Teaching high school computer science with videos of historical figures— An augmented reality approach

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***Abstract*— This study investigated the effects of teaching history of computing with videos of historical figures. Augmented reality (AR) techniques were applied to assist student accessing the videos of historical figures while reading a printed textbook. Whenever a student was interested in a historical figure, one could use a tablet PC to scan the figure's picture, and the corresponding video about the person would then be played on the screen. We adapted thirteen videos of historical figures in computer network field and adopted a quasi-experimental method to evaluate the effectiveness of the AR-based learning approach. Two classes of high school students, with a total of 84 students, participated in the experiment. One class of the students used Tablet PCs to access the videos of historical figures; and the other class using traditional didactic instruction served as the control group. The data collected for analysis are students' achievement test scores and answers to a questionnaire, which consists of questions on attitudes toward learning, perspectives of nature of science, and perceptions on the AR activities. Our findings showed that the AR-based historical figure videos helped students comprehend learning contents and promoted their attitudes toward learning. Students appreciated the convenience of using AR tools to access the history videos. Future research should investigate other approaches to integrate AR with the videos of historical figure; and in general, to integrate AR with other media format of computing history.**

Keywords— history of computing, videos, historical figures, augmented reality

I. INTRODUCTION

History of science is a combination of humanities and science fields. It plays an important role in science education. Integrating history into teaching of science can promote students science concept understanding, connect society and culture interacted with the progress of science at that time of historical context of the events, improve students' perspectives on nature of science and understanding of the relationship between concepts and scientist [1].

Many teaching strategies can be applied to teaching history of science such as historical case study [2], historical dialog [3], interactive historical vignettes [4]. Some proposed "scientific biography" and "historical video" can be applied to demonstrate historical data, because large number of information would enlighten students to discover the development of science. Integrating videos into teaching computer science helped students understand and recognize the development of computer sciences [5,6].

Augmented reality offers an interface composing of words, specific information, and 3D models; and it also helps users to interact with both real and virtual worlds by a tangible interface [7]. AR can be used in different kinds of multimedia displays, and it effectively delivers the information by real environment and virtual objects. Users interact with virtual objects in a real environment, in which the figures and words are lively, and the abstract concepts can be understood more easily and the learning effect can be increased at the same time. Learning history from AR videos can offer more vivid details, background information, and character's emotion than traditional ways, in which history can only be described by words, static figures, and oral report [8].

The purposes of this study were to investigate the effects of teaching history of computing with the AR accessed videos of historical figures. We evaluated the effects in terms of students' learning achievement, attitudes toward learning, and perceptions on learning activities. The research questions were as follows: (1) How did the videos of historical figures improve students' learning achievement and attitudes toward learning? (2) How did students perceive their understanding of the history of computing being taught? and (3) How did the AR make a differences in learning?

II. RESEARCH DESIGN

A quasi-experimental method was adopted to assess the effects of the AR-based learning activities. Two high school classes, with a total of 84 students, were selected for the experiment, with one class serving as the experimental group and the other as the control group. Tablet PCs were given to students in the experimental group to access the videos of historical figures, while the control group received traditional didactic instruction. Both groups were taught the same contents using the same teaching materials. The experiment lasted for four weeks, during which a two-hour long class was given weekly. The perception questionnaire and the achievement test were conducted at the last week. The questionnaire used the five-point Likert scale and consisted of three types of questions:

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(1) Attitudes toward learning and senses of accomplishment,
(2) Understanding of historical contexts, and
(3) Perceptions on using AR tool (the tablet)

Students in the experimental group were asked additional questions about their experiences on accessing the AR-based materials with the tablets. The achievement test contained questions such as Tim Berners-Lee's proposing of the specifications of WWW and Paul Baran's initiating the concept of packet switching and application of the IP address.

III. AR-Based Historial Figure Videos

In order to meet the need of the students who participated in the experiment, we selected 13 historical figures from computer network related fields, who or whose contributions were mentioned in the high school CS textbooks. We then searched the Internet for related videos and adapted them for our instructional use. The sources of the original videos were properly quoted in our produced videos. Thirteen historical figure videos were produced for the experiment. All videos were about one minute long and addressed with the first-person perspective of the history figure. The contents included the explanation of the contributions made by the figure, the development of one's ideas/concepts, and the social and cultural context of the time of the development. The Chinese subtitles were added because most of the materials were in English

Augmented reality (AR) techniques were applied to give students access to the historical videos when reading a textbook. Aurasma, an augmented reality software, was chosen to connect a printed picture of a historical figure with its corresponding video. Whenever a student read the textbook and was interested in a historical figure, he could scan his/her picture with the tablet and the corresponding video of the figure would then be played on the screen. Figures 1 to 3 show the example of a student, after scanning Vint Cerf's picture (Fig 1.), whose tablet played an interview video of Cerf depicting his invention of the Internet concept (Fig 3.). The video was accessed via the AR software Aurasma (Fig 2.).

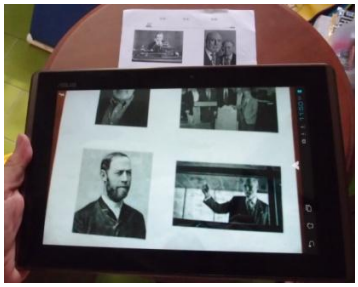

Fig 1. Scanning Vint Cerf's picture

Figure 2. video accessing via the AR software Aurasma

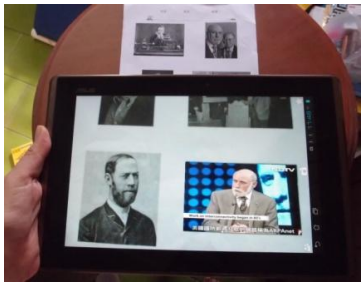

Figure 3. video playing about Cerf's invention on tablet

IV. Results

Table 1 presents the t-test statistical results on students' achievement test. There were significant differences (t = 2.15 (80), p < .05) between the experimental group and the control group. The results shown that the experimental group, who used AR application to access the videos of historical figures, performed better than control group.

