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The Development of AR Book for Computer Learning

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Abstract Educators need to provide the alternative educational tools to foster learning outcomes of students. By using AR technology to create exciting edutainment experiences, this paper presents how augmented reality (AR) can be applied in the education. This study aims to develop the AR book for tenth grade students (age 15-16) and evaluate its quality. The AR book was developed based on ADDIE framework processes to provide computer learning on software computer knowledge. The content was accorded with the current Thai education curriculum. The AR book had 10 pages in three topics (the first was "Introduction," the second was "System Software" and the third was "Application Software"). Each page contained markers that placed virtual objects (2D animation and video clip). The obtained data were analyzed in terms of average and standard deviation. The validity of multimedia design of the AR book was assessed by three experts in multimedia design. A five-point Likert scale was used and the values were $\bar{X}$ = 4.84, S.D. = 0.27 which referred to very high. Moreover, three content experts, who specialize in computer teaching, evaluated the AR book's validity. The values determined by the experts were $\bar{X}$ = 4.69, S.D. = 0.29 which referred to very high. Implications for future study and education are discussed.

INTRODUCTION

Augmented Reality (AR) includes many advantages enabling designing and developing effective solutions to improve life standards. Researchers think that AR can allow improving people's perceptions, knowledge, and interaction with the real-world and it can also lead to improved productivity in real-world tasks. In this sense, education is one of the most popular fields in which AR applications are often performed. More specifically, the e-learning technique in the education field is one of the most remarkable application areas within today's AR oriented solutions [1].

The multimedia learning principle, students learn better from words and pictures than the words themselves. AR can implement this principle by overlaying printed texts with virtual contents (for example; integrating videos, 2D animation, and 3D animation to a textbook). Moreover, the principle states that presenting textual information with an auditory format is better than a textual format alone. AR can also implement the principle by playing text narrations synchronized with printed texts [2]. Some teachers and researchers have successfully applied the AR technology as educational technology tools in their instruction.

Sommerauer and Müller tried to study the effect of AR on learning outcomes. The study presented the field experiment on the effect of AR in learning mathematical contents. The results showed that AR has the potential to be an effective tool for mathematics learning formal contents in informal learning environments as museums. Museum visitors learned significantly more from augmented exhibits than from non augmented exhibits, perceived AR as a valuable add-on of the exhibition [2].

Hsu developed and compared two Augmented Reality (AR) educational games for third grade students to learn English vocabulary. First game was developed based on a self-directed learning approach and did not control the learning sequence while the other was based on a task-based learning approach and control the learning sequence.

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The results found that students using both the self-directed and task-based AR educational games had high learning effectiveness and were helpful for learning [3].

Wei, Weng, Liu, and Wang tried to improve the learning motivation and creativity of students in China by using augmented reality (AR) technology into creative design courses. The study approach was based on the ARCS model of motivational design, social psychology, and a computational model of creativity. The results of a pilot study showed that AR Creative-Classroom which was the proposed teaching scheme significantly improved learning motivation, student creativity, and the teaching of creative design [4].

Fotouhi-Ghazvini, Earnshaw, Robison, and Excell studied designing augmented reality games for mobile learning using an instructional motivational paradigm. They explained that the learning objectives must be integrated into the game rules, story and different levels. The game model must be closely realistic. By using this emerging paradigm of instruction, educators can effectively incorporate these games into the instruction [5].

Accordingly, educators need to provide the alternative educational tools to foster the learning achievement of students. Using AR book could make student have good attitudes toward learning. The potential and advantage of the AR book have inspired researchers to realize that studying in a development of AR book can support computer learning. The key to this success is that students become motivated to learn through the use of educational technology tools.

The approach of the AR book development is based on ADDIE framework processes that could be used as instructional tools via mobile devices. The objectives of the study were:

1) to develop the AR book for computer learning,

2) to evaluate the quality of the AR book by experts.

