phenomena that can increase collaboration and engagement among its users as a compliment to the conventional methods in raising dengue awareness.

II. LITERATURE REVIEW

A. Dengue Awareness

Many of the tropical and subtropical regions of the world are facing significant socioeconomic concerns. In relation to this they face the spread of dengue fever [5]. From the populations of Southeast Asia and Western Pacific regions, Asia remains disproportionately affected by 75% of the dengue infection [6]. Thus, it has become a major challenge to the public health because of the worldwide spread and the dramatic increase in dengue cases particularly in the Asian region [6]. About 50 to 100 millions of dengue infections have been estimated by the World Health Organisation (WHO) occurs worldwide every year [7]. As a result, almost half a million of patients with dengue fever is hospitalized with 2.5% death rate from the infection and many of them are children.

Due to the significant geographic spread of the virus, dengue has been categorized as the most crucial mosquito-borne viral disease in the world [6]. Even though, action has been taken by the government and community, to combat the diseases through media campaign and other activities, the lack of knowledge such as understanding the life cycle and breeding of a mosquito may result in less effective mosquito control measures[8]. A study by [9] suggested that the people's ignorance about this knowledge has caused them do nothing to control dengue. An interesting study by [8] has revealed that school-aged children understood that mosquitoes were in some way related to dengue, however information as to how to destroy mosquito eggs such as by stepping on them have been incorrectly assumed by the child. This, however, gives a reflection on the importance of the control of the mosquito eggs as it is the earliest stage of the mosquito life cycle. Thus, it is crucial to educate people with the proper knowledge, so that we can control the mosquitoes breeding and prevent the disease from spreading at the early phase.

B. Mobile AR

AR is defined as a technology which allows virtual information to be overlaid onto user's natural environment, thus enables the user to view the information in the real world AR as a learning tool has been developing at a rapid pace, which has dramatically affected education. The technology allows students' interaction between virtual and real worlds in real time, where they become engaged with the learning. Interesting features such as real time rendering for AR coloring has created an interesting way in

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bridging the real within virtual worlds, thus creating a magical feeling to capture the student's attention during learning. The use of AR technology has shown the enormous potential in enabling students to construct new understanding. The capability in layering digital displays over real-world environment is able to provide scaffolds for students to experience the learning as well as to perceive virtual elements as part of their present world [11].

Mobile AR with marker-based use trigger such as 2D image with visual features for object recognition and object tracking. Using the available AR SDKs in market such as Vuforia, a particular algorithm is applied to extract features from the marker and recognize it [12]. With the rapid development in AR technology, features such as real time rendering is able to capture elements such as painted colors on the 2D image where it can be viewed in 3D animation on the mobile screen [13]. Thus, create an enjoyment feeling and engage them with the learning. Creating an education topic particularly for raising awareness not only requires providing visual that can stimulate content but also requires students to interact, create and express themselves.

III. MATERIALS AND METHODS

The central focus of this research takes the nature of a design practice and thus contribute to the body of knowledge through the creative outcomes. This study unfolds into three parts: (a) booklet design for information and marker-based trigger (b) AR content development and (C) Users' experience:

A. Booklet Design for Information and Marker-based Trigger

The booklet contents include information of Aedes mosquito types, habitat, life cycle and mosquito control and prevention. The booklet pages were also designed as a marker-based trigger which can be recognized by a mobile camera to make the virtual AR image appears in the mobile screen. The booklet contains 9 pages in total with 3 main trackers: types of Aedes mosquito, habitat and life cycle. The coloring sheets of type of Aedes mosquito is provided at the end of the booklet. A demonstration of the AR can be seen in Fig 1 and Fig 2.

Fig 1. AR demonstration using mobile device and booklet as target marker

Fig 2. AR screenshot demonstration using booklet as target marker

B. AR Content Development

The AR content development process was derived from works, which involved three main stages: Data extraction, modelling and AR interface as shown in Fig 3

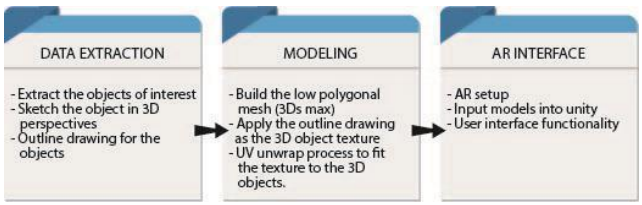

Fig 3: The development method used in the mobile AR coloring

The data extraction starts with extracting the objects of interest from the actual image of the mosquito. Using the clip studio paint, the

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mosquito image was drawn and transformed into 2D digital image which later were used as references guide in developing the 3D perspectives. Fig 4 shows the process done in data extraction.

