

## **A Pilot Study Exploring Augmented Reality to Increase Motivation of Chinese College Students Learning English**

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# Exploring the Potential for Augmented Reality to Motivate English Vocabulary Learning in Chinese College Students

## Abstract

With the advent and accelerated development of augmented reality (AR), an increasing number of studies have been conducted to test the effectiveness of this technique in education. Few, however, have investigated how AR might influence students' motivation toward learning of a second language. To address this gap in the literature, we used a combination of convenience sampling and criterion sampling to select five Chinese college students to evaluate an English vocabulary learning application built upon augmented reality technology. To assess student motivation, the ARCS motivational model was adopted. A semi-structured interview with open-ended questions was used to collect data. Participants indicated that though they were attracted by this tool at the beginning, their motivation level decreased toward the end of the study session. An interpretation of our observations in the context of the ARCS model suggests three motivational issues. First, predefined AR materials failed to establish relevance to subjects' personal interests and previous experiences. Secondly, subjects' confidence seemed to have been negatively influenced due to their difficulty in achieving the stated learning objectives. Lastly, technical issues delayed the computer quickly identifying the triggering image and thus resulted in a noticeable lack of system responsiveness. It seems this delay decreased subjects' satisfaction and distracted their attention from the learning task. These factors seemed most determinative in compromising AR's effectiveness as a tool to increase student motivation toward English vocabulary learning. It must be stressed that this study is a low subject *N* exploratory pilot not intended to produce binding generalizations. Nonetheless, these findings should provide useful insights toward the successful application of AR in the educational realm and identify potential causal factors that could form the foundation of future experimental research. The authors recommend further study with a larger number of subjects with a wider range of vocabulary sample and a more powerful viewing device capable of more quickly identifying the trigger images.

Keywords: English vocabulary learning, augmented reality, learning motivation, ARCS Model

## Introduction

With the increasing number of Chinese students study in America, Chinese students represent one of the largest groups of international students in the United States. For better adapting to study and life in an English environment, Chinese students need to have a good command of both spoken and written English. Language barriers negatively influence Chinese students to develop their full potential not only on campus, but also in the more fiercely competitive society at large. In order to get better involved in American student life and to prepare for the engineering career market of the future, improving these students' English clearly seems a critical subject for the Chinese student in the U.S.

Learning vocabulary is the most foundational block and first step in learning English as a second language, since no language acquisition and application can take place without the accumulation of vocabulary<sup>26</sup>. Research has shown however that the problem of learning vocabulary was the

biggest obstacle for second language learners to overcome<sup>32</sup>. Therefore, how to improve students' performance on vocabulary learning is a critical issue for both learners and educators. The significance of motivation as a contributing factor in second language acquisition has been widely studied<sup>15, 8, 10</sup>. Studies have shown that motivation as the force that initiates and directs behavior had a direct influence on students' learning performance<sup>7</sup>.

Argument Reality (AR) has been used in the education area<sup>22, 17, 24, 31</sup> because it enhances our sensory information with virtual information superimposed on top of real world information by digital means<sup>1</sup>. However the potential of AR as a motivation-stimulated factor in language learning and vocabulary learning remains unexplored. The purpose of this study was to explore how AR might affect student motivation for vocabulary learning.

An exploratory pilot study of a freely available augmented reality English vocabulary learning application was conducted to assess AR's influence on students' learning motivation. Semi-structured interviews were used for gathering assessment data. By analyzing the gathered qualitative data within the framework of the ARCS Model, our results suggest that AR may help with student motivation toward the beginning of the application session, but tended to decrease toward the end of the session. Several potential motivational issues were identified, as well as important technical issues.

## Literature review

### *The role of motivation in English learning*

Increasing student motivation toward learning a new language has long been a goal of teachers due to the role of motivation as a significant factor in improved academic performance<sup>29</sup>. Educational research in different countries has sought to find teaching strategies to facilitate meaningful and attractive learning experiences for students learning English as a second language<sup>12, 21, 23</sup>. Previous research has shown that motivation is significantly different depending on educational level with age and therefore it is necessary to choose different approaches to motivating students of different ages<sup>30</sup>. At higher educational levels such as college students, the more self-directed and problem-oriented is their learning style thus presenting challenges in increasing their learning motivation<sup>12</sup>. Moreover, for international college students who have already learned a different language, developing new pronunciation habits is not as easy as when they were children. Chinese students, as one of the most fast-growing English learning groups, has already reached almost 235,000 according to the report of international college students enrolled in the U.S during the 2012-2013 school year<sup>13</sup>. However, the current situation of English learning, specifically vocabulary learning, is not optimistic, according to the study of Liu<sup>26</sup>. A lack of systematic research in vocabulary learning, a passive way of learning vocabulary, and a lack of motivation contribute to students' diminished competence in actual use of English. As such, discovering more efficient means of motivating Chinese college students' English learning is highly important.

