

Development and Evaluation of 2D Virtual Agent Multimedia Quiz App

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Abstract: Quizzes refer to a useful assessment method that assesses overall about what has been taught. Quizzes devised from various interactive ways are capable of encouraging students to pay closer attention and indirectly improve their comprehension towards the subject. Hence, two-dimensional (2D) virtual agent multimedia quiz application (app) was developed. Accordingly, a 2D female virtual agent with Malaysia's native look had been designed to perform the quiz through the app. The quiz app is composed of 20 multiple-choice questions. The targeted participants who took this quiz were from fourth and fifth semester students from electrical engineering department of Malaysia polytechnics. The quiz app was developed based on several theories, principles, and literature overview. The quiz app drives with different functions through several screens namely home, question, feedback, hint, reward and review screens. Additionally, this paper reports the outcomes of usability and user satisfaction based on the tests conducted.

Key words: *Multimedia quiz app, virtual agent, pedagogical agent, quiz, usability test, multimedia learning environment*

INTRODUCTION

Quizzes appear to be a useful assessment method that evaluates overall about what has been taught [1]. Quiz items are designed by focusing on both the application and the combination of concepts [2], which are able to promote flexibility in the usage of information. Quizzes that are created with various interactive ways possess the capability to encourage learners to pay closer attention and indirectly enhance their understanding [3][4]. Hence, quizzes that are presented conventionally via in-class quizzing [5][6] can be transformed into online quizzing [7][8].

Repeated quizzing found on online platform has led to better performance, when compared to those conducted in classrooms [7]. Quizzes developed via online are more effective to can assist learners in remembering important terms or concepts. Besides, the integration of quizzes with other instructional activities in a teaching strategy seems to be favorable to learners [9]. Students highly appreciate the role of quizzes in online platform as it helps keep students up with the

course and strengthens their involvement. Consequently, online quizzes generate a positive impact on academic outcomes. After weighing in these points, a quiz app with 20 multiple-choice questions was developed for research purpose.

MULTIMEDIA QUIZ APP

The developed quiz was fully based on Multimedia Learning Environment (MLE) that promotes learning among students [10][11]. A well-established line of researches demonstrates that students happen to learn better from words and graphics, in comparison to words alone [11]. Hence, the quiz app was designed with Gagne's nine events of instruction [12] and integrated with several multimedia elements, such as texts, graphics, audio and video clips, as well as animation.

Successful learning experiences can be enabled by designing an exceptional virtual agent within effective learning environment [13]. Virtual agent is one that offers students additional life-like communication that increases the interaction capability of the instructional media and consequently improves its

capability in engaging and motivating learners [14][15][16].

Accordingly, the virtual agent is present at all times throughout the quiz app to guide the students with multiple spoken dialogues as the social affinity between the user and the agent. The quiz app is comprised of 20 questions derived from the first chapter of the chosen subject. The students were required to answer 20 multiple-choice questions provided by the virtual agent. The virtual agent is designed to provide response based on the choice of answer made by the students.

DESIGN STRUCTURES OF QUIZ APP

Five essential multimedia elements were embedded in the psychical design structure of this quiz app, including texts, audio and video clips, animation, and graphic. In addition, the psychical design structure took into account the screen design to produce a computer-based app.

Text

The questions in this quiz app are presented in the form of texts for the student to read. The students may respond by clicking on the available text responses. Text styles and background colors on the screen can affect the readability of texts that appear on the screen, external cognitive load, and learning retention [17]. Accordingly, the texts employed in this quiz had been selected by considering the following criteria:

- **Font Type** - The chosen font for this quiz was from san serif category, which is Verdana. This font face was chosen due to good readability on screen display, as compared to serif fonts that better suit for printed output [18][19]. Hence, the Verdana font was applied to present the questions on screen.
- **Font size** – Use of font size smaller than 12-point makes reading slower and challenging for the students [20][21]. Hence, the chosen size of the font for this app was 12-point, so as to ascertain easy and clear readability of the questions by the students.
- **Font color** – Black text on a blank background makes a huge difference to allow the students to read more quickly and easily [20][22]. Hence, the font color for the question texts was black.

Graphic

Graphic refers to any image produced with the use of certain software and computer technology. In the quiz app, graphics were used as clickable icons, such as home, next, replay, info, and exit buttons. The behavioral aspects of button commands enable the end-user to activate an event [23]. All screens or events

linked to each other had been based on the aspect of button interactivity. Each button was created with unique appearance based on the following criteria:

- **Button's appearance**- The use of images to represent an object is easier to remember than text [20][24]. The buttons were produced by scratching the appropriate image using Adobe Photoshop CS6. Next, the scratched buttons were designed with a three-dimensional (3-D) appearance and were modified by filling with colors.
- **Button's text** - Students can integrate an image clickable if it is designed together with text [20][22]. Thus, the image buttons were added with the most common text. Buttons designed along with texts indicate the linking screen name [25][26].
- **Button's state** - The existing screens of the quiz app were portrayed with 'push-down' button state.

