The Effects of Learning Style on Mobile Augmented-Reality-Faciliated English Vocabulary Learning

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***Abstract*—The affordance of mobile-based learning, including supporting a more personalized, authentic, situated learning are obvious. Research also revealed that mobile learning had positive effects on Second Language (L2) learning. However, individual differences on learning styles and prior knowledge could significantly affect the learning outcomes. This study aimed to investigate the effects of learning styles (field independence/dependence, FI/FD) and prior English proficiency (high/low) in a mobile augmented reality (AR) facilitated English vocabulary learning. Target subjects were elementary school children learning English as L2 and learning objective was set to memorize/understanding a set of ten English vocabulary. An experiment was done with self-developed AR-facilitated instruction. The results indicated that that FD learners benefitted significantly better from the mobile AR instruction on learning outcome; there was a marginal significant difference between high and low English proficiency learners on learning outcome; and neither learning styles nor prior English proficiency affected learning motivation. These findings indicated that individual differences should be considered while mobile AR L2 vocabulary instruction was applied.**

Keywords-augmented reality, learning style, English vocabulary learning

I. INTRODUCTION

Vocabulary learning, in particular, has always played an important role in laying a solid foundation for the acquisition of a foreign language [1]. As the basic building blocks of English sentences, vocabulary acquisition is necessary for second language (L2) learners to make correct inferences or to understand the content, or even to avoid being diagnosed as learning disabled [2] [3]. However, stated the main problems in traditional schooling practices are that information becomes decontextualized, knowledge appears to be more indirect, abstract, and experiences are second-handed confined in classroom context [4].

Nevertheless, individual differences also play an essential role in the effectiveness of learning. For example, Oxford and Anderson (1995) suggested that there is a need for language instructors to understand students' learning style to achieve optimal language progress [5]. Furthermore, learning styles-field independence/dependence (FI/D), in particular, has been considered potentially important in second language acquisition [6]. In addition to learning styles, learners' prior English proficiency may also make a difference in terms of learning outcome. However, previous studies that treated learners' English proficiency as an independent variable were mostly about their usage of learning strategies rather than the effect of a particular instructional method [7] [8].

Learning style, prior knowledge, and competencies, are also widely investigated in technology-supported learning, as the aid of technology in educational settings enables learning to be personalized and creates learning environments that support learners' diversity and individual needs [9] [10]. however, the results whether individual differences affect learning outcome with an technology-enhanced instruction are mixed. Accordingly, there is a need for further research into the relationship between individual differences and a particular technology-supported instructional approach.

As technology advances, AR incorporating with the use of mobile devices then provides a solution to support situated learning theory, since AR has the affordances of the real world setting by offering additional and contextual information to support learning, blending learner's learning environment into their real-life contexts (Squire & Klopfer, 2007). With the aid of mobile AR technology, the present study allowed students of different learning style, field independent and field dependent, to learn English vocabulary in a real setting outside of the classroom by using handheld AR-facilitated devices, investigate how students of different learning styles and language proficiency respond to such an AR instruction, and probe into their learning motivation, as motivation is closely related learning.

II. METHODS

A. Research Goal and Questions

This study aims to describe early research into augmented-reality-based mobile learning that attempts to assess its effect on students of different learning styles' learning outcome and perceived motivation in English vocabulary learning of elementary students, by enabling students to actually see, touch and interact with the "vocabulary" in a real setting. The research objective of this study is to investigate whether there is a difference among learning motivation and learning outcome of students of different learning styles exposed to a mobile-based AR

978-1-4673-8611-1/15/$31.00 ©2015 IEEE

simulations learning system proposed in this study. Accordingly, the three primary research questions are:

1. Is there a significant difference between FD and FI learners in the mobile augmented-reality-supported English vocabulary instruction?
2. Is there a significant difference between FD and FI learners in learning motivation while the mobile augmented-reality instruction was applied?
3. Is there a significant difference between learners of high and low English proficiency levels in the mobile augmented-reality-supported English vocabulary instruction?
4. Is there a significant difference between learners of high and low English proficiency levels in learning motivation while the mobile augmented-reality instruction was applied?

A quasi-experimental was designed to examine the differences of learning styles (field independence/dependence) and prior English proficiency levels (high/low) in learning motivation and learning outcome. A pilot test was conducted to discover problems before the main experiment and thus to ensure the validity of the experimental design. Then, all the participants would take the Group Embedded Figures Test to distinguish field independent and field dependent learners, followed by a pretest on English vocabulary. After the pretest, participants would then use mobile devices to learn vocabulary in a real setting, which would be their classroom. Finally, they were then given questionnaires and vocabulary tests to measure their learning motivation and learning outcome respectively. Aside from the experimental design, a semi-structured student interviews were also conducted at the end of the experiment in order to provide an in-depth understanding of the lived experience of the third graders regarding their opinions and learning attitude toward the usage of the proposed learning system.