Previous research on increasing learning motivation indicated that the use of multimedia can exert a positive influence. Eight principles were proposed by Gilakjani<sup>11</sup> to better design a multimedia learning system. They are as follows:

- (1) Pictures are more effective than words alone,

- (2) Absorb the learner attention is important,
- (3) Redundant information should be excluded from the presentation of multimedia contents,
- (4) User control and interaction are better,
- (5) Helping students recall or acquire knowledge structures before exposure to multimedia content,
- (6) Animation can improve learning,
- (7) Multimedia is more effective when engaging users,
- (8) Let learners apply their newly acquired knowledge and receive feedback.

This study also pointed out that effectively using multimedia is not only putting multiple media together, but combining them in a meaningful way that utilizes the characteristics of each individual medium to their best.

### ***Rationale for AR in education***

Augmented Reality (AR) has aroused much attention in the educational area due to several aspects of the technology that might positively influence students' learning process. These aspects are: to provide a novel context with which to engage students<sup>22</sup>, to facilitate the collaboration between instructor and students<sup>17</sup> and to enhance students' spatial ability through direct interaction with 3D synthetic objects in virtual space<sup>24,31</sup>. According to<sup>1</sup>, the term AR refers to technology that enhances the user's sensory perception of a real world with a computer-generated overlaid layer of information. With AR, it is possible to show the user a seamlessly coexistent virtual and real space, in which real-time 3D models, video, and text can be superimposed onto an image taken from a real environment. In addition, it enables ubiquitous, collaborative and situated learning. Comparative studies between AR and traditional classes have confirmed that AR has the potential to enhance learning performance in teaching mathematics and geometry<sup>17</sup> and also in second grade-level concepts by maintaining high levels of motivation among children<sup>10</sup>.

### ***Use of AR in English learning***

Regarding research investigating the use of AR in language learning, one example was an AR-based game system named MOW<sup>2</sup>. The researchers adopted the construction of a 3D object vocabulary, which was superimposed on the object's text to help children associate each word with the 3D object. Through the comparison between the AR and traditional teaching method, the results indicated that children who used the MOW system had superior learning progress than those who used only traditional methods. This study only evaluated learning performance based on the statistical analysis of time and grade in a pre-test and post-test, but did not focus on motivational factors. Another two studies evaluated the user acceptance of the implementations of an AR-learning system for English vocabulary and showed that system quality was a critical factor affecting perceived satisfaction and that children preferred the AR game<sup>14,16</sup>. These studies built the first step in investigating the adoption of AR in English vocabulary learning, however several limitations still remain. First, all these studies only found a positive influence of AR on vocabulary learning among populations of children, adults were not tested. Similar research should be extended to college students who have more challenges in learning a second language. Second, prior research built their conclusion that AR has positive effect on learning

outcomes with quantitative data analysis while less focused on how AR influences students' learning motivation. Third, the three studies mentioned were not conducted among Chinese students, which naturally would not address any cultural factors that might be in effect.

### ***Motivation evaluation framework***

In order to measure and evaluate student motivation, a theoretical framework of motivation was selected before collecting the data – Keller's ARCS motivation model. The ARCS model is a descriptive model used for diagnosing problems associated with learning motivation<sup>20</sup>. This model had been used in evaluating learning motivation for instructional tools such as evaluating AR for visual art courses<sup>7</sup> and a computer-based tutorial<sup>14</sup>. According to Keller's definition, motivation in the educational area refers to a student's desire to engage in a learning environment<sup>19</sup>. To be more specific, four dimensions in Keller's ARCS motivation model were used to explain the motivation: attention, relevance, confidence and satisfaction<sup>18</sup>. Keller posited that learner attention should be gained and sustained in two ways. One was using surprise or uncertainty to gain interest; another was by simulating curiosity. The second step was to establish relevance in order to increase a learner's motivation. Allowing a choice was one suggested strategy. Next, in the confidence stage, students should understand their likelihood for success, for if they feel they cannot meet the objectives, their motivation would be decreased. Satisfaction meant if the outcome of a learner's effort was consistent with their expectations and they felt relatively good about those outcomes, they would remain motivated.

### **Methodology**

There are two research questions in this study: First, how does our AR application influence Chinese students' reported vocabulary learning motivation, and second, if there are any motivational issues, what potential factors might compromise the use of AR technology in vocabulary learning?