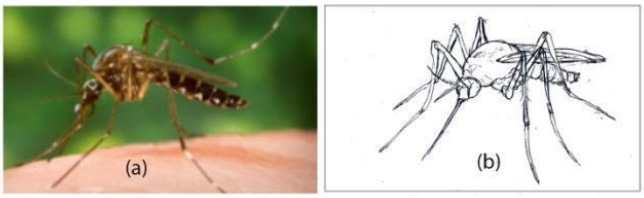

Fig 4: (a) Extract the objects of interest, (b) 3D object perspective

Next, for the modelling, the process starts with building the 3D object using low polygonal mesh in Autodesk 3Ds max software. The 3D model then was rendered as an image tracker. Afterwards to coordinate the mapping which enables the coloring features, the UV unwrap process is applied to fit the rendered image as a texture to the 3D components. However, 3D objects used for the dynamic visualization in the printed booklet material do not need to be rendered as an image for further process.

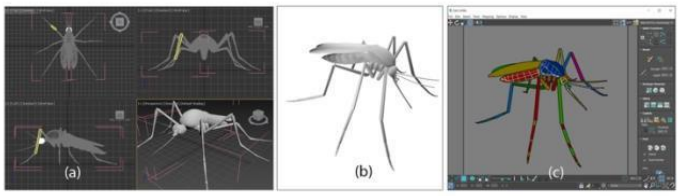

Fig 5: (a) Low polygonal mesh, (b) Rendered image and (c) UV unwrap process.

Lastly, the final 3D object with texturing is converted in fbx format before imported into Unity development platform as the main asset for the AR Aedes application. The AR is setup first in the Unity, which Vuforia is used as an AR SDKs with a specific algorithm to extract features from the marker and recognize it. User interface and buttons interaction then were design for the navigation.

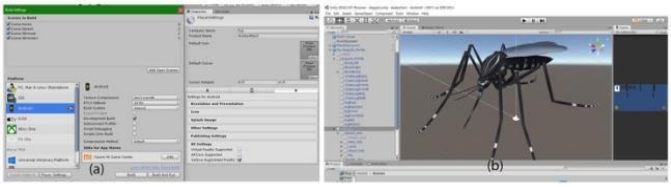

Fig 6. (a) AR setup process and (b) Import model into Unity for creating navigation and functionality.

C. Users Experience Questionnaire (UEQ)

The questionnaire for user experience was established byThe survey instrument for the UEQ used 26 questions. Laugwitz et al. (2008) has constructed a user experience questionnaire (UEQ) as a tool for the user-driven assessment of software quality and usability. The questionnaire allows a quick assessment done by end users covering a preferably comprehensive impression of user experience. Theoretical framework of UEQ distinguishes between perceived ergonomic quality, perceived hedonic quality and perceived attractiveness of a product.

Perspicuity, efficiency and dependability represent ergonomic quality aspects that focus on the goal oriented or task-oriented aspects of product design. Stimulation and novelty represent hedonic quality aspects which focus is on the non-task-oriented quality aspects of a software product such as the beauty of the user interface. Therefore, the attractiveness scale forms from user impressions are the result of an averaging process that concerns the quality of pragmatic and hedonic. Table 1 describes items in UEQ questionnaires. The participants involved in this survey were all standard 6 students from public schools. The total number of participants was 86. Using standard Likert scale questionnaire design, the forms were administered by online surveys.

Table 1. UEQ questionnaire items

Scales	Items	
	Q1.	Annoying/Enjoyable
	Q2.	Good/Bad
Attractiveness	Q3.	Unlikable/Pleasing

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	Q4.	Unpleasant/Pleasant
	Q5.	Attractive/Unattractive
	Q6.	Friendly/Unfriendly
Efficiency	Q7.	Fast/Slow
	Q8.	Inefficient/Efficient
	Q9.	Impractical/Practical
	Q10.	Organized/Cluttered
Perspicuity	Q11.	Not understandable/Understandable
	Q12.	Easy to learn/Difficult to learn
	Q13.	Complicated/Easy
Dependability	Q14.	Clear/Confusing
	Q15.	Unpredictable/Predictable
	Q16.	Obstructive/Supportive
	Q17.	Secure/Not secure
Stimulation	Q18.	Meets expectations/Does not meet expectations
	Q19.	Valuable/Inferior
	Q20.	Boring/Exiting
	Q21.	Not interesting/Interesting
Novelty	Q22.	Motivating/Demotivating
	Q23.	Creative/Dull
	Q24.	Inventive/Conventional
	Q25.	Usual/leading edge
	Q26.	Conservative/Innovative

IV. AR AEDES ALERT PROTOTYPE

The following figures illustrate the prototype design of AR Aedes Coloring:

Fig 7. (a) Splash screen and (b) Main interface

The application starts with a splash screen in 5 seconds duration before the main interface appears. There are 9 buttons navigation in the application namely as type, habitats, life cycle, enemy, gallery, role play, quiz, AR coloring and multi-user. Using the booklet as tracker, user can navigate and explore the AR content. Fig 5. shows when user navigate to Type button which allows them to choose between two types of mosquito namely as Aegypti and Albopictus. Once one of this option is selected and using the booklet as tracker user can view the mosquito in 3D object. In this AR content, user can explore information about mosquito as shown in Fig 8 and view mosquito animation as shown in Fig 9.

