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ENHANCING USER INTERACTION IN A NUTRITIONAL EDUCATIONAL PACKAGE FOR THE ELDERLY USING 3D ANIMATION

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ABSTRACT

Most of the elderly have difficulties with computer technology. They lack computer literacy, and at the same time, have physiological changes that are associated with impaired perception, cognition, and other social aspects. These limitations can be lessened using multimedia elements to assist in their interaction with computers. One of these multimedia elements is 3D animation. We have incorporated 3D animation into a digital educational nutritional package, which was designed following the design guidelines for older adults, for better interface user interaction. An experiment was carried out to measure user acceptance; and a comparison was made between the digital package and a booklet. Questionnaires were distributed to six elderly subjects, aged 60 to 75 years old. Overall, the results showed that the 3D animation was helpful in facilitating an understanding of the content. The comparison experiment involved ten respondents that were divided into the experiment (digital package) and control (booklet) groups. Each group was given a task and the completion time for each was recorded. The findings indicate that the content exploration using the digital package was faster than using the traditional booklet. Of the respondents, 60% from the experiment group were able to access the content in less than two minutes; compared to 40% from the control group. These initial findings indicate the possibility of using a digital education package, and as such, should be explored further with larger samples and modules, in order to increase the nutritional and health knowledge and awareness among the elderly.

Keywords: *Interface Design, Elderly, Nutrition Education*

1. INTRODUCTION

Computer interfaces today, may be appropriate for normal users. However, existing interface designs are not appropriate for every type of user, due to varying physical and cognitive factors among users. This issue also applies to senior citizens. Their cognitive functions tend to be less than they were at a younger age [16]. This may cause them to be left behind in the ICT field, as they have a slower learning rate than younger people. For example, a lack of sensitivity makes it difficult to read normal-sized text or to distinguish a button when interacting with a system's interface.

Czaja & Lee [6] states in his study that the elderly often have difficulty in adapting to new technologies. The main reasons for this are a decreased cognitive ability and a mental reluctance to accept new technology. Recent research shows that even though the elderly having trouble with technology, their performance could be enhanced if the system's interface design was adapted to meet their needs.

Integration of interactive multimedia is been widely used in education and entertainment. Multimedia interaction can include text, audio, video, graphics, and 3D animation. According to Gould & Anderson [9], combining multimedia elements could help people who are illiterate. 3D animation objects are widely used today, especially in medical and education application areas. These interaction designs allow for the learning process to become easier and more effective than traditional reading methods. Thus, the design of interaction interfaces for the elderly need appropriate consideration and should emphasize their abilities and cognitive levels.

This paper is organized as follows: Section 2 explains some of the related work on interface designs related to elderly people. Section 3 describes our developed digital package for the

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elderly, with the approaches used during the design process. Section 4 discusses the experiment, followed by the findings in Section 5. It concludes with a summary and our future work in the final section.

2. RELATED WORKS

A study by Stuen & Faye [19] showed that the elderly often have vision problems, such as focusing, low-light vision, and a decreasing sensitivity towards similar colours and glare. The elderly are much more likely to have a hearing impairment than younger people, and an intolerance loud noise. The loss of the ability to hear high-frequency sounds is also a typical hearing impairment in many elderly people. Many elderly people experience difficulties in hearing in a noisy environment, because they cannot separate speech from background noise [2].

Elderly people need different approaches in using computers [3][16]Their reduced interaction with input devices might be due to a lower motor ability [5]. In fact, a reduction in their perception and cognitive functions would also affect this interaction [16]. Decreased motor ability adversely affects their use of input devices. For example, decreased motor ability slows down the user's interaction with a mouse to select objects on the interface; especially small objects [5]. Therefore, the design of interaction interfaces for the elderly need appropriate consideration, emphasizing particularly on their ability and cognitive levels. One technology that is suitable for user interaction is a touch screen interface. Touch screen technology is a direct touch device. By using touch screen technology, input devices (such as keyboards and mice) are no longer needed.

In terms of visuals, 3D has many advantages, such as the interactivity with an interface. Sig & Dennis [17] state that people try to interpret a mental visualization in 3D, when they are faced with a 2D display. This is because human cognition is friendlier with a 3D environment; when it resembles a real human environment. 3D visuals facilitate human mental functions, without having to interpret the 3D display. For the elderly to accept3D visualizations, interface designs should be based on being elderly-friendly [13].