In order to address our research questions, we adopted a qualitative approach and collected data through interviews after user testing. The goal of the interview was to ascertain to what extent students felt AR was a compelling tool for language learning, but also to identify processes related to AR that might have influenced students' language learning motivation. Compared with pure quantitative research such as a controlled experiment, a major strength of qualitative research is in revealing processes that may have led to an experiment's observed outcomes<sup>27</sup> and is therefore an appropriate choice for revealing unknown factors.

### ***Participants***

Before recruiting study participants, criteria were predefined to screen subjects. According to Patton, criterion sampling involves "selecting cases that meet some predetermined criterion of importance"<sup>28</sup>. Only Chinese students at Purdue were invited to participate in this study. Five subjects were selected (Figure 1). All participants were graduate students who had been learning English for several years. Only one user had prior experience using AR technology. Subjects were asked what their current attitude was toward learning English vocabulary. Though some users indicated positive statements regarding their own methods, most reported concerns and problems with their own learning approaches.

	Gender	Education	Experience with AR	Attitude to their usual way learning vocabulary
User 1	Female	Master	No	Easy to forget not interesting
User 2	Male	Ph.D.	No	Troublesome
User 3	Female	Ph.D.	Yes	Boring
User 4	Female	Ph.D.	No	Efficient
User 5	Male	Master	No	Time-consuming

**Figure 1. Attributes of study participants.**

***Instruments***

This study used a free-to-download AR application named *Aurasma* to investigate AR’s influence on students’ English vocabulary learning motivation. *Aurasma* is a mobile application built on AR technology and is available for IOS and Android systems. We chose this application primarily because the program does not demand technical expertise, thus decreasing the likelihood of novice users being intimidated by program complexity.

The testing process first required participants to move the device to find the triggering images (Figure 2) that were used to activate the “Auras” (a virtual overlay) (Figure 3). The Auras are the virtual objects (video, animation, and image) that are locked to the triggering image in the physical environment. After the virtual overlay is shown on the device, participants were taught the accompanying word. For the next word, subjects moved the device to the next word card and repeated the process. Six English-word flashcards were used as triggering images and attached to six separate online videos before testing. The English words were six nouns: Chipmunk, Platypus, Pelican, Hamster, and Hummingbird. In order to eliminate influence due to familiarity with previous words, participants were asked to choose only the words they did not know in order to complete the test.



*Figure 2. Word flashcards as triggering image.*



*Figure 3. Virtual overlay.*

### ***Data collection***

After downloading the application on an iPhone4, each participant was afforded one hour to do the testing in a campus library study room. Before asking participants to use the application, the researcher briefly introduced how to control it and allowed some time for participants' questions.

The six printed flash cards with both image and text of the study's vocabulary words were provided to the subjects. All flash cards were already attached with AR virtual elements, such as 3D animation and videos. Each subject spent approximately 15 minutes using the AR application to scan over only the vocabulary flash cards with which they were unfamiliar, and to view the accompanying AR counterparts. When subjects completed the flash cards, a recorded semi-structured interview was conducted individually for 10-15 minutes per person. This method was chosen as it not only gives researcher an opportunity to present prepared questions, but also provides flexibility such that informants are free to express their views in their own terms<sup>6</sup>. To facilitate communication, interviews were conducted in Mandarin. Interview questions were structured with the intent of evaluating motivational aspects of using the AR application and exploring the reasons supporting each user's attitude. A four-dimensional ARCS motivation model was used as the conceptual framework for interview questions.

### ***Data analysis***

After data collection, all interview records were transcribed into documentation. Thematic analysis was used to identify, analyze, and report patterns (themes) that stemmed from the data<sup>3</sup>. Critical and representative patterns were extracted from the data and coded into four major themes that indicated how AR influenced student's motivation in vocabulary learning.

### ***Reliability and validity***

To improve validity, five participants from different majors were selected in order to provide multiple viewpoints. To increase reliability, triangulation was used to analyze the data. Two researchers worked together to analyze the data and reach a consensus on the themes that emerged from the data. Each of the themes was supported by citation from the participants' responses. Interview questions were framed based upon discussions with an expert in qualitative research in order to avoid leading questions and to help minimize the researcher's personal interpretations of participant responses.

### **Results**

Testing data were analyzed based upon the interpretive paradigm for understanding how AR may influence motivation in vocabulary learning. Thematic analysis was for identifying, analyzing and reporting patterns (themes) within the data<sup>3</sup>, and was also used to diagnose the motivational issues from the critical and representative phenomenon in the data.