B. Subjects

The participants in this study were 52 third-grade students from two different classes at an elementary school in New Taipei City, Taiwan. These students were aged 9-10 year-old and had at least received 2 years of formal English education at school. As for the usage of mobile devices, 84% of the students had some experiences of using mobile devices, such as tablets and smartphones or iPods; while 44% possessed their own mobile devices; and 44% of the participants indicated that they had used mobile devices as learning tools. In brief, participants were familiar with mobile devices and would not encounter major problems while using mobile devices.

C. Mobile AR Instructional Tool

The mobile AR instructional tool enabled learners to collaborate with teammates to complete the assigned task using mobile devices equipped with an AR platform. With wireless Internet connection and the built-in video camera, additional information were shown on students' screen when a trigger image was detected by mobile device's built-in camera. To be more specific, when participants turned on the AR application with their mobile tablets, and found the assigned items in the classroom, relevant digital content would be dubbing onto their screens, showing corresponding English, Chinese and English pronunciation, as shown on Figure. 1.

Figure 1. The Mobile AR Instructional Tool

D. Procedure

Before the activity using the proposed mobile-AR English vocabulary learning system, participants were given pretests on their prior knowledge to classify their levels of English vocabulary knowledge. Group Embedded Figures Test (GEFT) was also administrated to determine their learning styles, that is, field dependence or field independence. An instruction on how the test works was given before participants took it. Fig. 2 shows how these pre-experiment activities were done.

Figure 2. Pretests on English vocabulary (left) and a demonstration of how GEFT works (right).

The activity began with the anticipatory set, where students were asked if they had hands-on experience of using a particular item in a classroom, and to contribute to a discussion about their personal experiences and knowledge of a classroom vocabulary, which they had showed great interest in sharing their own thoughts, since the topic was closely related to every student's daily life. After a pre-information and instruction of the activity explaining what they need to do in the classroom, students were randomly divided into nine sub-groups with three members in one group, given a mobile device, and began with the activity. In the classroom, they were assigned to a task: 1) they were given a clue for the first item; 2) when they successfully found out the first item, additional information of the item, the English vocabulary, Chinese equivalent, and audio pronunciation would appear on their screen when scanning the right item; 3) they had to return to the control center to show the screenshot proving they had successfully

discovered the assigned item and utter the Chinese and English pronunciation of the vocabulary to get the next clue, as shown in Fig. 3. In order to accomplish the task, participants need to collect every required item. After all groups had finished the task, the group who spent the least amount of time was awarded.

Figure 3. Detecting an assigned item and getting additional information of that particular vocabulary (right); participants went back to the instructor to show what they had just discovered (left)

To ensure grouping (i.e., the composition of group members) would not have an effect on students' learning outcome, learners were asked to take turns using the tablets to eliminate possible confounding factors caused by grouping. Finally, after the activity, they were asked to answer questions on the motivation questionnaire and English vocabulary posttest to evaluate their learning outcome.

E. Instruments

Three sets of instruments were used for gathering research data, they are: the Group Embedded Figures Test (GEFT), a motivation survey form, and an English vocabulary test.

III. Findings and Discussions

The overall performance, students' English vocabulary test scores and scores of the questionnaire used to measure learning motivation were collected and analyzed using ANCOVA and independent t-test to identify any significant differences between learners of the two different learning styles, FI/FD, and those of high/low English proficiency levels. As for the qualitative data, all interviews were audio-taped and transcribed by the researcher and analyzed with the procedure by first-organize the data, generate categories, themes and patterns; search for alternative explanation for the data and write the report. Five interviewees from three different classes were chosen and coded according to the class they belong. Following are findings of the study, reported as the answers to each research question.

A. Answers to research question 1

Is there a significant difference between FD and FI learners in the mobile augmented-reality-supported English vocabulary instruction?

An Analysis of Covariance (ANCOVA) was conducted to analyze the data. The descriptive statistics of FI and FD learners' performance are showed in Table I. As the homogeneity of regression coefficients was not significant, the ANCOVA was processed. The results (F=10.010, p=.003) indicate that learning styles, FI and FD, do make a difference when students received our mobile AR instruction (Table II). Furthermore, the estimated posttest score after removing the effect of covariance, showing FD learners' posttest scores (9.602) higher than that of FI learners (8.543). Thus, it can be concluded that FD learners benefitted more than FI learners while a mobile AR English vocabulary learning approach was applied.

TABLE I. Descriptive statistics of FI and FD's on learning outcome

Learning Styles	Adj. Mean (posttest)	SD	N
FI	8.543	3.153	22
FD	9.602	3.232	30

TABLE II. ANCOVA on FI and FD on learning outcome

Source	SS	*df*	MS	*F*	*P*
Style	12.732	1	12.732	10.010	.003
Error	62.322	49	1.272		
Total	4456.000	52			

B. Answers to research question 2

Is there a significant difference between FD and FI learners in learning motivation while the mobile augmented-reality instruction was applied?