The elderly are less exposed to 3D technology. The elderly have problems with vision and physical abilities. These problems increase their difficulty to interact with 3D visualizations. In Peter's [16] study, he states that younger people were able to achieve a goal using a 3D interface quicker than the elderly. This is probably because younger people are exposed to the use of 3D visualizations in applications, such as video games and 3D software. An increase in film productions, using 3D visual effects, has led to an increase in the production of televisions capable of displaying 3D images. However, senior citizens are not suited to watching 3D visual effects that may result in shock or over stimulation of their hearts. Suitable 3D visual effects for the elderly may include 3D visuals with a slower speed.

Several systems have been developed with interface design specifically for the elderly, such as PointerWare [10] and Eldy [8]. For example, large sized buttons are provided to meet the requirements of the elderly. This, coupled with the use of touch screen technology, allows this group of users to interact more efficiently. Furthermore, the design of graphical buttons helps the elderly to understand the function of the button better, rather than just reading the text on the button. The fonts and their sizes are clear and large, respectively. The background colour used in Eldy [8] is a combination of dark and light blue. Meanwhile, PointerWare uses white or lighter colours.

A work by Andreas, Kizito, & Alexander [1] combined the research areas of Human and Computer Interfaces (HCI) with Usability Engineering, to create a concept of multimodal interaction. An interface that uses the concept of multimodal interaction is not limited, as it combines a variety of input and output devices, including the use of voice, touch, and movement. The concept of multimodal interface usability study was also conducted by Carlos et al., [4] where they developed computer systems to facilitate those who have problems with common interfaces.

These are some of the works related to the design of elderly people interface and the efforts carried out to increase the interaction between the elderly and new technologies.

3. DIGITAL NUTRITION EDUCATIONAL PACKAGE

WE SIHAT is a nutritional educational digital package that was developed based on an elderly interface design approach, using checklist guidelines and heuristic evaluations [18]. The digital package was developed with the nutrition content development based on work carried out by Suzana et al. [20]. The aim of the development of a prototype tool is to enhance the interaction of the

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elderly with new technologies and enhance knowledge in nutrition for better healthy living. Studies of user acceptance have been carried out, and the results have shown a very positive feedback. Complete results and discussions can be found in Nazlena et al., [14].

To follow-up the success of the WE SIHAT package, with positive feedback and user acceptance, we can further enhance the system to include more interactive multimedia elements using 3D animation. 3D animations were used to simulate some of the content in the package, instead of using static graphics for the effects of food intake on organs, such as blood circulation simulation. These3D simulations were included within certain aspects of the module, thus replacing static text or graphics.

3D animations where incorporated within the WE SIHAT package, with the aim of enhancing content understanding using a multimedia concept. 3D animation can help to increase the rate of learning, and the understanding of the visuals viewed [7]. The elderly are less exposed to 3D technologies, and in order to facilitate their acceptance of 3D visual animations, an elderly-friendly interface should be designed. The animations were design based on guidelines that help older adults, in terms of content understanding. These guidelines focused on the use of colour combinations, slow animation speeds, and loud but clear background sounds. The 3D animations also included help labels for 3D objects or processes taking place. Figure 1 shows an example of a 3D animation, and the visuals displayed on the WE SIHAT digital package.

Figure 1: A 3D Animation Of The Effect Of Calcium On Bones. Example Of A 3D Animation, And The Visual Displayed On The 'WE SIHAT' Digital Package.

The colour used for the 3D objects should not be bright, such as white or yellow [12]. The elderly are uncomfortable with brighter colours. According to Niamh et al.,[15] simple buttons are the best interaction method for the elderly. Therefore, we designed large clear buttons. The size of the buttons used on the main page and the common page are 24 mm^2 and 19 mm^2, respectively. The elderly cannot keep up with very fast animations, due to their decreasing spatial functions. Thus, movements involving 3D (or animation) need to be slow, in order to help them identify objects correctly. Animations should consider the elderly's visual perception problems. As for animations in the package, each movement slow, in order to make sure that the elderly can keep up with it. Higher frame rates should be used to ensure the smoothness of animations. The animations in WE SIHAT use a frame rate of 30 frames per second (fps).