TABLE 1 t-test results on achievement test

	GROUP	M	SD	*t*	*P*
achievement test	experimental group	83.6	1.30	2.15	.035*
	control group	76	1.85		

*p < .05

The questionnaire results (Tables 2 and 3) show that students in the experimental group were more interested in the history materials and felt more sense of accomplishment in learning than students in the control group. Over 60% of students in the experimental group gave positive feedback (Strongly agree and Agree) to the first three questions. In both groups, there are less than 15% of students who thought learning the stories of computer scientists would require their additional work. Table 3 shows the t-test statistical results. There are significant differences between the two groups on Question 1 (t(80) = 2.68, p = .009 < .05) and Question 2 (t(80) = 2.82, p = .006 < .05) which indicate that students who used AR based materials showed more interests in the stories of

historical figures and felt greater sense of accomplishment after the treatment.

TABLE 2 Questionnaire results about learning attitude

Question	Group	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. The history stories on computer network were interesting.	Experimental group	43%	22%	33%	2%	0%
	Control Group	13%	36%	44%	2%	5%
2. I felt a sense of accomplishment in learning computer network.	Experimental group	38%	24%	36%	2%	0%
	Control Group	13%	31%	41%	13%	3%
3. I would like to learn more about computer network.	Experimental group	36%	33%	29%	2%	0%
	Control Group	23%	41%	33%	0%	3%
4. Learning computer scientist stories required my extra work.	Experimental group	0%	24%	62%	12%	2%
	Control Group	0%	33%	54%	10%	3%

TABLE 3 t-test results on learning attitude

Question	Group	M	SD	*t*	*p*
1. The history stories on computer network were interesting.	Experimental group	4.05	.94	2.68	.009*
	Control Group	3.49	.94		
2. I felt a sense of accomplishment in learning computer network.	Experimental group	3.98	.96	2.82	.006*
	Control Group	3.38	.92		
3. I would like to learn more about computer network.	Experimental group	4.02	.88	1.04	.301
	Control Group	3.82	.87		
4. Learning computer scientist stories required my extra work.	Experimental group	3.1	.69	.804	.424
	Control Group	3.2	.72		

*$p < .05$

Understanding of Historical Contexts

The results form table 4 show the influence of the historical figure videos on students' understanding of historical context. Eighty-six percent of students in the experimental group believed that they had learned how the computer scientists thought at the time when they made inventions, as compared to sixty-four percent of the control group (Question 1). Table 5 presents the t-test statistical results on students' historical understanding. As to noticing the time of historical events, the experimental group also showed higher percentage of agreement than the control group. There were significant differences on both questions (Question 1, $t(80) = 3.32$, $p = .001 < .05$; Question 2, $t(80) = 2.24$, $p = .028 < .05$) between the two groups. In sum, students in the experimental group had a better grasp of historical context of the events than the control group after the treatment.

TABLE 4 Questionnaire results about historical understanding

Question	Group	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. The history stories helped me understand how scientists thought at their time.	Experimental group	45%	41%	14%	0%	0%
	Control Group	15%	49%	33%	0%	3%
2. I became noticed the time of historical events.	Experimental group	43%	19%	36%	0%	2%
	Control Group	13%	39%	41%	2%	5%

TABLE 5 *t*-test results on historical understanding

Question	Group	M	SD	*t*	*p*
1. The history stories helped me understand how scientists thought at their time.	Experimental group	4.31	.72	3.32	.001*
	Control Group	3.74	.82		
2. I became noticed the time of historical events.	Experimental group	4.00	1.01	2.24	.028*
	Control Group	3.51	.94		

*$p < .05$

Perceptions on Using AR

We also investigated students' opinions on using AR tools. The questionnaire questions phrased the AR tools as tablets because the tools were embedded within the tablets, which is all what students perceived. The questions were only answered by students in the experimental group. Table 6 shows that more than 70% of the students thought that tablet made the classes more interesting (Question 1, 74%), helped them better understand the contents (Question 2, 72%), was easy to use (Question 3, 86%) and could be used fluently (Question 4, 86%) and increased their interest in learning (Question 5, 79%). Students' answers on the open-ended questions of the questionnaire echoed the above results. Their comments on the ways the tablet facilitated learning were: (1) better control of learning progress, (2) convenient to use, and (3) interesting in nature.

TABLE 6 experimental group students opinions by using tablet

Question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	M
1. Using tablets made the classes more interesting.	33%	41%	21%	5%	0%	4.02
2. Using tablets helped me better understand the learning content.	31%	41%	26%	2%	0%	4
3. The tablet was easy to use.	29%	57%	12%	0%	2%	4.10
4. I had no problem of using the tablet.	29%	57%	14%	0%	0%	4.14
5. Using tablet increased my learning interest.	31%	48%	19%	2%	0%	4.07

V. CONCLUSION

In this study, we used the videos of historical figures to help students learn computer network concepts. The AR techniques were applied to access the videos when students reading the textbook.

Students thought that the history videos helped them better grasp not only the key concepts but also the historical contexts of the original ideas. Our findings showed that the AR-based historical figure videos helped students comprehend learning contents and promoted their attitudes toward learning. Students who used the AR-based materials had more interests in learning and felt greater sense of accomplishment. Students appreciated the convenience of using AR tools to access the history videos. Future research should investigate other approaches to integrate AR with the videos of historical figure; and in general, to integrate AR with other media format of computing history .

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