METHOD

Participants

Participants consisted of 6 experts (3 experts who specialize in multimedia design and 3 content experts who specialize in computer teaching)

Instruments

The instruments used in this study are questionnaires which are divided into 2 parts; the first part is a 5 likert rating scale (1 = very high, 2 = high, 3 = average, 4 = fair and 5 = poor) to evaluate the multimedia design and content quality of AR book on computer learning for grade ten students and the second part is an open-ended question (optional) for additional views and suggestions. The obtained data were analyzed in terms of average and standard deviation.

ADDIE framework processes

This study was a progress study based on ADDIE model called an instructional systems design (ISD) framework in 5 steps [6] are as follows: 1) analysis step, 2) design step, 3) development step, 4) implementation phase, and 5) Evaluation step.

RESULTS AND DISCUSSION

This section presents assessment results for the development of the AR book on computer learning. The AR book design and development were described. Average and standard deviation were used to analyse the results obtained from the questionnaires.

The description of AR book

The AR book for computer learning scopes, the content covered computer learning that is referred to the current Thai Basic Education Core Curriculum B.E. 2551 (A.D. 2008). The AR book was delivered in Thai. The targeted

users were tenth grade students in the range of 15-16 years of age. Educators and students can use this AR book in the classroom or an individual tool as informal learning.

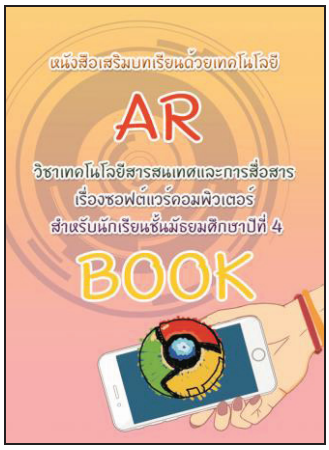

FIGURE 1. The cover of the AR book

The AR book had 10 pages in three topics; the first was "Introduction," the second was "System Software" and the third was "Application Software". Each page had markers that placing virtual objects (2D animation and video clip) that are seen by a camera on a computer or a mobile device. Researchers used red arrows to locate the markers in each page (see Figure 2.).

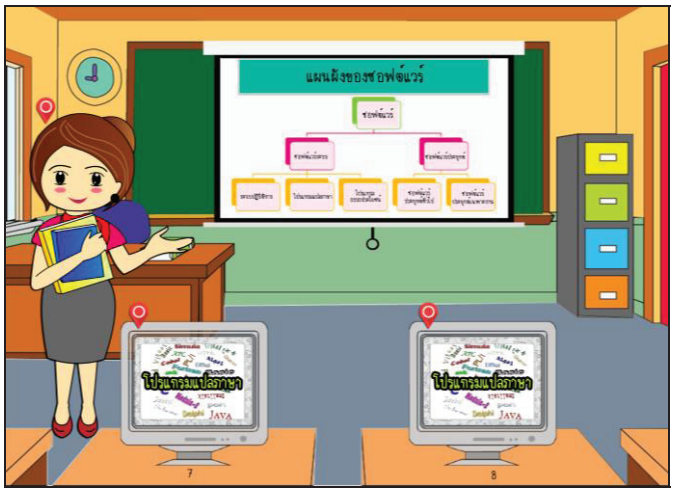

FIGURE 2. Markers in AR book

Quality assessment of the AR book

The results presented in Table 1. shows the validity scores of the AR book by experts in multimedia design. Table 2. shows the validity scores of the AR book by experts in computer teaching.

TABLE 1. The validity scores of the AR book design in multimedia

Criteria	$\bar{X}$	S.D.	Quality level
1. Texts	**4.80**	**0.34**	**Very high**
- Appropriate size of fonts	5.00	0.00	Very high
- Appropriate type of fonts	4.67	0.58	Very high