4. USER EXPERIMENT

We conducted a user evaluation, with the objective of gauging user experiences subjectively, in using an enhanced version of WE SIHAT; which incorporated 3D animation. Self-complete questionnaires, asking about content understanding, animation speed, fonts or labels, audio, interaction design, and ease of use of the 3D animations in WE SIHAT, were administered. The evaluation process for this study required a sample of subjects aged 60 years and above. This study received cooperation from Kuala Lumpur City Hall to evaluate a Senior Citizen's Club.

The elderly were initially tested using a Mini Mental State Evaluation (MMSE). MMSE is a brief 30-point questionnaire test that is used to screen cognitive impairment [11]. The MMSE test includes simple questions and problems; for example, the time, location of the experiment, repeating lists of words, simple arithmetic, such as serial sevens, language use and comprehension, and basic motor skills. A score of greater than or equal to 25 points (out of 30) is deemed to be effectively normal.

For the first experiment, only 6of the 18 elderly participants (aged 60 to 74) passed the MMSE test, (3 men and 3 women), and were recruited to evaluate the acceptance level of 3D animation in the WE SIHAT package. All subjects were given ample time to explore every 3D animation module included within the package, by browsing and exploring the content of each package. After the

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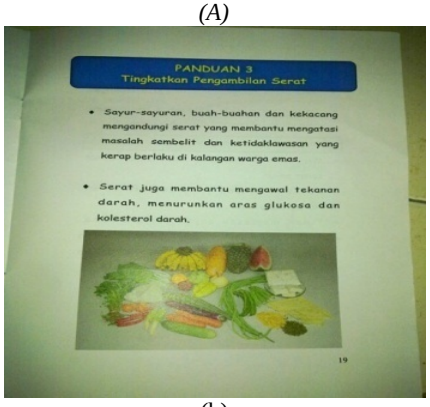
exploration, the subjects were given a set of questions, assessing their acceptance of the animated 3D visuals.

We also conducted a second experiment to compare the time access rate of content from the digital package and the traditional booklet. We provided a booklet with similar content of the nutritional package. Figure 2 shows an example of the medium used in the experiment. A total of 10 elderly participants (out of 20), who passed MMSE test (6 men and 4 women), were divided into two groups. One group was tested with the WE SIHAT digital package, while the other group was tested with the booklet. The first task for this experiment was to compare the time taken for each group to completely read the content of the nutritional education. Each subject (in both groups) was given a questionnaire. Questions required the subjects to find an exact page of the answer for the question. The time and number of the trials required to access information for both methods was recorded and compared. In the final task, participants were given a quiz. All questions had to be answered by referring to their nutritional education medium; completion times for all questions were recorded.

(A)



(b)

Figure 2: Example Of The Medium Used In The Experiment. A) Digital WE SIHAT Package, B) Booklet

5. RESULTS AND DISCUSSION

The user assessment results of 3D visual animations can be seen in Table 1.The majority of subjects gave positive responses; in that animated 3D visuals were easy to understand. All subjects also gave a positive answer that 3D visual animations facilitated content delivery. The results showed that 83.3% of the subjects were satisfied with the speed of the 3D animations and their appropriateness. One subject felt that the 3D animation speed was at a normal level i.e., neither too fast nor too slow. These results show that the developed animation attempts to match the efficiency rate of the elderly.

In terms of providing interactivity buttons using animation, all subjects felt that the buttons were clear and easily identified. All subjects stated that the "*Replay*" button provided at the end of each animation helped them to understand the content, by enabling them to re-play the animation. Audio and voice was also added to help the subject to understand the animation better. The results of the questionnaire indicated that 100% of the subjects agreed that audio and voice helped them to understand the animation. All subjects gave a positive response that the text and labelling incorporated into the animation also helped their understanding.