An Independent t-test was conducted. The result of the test inferred that there is no statistical difference (p=.512) in motivation between learners of two different learning styles. That is, learning motivation of both FI and FD learners is more or less similar after they received the proposed mobile AR English vocabulary instruction. The descriptive statistics and the results of the t-test are showed in Table III.

TABLE III. Descriptive Statistics of FI and FD's Learning Motivation

Learning Styles	Mean	SD	N	*t*	*df*	Sig.
FI	70.682	13.396	22	.660	50	.512
FD	68.800	6.910	30			

C. Answers to research question 3

Is there a significant difference between learners of high and low English proficiency levels in the mobile augmented-reality-supported English vocabulary instruction?

Students were first classified into two groups: higher English proficiency level and lower English proficiency level. Students whose average exam scores among the top 27% (N=14) were categorized as high English proficiency group; while the lowest 27% (N=14) were deemed as low English proficiency group. The descriptive statistics of the two groups' learning performance are showed in Table IV. An ANCOVA was conducted to analyze the data. As the homogeneity of regression coefficients was not significant, the ANCOVA was processed. The results (F=4.179, p=.052) indicate there is marginal (p <.10) significant difference in English proficiency in terms of learning outcome. In other words, learners' prior English ability is very likely to have an effect on learning achievement when students received our mobile AR instruction. Table V displays the detailed result of ANCOVA. Furthermore, the adjusted means inferred that learners of lower English proficiency benefitted more from the proposed mobile AR instruction.

TABLE IV. DESCRIPTIVE STATISTICS OF HIGH AND LOW ENGLISH PROFICIENCY ON LEARNING OUTCOME

English proficiency	Adj. Mean (posttest)	SD	N
High	9.527	3.378	14
Low	8.258	3.249	14

TABLE V. ANCOVA OF HIGH AND LOW ENGLISH PROFICIENCY ON LEARNING OUTCOME

Source	SS	*df*	MS	*F*	*p*
Eng. Proficiency	5.425	1	5.425	4.179	.052
Error	32.458	25	1.298		
Total	2281.000	28			

D. Answers to research question 4

Is there a significant difference between learners of high and low English proficiency levels in learning motivation while the mobile augmented-reality instruction was applied?

An independent samples t-test was conducted. The results of the t test inferred that there is no statistical difference (p=.740) in motivation between learners of two different English proficiency levels. That is, learning motivation of both high and low English proficiency learners is the same after receiving our mobile AR English vocabulary instruction. The descriptive statistics and the results of the t-test are shown in Table 7.

TABLE VI. DESCRIPTIVE STATISTICS AND INDEPENDENT T-TEST OF ENGLISH PROFICIENCY ON MOTIVATION SCORES

Eng. proficiency	Mean	SD	N	*t*	*df*	Sig.
High	72.071	8.176	14	.336	21.358	.740
Low	71.214	4.933	14			

IV. CONCLUSIONS

As the fast growth of information technology, more and more mobile-technology-facilitated language learning programs have been developed. However, the effects of individual differences on mobile-based language learning have not been fully discussed. In this study, we consider that learning styles (FI/FD) and prior English proficiency are two major variables that may affect the effectiveness of mobile-based language learning. A self-developed mobile AR English vocabulary instruction for learning English as L2 was applied to fifty-two fifth grade children, and the effects of the two individual variables were examined.

The first important finding of this study is that FD learners benefitted more from the mobile AR instruction which allowed learners to learn in an authentic context. FD learners can be the significant positive correlations given an instructional approach that relates to their learning style. However, there was no significant difference between FI and FD learners in learning motivation was found after the learning activities. It can be concluded that both FI and FD learners motivated by the mobile AR learning activities.

The second important finding of this study is that although both had significant learning achievement, students with high prior English proficiency are very likely to be benefited more than those with low prior English proficiency, while the mobile-AR instruction was applied. This result could mean that additional remediation needs to be taken in order to further upraise the learning performance for the low proficiency learners. It could not achieve solely by mobile AR instruction. However, in terms of learning motivation, the AR instruction did eliminate the gap between high and low prior proficiency learners. This finding echoes with the findings of August, Carlo, Dressler, and Snow that the use of technology in vocabulary learning can generally provide learners with incentives, and thus be motivated regardless of learners' individual differences [11]

Although findings of this study are distinct, several limitations have been found in the process of the research, including small sample size, time constraint, limited teaching material, and constrained learning environment. Further research is necessary to verify these preliminary findings.

ACKNOWLEDGMENT

Funding of this research work is supported in part by the National Science Council of Taiwan (under research number MOST 104-2918-I-003-006)

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