TABLE 2. The validity scores of the AR book design in computer teaching

Criteria	$\bar{X}$	S.D.	Quality level
- Appropriate color of fonts and backgrounds	4.67	0.58	Very high
- Appropriate arrangement fonts and sentences	5.00	0.00	Very high
- Correction of sentences following language methodology	4.67	0.58	Very high
2. Images	**4.93**	**0.11**	**Very high**
- Appropiate size of images	5.00	0.00	Very high
- Vibrant color of images	5.00	0.00	Very high
- Appropriate meaning of images to communicate	5.00	0.00	Very high
- To be balance arrangement of images	4.67	0.58	Very high
- Appropriate amount of images for the content	5.00	0.00	Very high
3. Animations	**4.86**	**0.23**	**Very high**
- Appropriate amount of animations	4.67	0.58	Very high
- Clear of animations	5.00	0.00	Very high
- Appropriate images of animations to communicate	5.00	0.00	Very high
- Appropriate arrangement of animations	5.00	0.00	Very high
- Appropriate amount of animations for content	4.67	0.58	Very high
4. Audios	**4.75**	**0.43**	**Very high**
- Frequently level of voice narration	4.67	0.58	Very high
- Appropriate level of voice for music	5.00	0.00	Very high
- Attraction of voice narration	4.67	0.58	Very high
- Correction of voice narration following language methodlogy	4.67	0.58	Very high
5. Videos	**5.00**	**0.00**	**Very high**
- Interesting and attractive videos	5.00	0.00	Very high
- Correct content of videos regarding purposes of lesson	5.00	0.00	Very high
6. Interaction	**4.67**	**0.58**	**Very high**
- Being easy and comfortable to control AR book	4.67	0.58	Very high
- Appropriate interactive to related content	4.67	0.58	Very high
Total	**4.84**	**0.27**	**Very high**

According to Table 2, the result showed that the quality of AR book design was very high ($\bar{X}$ = 4.84, S.D. = 0.27).

TABLE 3. The validity scores of the AR book in computer teaching

Criteria	$\bar{X}$	S.D.	Quality level
1. Related content with indicated behavior objection	4.67	0.58	Very high
2. Appropriate introduction of lesson content	4.33	0.58	Very high
3. Correction and completion of content	5.00	0.00	Very high
4. Appropriate consequence of content	5.00	0.00	Very high
5. Frequency of content from ease to difficulty	4.00	0.00	Very high
6. Appropriate kind and way to present	5.00	0.00	Very high
7. Clear explaination of content	4.67	0.58	Very high
8. Appropriate pictures, animations and sounds with content	5.00	0.00	Very high
9. Appropriate content with level of students	4.67	0.58	Very high
10. Appropriate content per each page	5.00	0.00	Very high
11. Appropriate time of study	4.33	0.58	Very high
12. Being able to apply klowledge with content and method of presentation	4.67	0.58	Very high
Total	**4.69**	**0.29**	**Very high**

According to Table 3, the result showed that the quality of AR book content was very high ($\overline{X}$ = 4.69, S.D. = 0.26). The results emerged from our research is both the quality of AR book design and the quality of AR book content were very high. We realized that the AR book will need to be improved and the implementation should be provided to the further studies.

According to the current study, the AR book is the innovative teaching tool that can enhance students to be the learners in 21st century skills. From these 21st century skills, teaching and learning in the 21st century aim to produce students proficient in content knowledge, specific abilities, literacy, numeracy, and technology uses [7]. The AR book is one of solutions to create exciting edutainment experiences for student learning [8]. Many studies reported that major advantages of AR are promoting learning attention and motivation because of graphical content and interaction. The features can help to explain well and make the students easily understand. Moreover, learning positive attitudes are reported as the effectiveness of using AR in educational setting [9, 10]. However, AR technology is still new in education and still some limitations. Significant limitations of AR tools pointed out the internet access and speed. Students may need to wait for the virtual information to be sent from the server to smartphones with a slow internet connection [11]. So, educators should consider the limitations of AR in their instruction.

CONCLUSION

This paper proposed the AR book for computer learning based on ADDIE framework processes. The AR book had 10 pages. Each page had markers that placed virtual contents (2D animation and clips). The quality of AR book design and the quality of AR book content were very high. The development and assessment was only a first step that the researchers realized to study the implementation in future studies. In conclusion, AR book is one of augmented reality technology solutions and it is certainly a powerful tool that can be used to motivate and amuse students to improve their learning achievement.

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