Table 1: Aspects of the acceptance of animated 3D visual assessment. Note. The values are in form of Likert's Scale. (1 Strongly Disagree to 5 Strongly Agree)

Aspects	Evaluation n (%)				
	1	2	3	4	5
Easy to understand	0.0	0.0	0.0	66.7	33.3
Audio/sounds facilitates understanding	0.0	0.0	0.0	66.7	33.3
Helps increase acceptance of the content	0.0	0.0	0.0	50.0	50.0
Animation speed is suitable	0.0	0.0	16.7	50.0	33.3
Touch button for interactivity is clear	0.0	0.0	0.0	66.7	33.3
"Replay" Button is necessary	0.0	0.0	0.0	83.3	16.7
Text/label facilitates understanding	0.0	0.0	0.0	66.7	33.3

The majority of subjects stated that WE SIHAT contained more detailed information on nutrition. Besides, they also perceived that WE SIHAT was

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capable of enhancing knowledge about healthy eating. Previous researchers have proved that the concept of interactive multimedia-based learning is effective. This is because an interactive multimedia package, implements various elements, such as graphics, audio, animation and interactivity in learning. The 3D animations included in this healthy eating guide are one of the factors that facilitate the understanding of the content of this package.

The second experiment, which was to compare between the digital nutritional education package and the booklet, was carried out using three predefined tasks. The experimental group's subjects used the digital package, whilst the controlled group's subjects used only the booklet. Table 2 shows a demographic profile in the comparison experiment.

Table 2: Demographic Profile In The Comparison Experiment

Aspects	Experimental Group (n = 5)	Controlled Group (n = 5)	Total (n = 10)
Ethnicity :			
Malay	4 (80)	5 (100)	9 (90)
Chinese	1 (20)	0 (0)	1 (10)
Marital status :			
Single	0 (0)	0 (0)	0 (0)
Married	3 (60)	4 (80)	7 (70)
Divorced	0 (0)	1 (20)	1 (10)
Widow	2 (40)	0 (0)	2 (20)
Educational level :			
Never	0 (0)	0 (0)	0 (0)
Primary school	2 (30)	1 (20)	3 (30)
Secondary school	3 (60)	4 (80)	7 (70)
Employment :			
Working	0 (0)	0 (0)	0 (0)
Retired	5 (100)	2 (40)	7 (70)
Housewives	0 (0)	3 (60)	3 (30)
Computer Experience :			
Yes	2 (40)	2 (40)	4 (40)
No	3 (60)	3 (60)	6 (60)

Figure 3 shows the time taken to completely finish reading the entire contents of the nutritional education guide, for both WE SIHAT and the booklet. A total of 80% (n = 4) of both groups took approximately 10 to 20 minutes to completely finish the reading.

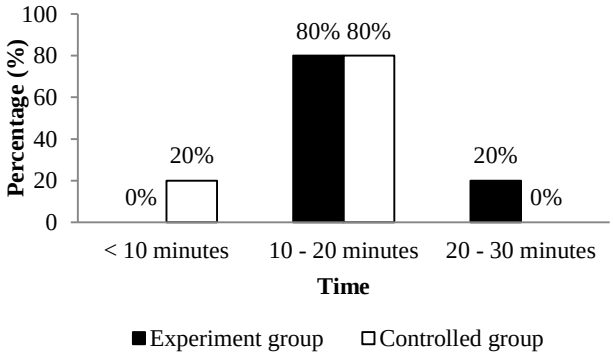

Figure 3: Time Taken To Completely Finish Reading The Entire Contents Of The Nutritional Educational Guide, For Both 'WE SIHAT' And The Booklet. The Experimental Group's Subjects Used The Digital Package, Whilst The Controlled Group's Subjects Used Only The Booklet.

The WE SIHAT package is different from the traditional booklet, which the user was only needed to read and because it also included animation and audio to help content understanding. Furthermore, computer-based interfaces may increase the reading time process for first-time users. The number of subjects that lacked experience in using computers was high in both groups. However, the results showed no major differences for reading completion times for both groups. This indicates that WE SIHAT is very easy to use; even for elderly participants without computer experience.

The second task given to the subjects was to access a page containing the correct information. The timer began as soon as the subject finished reading the question. The timing was based on the researcher's observation. Figure 4 shows that 60% of the subjects from (n = 3) took less than 2 minutes to access the correct information; whilst 40% of the subjects took 2 to 4 minutes. The control group, who only needed to access information from the booklet, showed that 40% of the subjects (n = 2) managed to access the correct information in less than 2 minutes; and only 20% (n = 1) took about 2 to 4 minutes (see Figure 4). This shows that subjects using the digital package required less time to find information compared to those using the traditional booklet.