There are four steps in our data analysis process. Firstly, the qualitative data from audio recordings were transcribed into text. Secondly, interesting features in the interview transcriptions were highlighted for initially coding the data. Third, focusing on a broader level of themes rather than coding, researchers sorted different codes into potential themes. Lastly, the themes were reviewed and refined by checking if any candidate themes should be discarded or combined. Based on the criteria that data within themes should cohere together meaningfully, and differences between two themes should be identifiable and distinguishable<sup>3</sup>, four themes were generated. Each theme drawn from the interview data related to the four dimensions in ARCS motivational model are described as follows.

#### ***Theme 1: First impressions are important***

When participants were asked for their first impression of the AR app, nearly all (except for one) thought it was appealing and attractive. Participants used words like "amazing", "fantastic", "novel", "interesting" to describe their feelings when they first saw the superimposed layer appearing on the device. Four out of five participants liked this new form of presentation and showed curiosity in what would happen next. They indicated that the AR app provided them with a brand new interaction form for learning that they had never before accessed through other technologies. Following are some user responses:

*- "I am attracted with this tool. First when I move my mobile phone on the image, a popup window appears, really **amazing!** Attract me so much. I want to know what happened next so I will stare at the device."*

*-- "Really **fancy**, what a magic happening. It is my first time to use such a novel technology and I am full of curiosity about that. Especially I never expected it would show me another video clip when I just placed the iPhone on the image."*

#### ***Theme 2: Learning materials are limited***



Though this AR tool made an impressive and appealing first impression on the participants, some critical opinions emerged afterwards, especially when the researcher asked whether they felt the tool could relate to their prior experience. Participants felt they were forced to view the materials they were provided without any choice (which in fact they were). Sometimes they criticized the quantity and quality of the AR materials, in that they felt it could not fully satisfy all their needs. Most participants indicated that they expected to have multiple choices of adding different media onto the virtual augmented layer. One participant expressed the desire to have optional AR materials as “we were forced to accept the predefined AR material even sometime it was not related to the word from their perspectives. If we are allowed to choose individually, we might find it more interesting.” Another participant indicated she preferred to have multiple AR materials according to different situations: “A conversation video in daily life will help me enhance my memory for common expressions because I can relate the words in my real life and remember them through practicing in daily life. But if that is an academic word, I probably like to see an animation to explain that terminology.”

**Theme 3: Benefit varies in different scenarios:**

When asked whether the AR app was a useful tool in vocabulary learning, all participants addressed that it could be helpful sometimes, but not always. The app’s performance in helping with vocabulary learning might vary according to scenario. One concern was that an AR app might be helpful for understanding vocabulary meaning but not for remembering spelling. Participants indicated they preferred traditional means for memorization such as writing down the words several times.

*“After I use this, I feel the only thing I can remember is the meaning of the word. I feel that it makes me confident to understand the meaning of the word. Because the virtual materials are really helpful for me to reinforce my understanding of its meaning however ignore the spelling. If I have to remember how to spell the word, I don’t think AR is helpful, I probably just write down the word several times to memorize it.”*

Another concern was that concrete and abstract words could not benefit equally from the AR application. Three out of five participants reported they did not feel the AR app helped a lot in learning the concrete words. They felt they could learn the concrete word used in testing, “Chipmunk”, by easier and simpler methods than the AR application and that it would be more helpful to them if the words were abstract.

*“I think the words you used here are not necessarily to use AR to teach, the word itself is concrete enough, I can use just image to help me remember. While if my purpose is to remember some abstract words related to the spatial relationship or a dynamic process in biology, which is hardly to be expressed by a fixed image, I think I would use AR tool. Because it shows me something that I cannot easily imagine through a still image.”*

**Theme 4: Image triggering does not work well enough**

Most participants complained about the effectiveness of the AR image triggering. Users had to hold the device and keep focusing on the image to trigger the AR overlay, otherwise the AR video would suspend. A participant said that “It is hard to focus the triggering image, when I place my cellphone on the image, it doesn’t show the AR material immediately”. In addition,

they felt the image triggering problem increased the inconvenience of usage and even distracted their attention from learning. *“It is inconvenient for me to hold the device on the triggering image all the time. I feel tired for that, and sometime my attention will be distracted by the triggering image because I need to focus my cellphone on it otherwise the AR material will stop.”*

## Discussion

The results of this study indicate that AR may have potential to increase students' learning motivation however some issues arose that should be considered in order to use it more effectively. According to Keller's ARCS motivation model, the first stage to increase motivation is to capture the learner's attention by using novel events<sup>20</sup>. In this study, AR made an attractive, novel impression and therefore demonstrated potential as a tool for stimulating motivation. Most participants stated that their motivation decreased in the end of the study. We propose several reasons within the context of the ARCS model.