Audio

Audio can be defined as any sound in digital form, such as background music, narration, and others that may be heard. The narration articulated by the virtual agent was embedded in the quiz app. Details pertaining to the audio are given as follows:

- **Narration** - The interaction between students and the virtual agent is established through an asynchronous voice dialogue [27]. The virtual agent spoke using standard and clear Malaysian female voice. Slang was omitted from the voice. The selection of voice took into account comfort of students as the students are familiar with localized voice.
- **Background music**- Past studies showed that background sound as music or ambient sounds can harm the learning process [28]. Hence, no background music was applied.

Video

The animated virtual agent was saved as a movie clip symbol for every dialog in the quiz app. The movie clip had its own timeline within the symbol. The movie clips were saved in the library to develop the quiz app. The movie clips had navigational control, such as play, pause, and stop buttons. This enabled students to replay the clips as they wished.

Animation

Animation is a technology that enables a still image to look as though it is alive, which is able to move, act, and

talk. Animated agent was used as a pedagogical agent for the virtual interaction with the students throughout the quiz app. The design and the implementation of an agent had been based on natural face-to-face interaction in the real world using verbal and nonverbal communication techniques [13]. Besides, the cognitive styles of individuals were produced by considering personality, human nature, and culture [29].

Consequently, animated 2D female virtual agent was developed. In the development of virtual agent, the consistent lip movements with the speech were weighed in [30]. Accordingly, synchronized lip movement was implemented to the virtual agent to provide speech that communicated with the students that added to the attractiveness of the quiz app.

Screen structures

The screens were organized systematically so that they were connected to each other and were limited to the present concept. A number of principles were considered while developing the screen layout, as depicted in the following:

- **Screen size** - The large screen size expanded the interface between humans and screens [31]. The default size or the resolution of the entire screen was 780x440 pixels [32]. This size was selected because the full screen display was convenient to the students.
- **Cues** - All the clickable objects were placed consistently at the top of each screen for better view and easy to achieve at all times [20][33].

- **Home button**

Home button should be placed on top of each page so that the students can reach the main page easily and immediately from any of other screen [20][34]. Thus, the present of home button at top-right of the screen should provide consistency and familiarity to the students to achieve it when necessary.

- **Exit button**

Students can exit from the screen by clicking on the exit button. This exit button was also positioned at the top-right corner of all screens for the students to exit the quiz.

- **Screen title** - The clear and concise title on each screen allows the students to easily recognize and access the screen [20]. Therefore, the title of each screen was displayed at the top-center of all screens.
- **Background color** - Black text on a white background is easier to read than other combinations [35]. Moreover, white background with black text provides maximum contrast [34]. Therefore, white was used as the

background color for the entire screen in the quiz app. The usage of similar color throughout the screen adds to the consistency based on soothing factor in the user interface design [36].