Fig 8. (a) AR interface for Type button and (b) AR content for Type button

In this AR content, user can explore information about mosquito in the Show Info submenu button as shown in Fig 6 and view mosquito animation in the Fly submenu button as shown in Fig 7.

Fig 9. (a) AR content for Show Info submenu button and (b) mosquito animation in Fly submenu button.

The AR coloring button consists of 4 coloring sheets: Aedes Aegypti, Aedes Albopictus, Guppy fish and Dragonfly. Once the coloring is done, through this button user will be able to scan the sheets and live view the 3D object the colors used on the image tracker. Pressing the Fly button will activate the flying animation, whereas the Land button changes from flying animation to landing movement. To control the mosquito movement, user can use the joystick symbol in the interface.

Fig 10. (a) AR coloring buttons and (b) AR coloring on the image tracker

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V. FINDINGS AND DISCUSSIONS

Table 1 shows the results of scales on attractiveness, perspicuity, efficiency, dependability, stimulation and novelty from the user experience questionnaires (UEQ). The users rate the multimedia learning material positive at all scales. In the standard interpretation, values between -0.8 and 0.8 represent a neural evaluation of the corresponding dimension. Values more than 0.8 represent a positive evaluation and values less than -0.8 represent a negative evaluation. If range of the scales is between +3 it is noted as a positive extreme and -3 as a negative extreme.

Findings from the UEQ showed that the scores for all scales represent a positive evaluation describing a pragmatic quality aspect (efficiency, perspicuity, dependability) with a value of 1.26, hedonic quality (stimulation and novelty) with a value of 1.50 and attractiveness with a value of 1.57. Alpha coefficients are 1.570 for attractiveness, 1.302 for perspicuity, 1.279 for efficiency, 1.186 for dependability, 1.750 for stimulation and 1.244 for novelty. Therefore, these values indicate a sufficient scale consistency.

The value of attractiveness and stimulation give the highest scale in the results. This showed that users have found that the overall impression of the application is attractive, exciting and motivate them to use it.

Table 2. UEQ results

Scale	Mean	Std Dev	Con	Con. Int	α
Attractiveness	1.570	1.399	0.296	1.866-1.274	.79
Perspicuity	1.302	1.315	0.278	1.580-1.024	.53
Efficiency	1.279	1.321	0.279	1.558-1.000	.61
Dependability	1.186	1.077	0.228	1.414-0.959	.49
Stimulation	1.750	0.987	0.209	1.959-1.541	.37
Novelty	1.244	1.100	0.233	1.477-1.012	.59

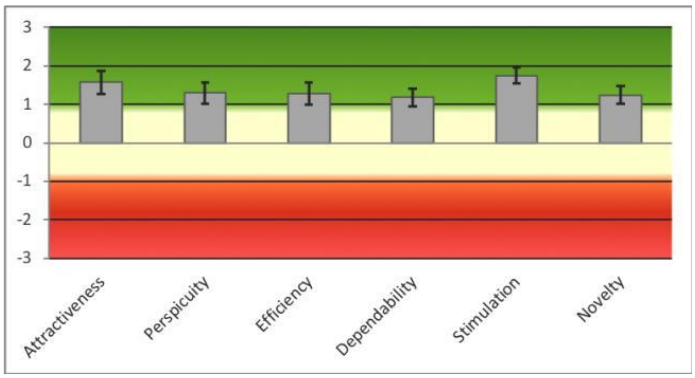

Fig 11. UEQ overview result

VI. CONCLUSION

This study aims to develop an effective AR application for knowledge transfer from the perspective of practice-based design, hence it defines a proper experimental set-up for the design issues and testing to enhance student's conceptual understanding by immersing students in an augmented environment. We have successfully developed the mobile AR with coloring sheets features which is able to attract, engage and motivate them to use the application, thus become as an educational tool in assisting student's conceptual understanding about mosquito breeding.

The education about mosquito breeding as one of the vector control programs is crucial in order to prevent dengue from spreading at the early phase.Hence, this study will give an impact on student's knowledge transfer about Aedes and dengue awareness particularly to school community in Malaysia by using the advantages of AR technology. Therefore, this study will be a step forwards to an exploration of the AR benefit in experienced-learning approach application.

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