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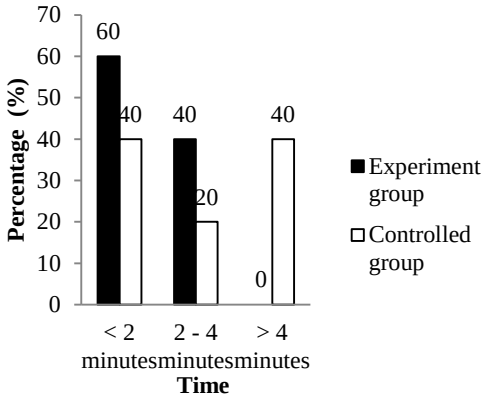

Figure 4: Time Taken To Find Information On A Single Question (Second Task).

The friendly interface of the Digital 3D WE SIHAT for the elderly gave a positive impact in this experiment. The buttons were designed with content-related graphics. This metaphor might simplify the subject to directly access the relevant information, compared to the booklet; which requires the subject to flip through pages to find the right information. Some subjects commented that WE SIHAT was very easy to use. The friendly interface facilitates the elderly in using this package. The process of flipping through pages (or navigating to find information) may cause confusion. This confusion may increase the number of attempts made to access accurate information. In addition, each information topic in the package was laid out consistently on each screen. The layout design might help subjects to focus better.

Subjects from the two groups were given a set of questions containing nine multiple choice questions. Subjects needed to refer to the healthy eating guidelines information to find the correct answer. As shown in Figure 5, 80% of the subjects from the controlled group (n = 4) completed the questions in 5 to 10 minutes. Subjects from the experiment group took different times to complete the quiz. 40% of the subjects completed the quiz in 10 to 15 minutes. One subject (from the experiment group) completed the task less than 5 minutes.

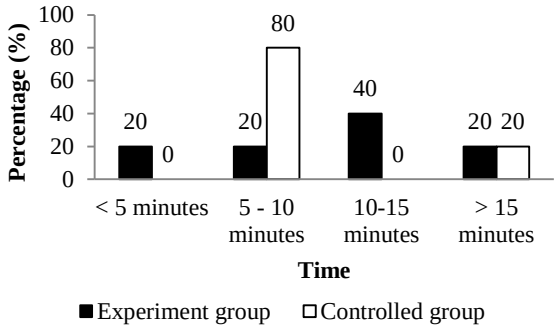

Figure 5: Time Taken To Complete Set Of Nine Questions. Subjects From The Two Groups Were Given A Set Of Questions Containing Nine Multiple Choice Questions. Subjects Needed To Refer To The Healthy Eating Guidelines Information To Find The Correct Answer.

The results show that the times taken for subjects using WE SIHAT were in consistent and varied. This may have been due to their different abilities to use a computer. Only 40% of the samples from this group claimed to have used a computer before. From our observations, the subjects with experience in using a computer could access quicker than those with less experiences. In addition, the number of questions was also a factor which we think could have influenced the results. Unlike the second task, this time the subjects needed to repeat the same process more than once and the time only stopped when all questions had been answered. The findings from the experimental group were different from the control group using the booklet. The majority of subjects required approximately the same time to answer all questions. Reading books or finding information from printed material is the traditional way for most elderly people. Therefore, they do not experience any of the difficulties encountered by the subjects from the experimental group using a computer.

Previous studies have proved that the concept of interactive multimedia-based learning is more effective. This is because interactive multimedia packages can easily implement various elements, such as graphics, audio, animation, and interactivity. 3D visual animations, which were also included in this healthy eating guideline, are one of the many factors that enhance the user's content understanding. We found that WE SIHAT is a package that is easy to learn, easy to use; and the content is easy to remember.

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This study was limited, as the sample needs to be increased to involve several senior citizens' clubs; so that a better generalization could be made.

6. CONCLUSION

We have demonstrated that based on subjective user feedback, the newly developed 3D digital nutritional package had a potential to be used both as an information kiosk and as a tool to educate the elderly on healthy diets. Utilizing a proper design and guidelines for the elderly is important, as it can contribute to better user interaction with the interface design. Further work needs to be carried out in order to enhance user interaction and the modules to cover a larger sample population.

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