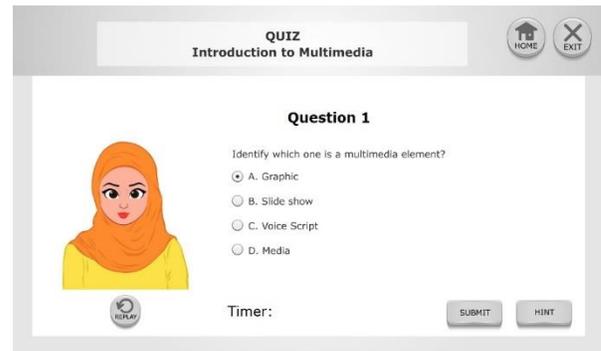


Fig 1 Question screen

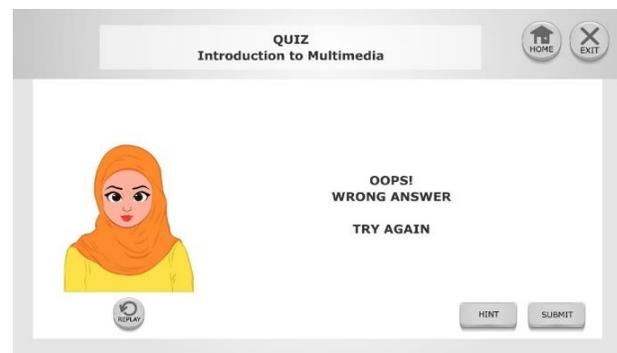


Fig 2 Wrong-feedback screen

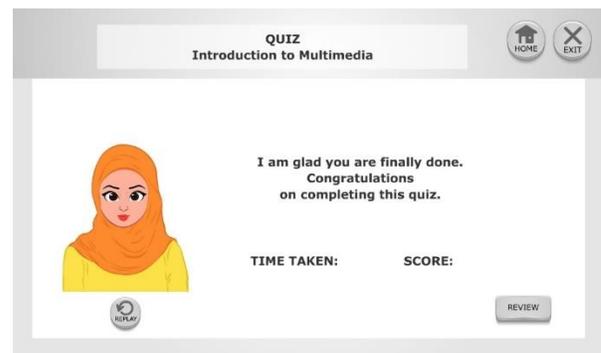


Fig 3 Reward screen

METHOD AND INSTRUMENT

Usability testing was carried out after the completion of quiz app development process. The adapted Post-Study

System Usability Questionnaire (PSSUQ) was used for evaluation purpose [37].

The PSSUQ is comprised of 21 items with 7-point Likert-scale (ranging from strongly agree [1] to strongly disagree [7]). The following illustration portrays a sample question: Lewis, J. R. [37]

The Post-Study Usability Questionnaire		Strongly Agree					Strongly Disagree	
		1	2	3	4	5	6	7
6	All the features in the quiz application functions well							

The PSSUQ consists of seven subscales: design / layout (items 1–3); functionality (items 4–6); ease of use (items 7–10); learnability (items 11–13); satisfaction (items 14–16); outcome / future use (items 17–19); and errors / system Reliability (items 20–21).

The participants of this study were composed of 40 polytechnic students. This study was conducted for 30 minutes after the students explored the quiz app. The basic functions of the quiz app were explained by the author prior to exploration. The participants explored the quiz app for about 20 minutes and later, answered the questionnaire.



Fig 4 Usability testing with polytechnic students

RESULT AND DISCUSSION

Cronbach’s alpha was employed to calculate the reliability of the quiz app. As a result, the Cronbach Alpha value of the usability test and user satisfaction of the PSSUQ questionnaire was 0.89. This signified that the quiz app had high reliability. Next, mean values and standard deviations were determined after 21 items were recoded (reverse scored). The outcomes from the PSSUQ showed that the participants were, overall, satisfied with the usability of the quiz app (see Table 1)

Table 1: Results of PSSUQ items

		MEAN	SD
Design / Layout			
1.	I liked using the interface of the quiz application	6.4	0.84
2.	The organization of information on the quiz application screens was clear	6.5	0.71
3.	The interface of this quiz application was pleasant	6.4	0.81
Functionality			
4.	This quiz application has all the functions and capabilities that I expect to have	6.3	0.85
5.	The information provided in the quiz application was clear	6.4	0.67
6.	All the features in the quiz application functioned well	6.5	0.60
Ease of use			
7.	It was simple to use the quiz application	6.6	0.54
8.	It was easy to find the information I needed	6.3	0.73
9.	The information provided in the quiz application was clear	6.6	0.59
10.	Overall, this quiz application was easy to use	6.7	0.62
Learnability			
11.	It was easy to learn by using the quiz application	6.6	0.64

12.	There wasn’t too much information to read before I can use the quiz application	6.4	0.74
13.	The information provided in the quiz application was easy to understand	6.5	0.68
Satisfaction			
14.	I felt comfortable using the quiz application	6.6	0.59
15.	I enjoyed exploring the quiz application	6.5	0.64
16.	Overall, I am satisfied with this quiz application	6.6	0.59
Outcome / Future use			
17.	I believe I could become productive quickly using this quiz application	6.4	0.64
18.	The quiz application was able to convince me on improving my skills	6.5	0.60
19.	From my current experience using the quiz application, I think I would use it regularly	6.2	0.77
Errors / System Reliability			
20.	Whenever I made a mistake in the quiz application, I could recover easily and quickly	6.6	0.59
21.	The quiz application gave error messages that clearly told me how to solve the problem	6.5	0.64

CONCLUSION

Quizzes are a useful assessment method that can be performed to examine overall about what has been taught. Besides, the integration of quizzes with other instructional activities in a teaching strategy is indeed favorable to learners. Therefore, the virtual agent functioned as the instructor in the quiz app and interacted with the students via narration. The usability evaluation showed that the polytechnic students possessed a high degree of satisfaction towards the quiz app. Moreover, the participants were really excited to use the quiz app and they replayed the quiz even after completing it.

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