First, limited AR materials influenced the relevance factor in the ARCS model. Learning materials should be aligned with learners' goals and interests in order to be perceived as relevant<sup>20</sup>. Prior research suggests that adult learners' learning motivation was based on the perceived value of the learning materials and how much of their prior experiences can be related with the topic they learned<sup>12</sup>. To increase relevance, Keller<sup>20</sup> suggests allowing learners a choice of different methods to pursue their work which can make this relation with their past experiences tighter. In this application, predefined AR materials were attached to each word without customization choices available, which likely violated this principle. Participants therefore passively accepted this method rather than intuitively build a relationship between the AR and the given word. A self-selection multimedia library is recommended in order to give learners freedom to choose virtual contents based on their personal preferences.

Second, the fact that some participants felt AR could not help them memorize the spelling of a word influenced the confidence factor described in the ARCS model. Confidence according to Keller means that learners believe a tool can meet the learners' objectives. If not, learners feel no likelihood for success and their motivation to learn will decrease<sup>20</sup>. For the learners in our study, the task of learning vocabulary meant not only understanding its meaning but also remembering the spelling of the words; all subjects indicated the AR tool only helped them better recall the meaning of the words while not helping them remember the spelling. One subject suggested adding a synchronized text box that simultaneously shows the spelling of a word while also displaying the animated contents.

Third, the problem of triggering the image overlay negatively influenced overall satisfaction with the application. At the beginning of using the application, users highly paid attention to the screen to see what would happen. However, because of slow processing time for recognizing the target image, users' attention would diminish over time. According to the ARCS model, if attention cannot be maintained throughout the learning process, motivation will decrease<sup>20</sup>. The use of the triggering image itself can be a potential problem. Previous studies have shown that using a marker, which in this case is the triggering image, interferes with students' ability to act in a natural way with the application. As a result, their satisfaction and the overall effectiveness of the AR application is diminished<sup>5</sup>. This problem is technical and restricted by the computational power of the viewing device and the speed of the image recognition algorithms.

Without advances in hardware or software this problem will remain a very difficult one to overcome.

### **Conclusion and limitations**

The authors would like to stress that this study's focus was exploratory and focused upon deriving, through qualitative means, insights that might help steer future quantitative research. A previous case study has demonstrated encouraging results for AR's potential to produce positive learning effects relative to traditional vocabulary learning approaches<sup>2</sup>. Though learner motivation is an important factor influencing learning outcomes, there is little published research examining to what extent AR technology affects learner motivations, particularly in the area of vocabulary learning. As far as is known, this pilot study was the first that has directly examined AR's relationship with student motivation for learning vocabulary and, further, did so within an established conceptual framework (the ARCS motivation model). Several themes were identified by the qualitative study. Learners' motivations were increased by AR in the beginning and decreased along with the disappearance of its novelty. The limitation of learning materials and technology capability were recognized as motivational issues as well.

The authors would like to acknowledge the most significant limitation of this study. Namely, given that only five participants were examined, the generalizability of our findings is limited. A larger pool of subjects would likely have resulted in more themes emerging while weakening insufficiently supported themes. Nonetheless, our findings suggest some promise for AR as a novel alternative in providing a vocabulary learning approach to supplement existing vocabulary instruction. Further, several factors that could facilitate improved instructional delivery using the technology were identified.

One finding of the study that was particularly interesting was the nature of our testing vocabulary. Based upon participants' feedback, the influence of AR technology on learning motivation varies by different vocabulary categories, such as concrete or abstract words. Learners indicated that their motivation to use AR to learn abstract words was higher than pictographic words. This finding was supported by previous research that AR was effective in alleviating the problem of understanding symbolic and abstract representatives and helping students to see relationships between concrete objects and their symbolic representations in the same view<sup>4</sup>. Perhaps classifying vocabularies into groups with personalized criteria and design would produce more suitable AR materials to better satisfy students' learning preferences.

### ***Future work***

Our findings suggest that the level of a given word's abstraction could be a significant factor in the utility of AR as a language learning tool. A study that experimentally tested for differential learning and motivation effects based upon manipulation of words' abstraction levels might indeed yield insights into how new vocabulary might be more effectively taught via technology-based pedagogies.

The current study focused on how an AR application might influence the motivation of English vocabulary learning in a group of Chinese students. Future studies should be expanded to

different non-native English speaking countries and compared. It is presently unclear if differential cultural factors may be at play and influencing optimal applicability of this tool across cultures.

Other factors of interest that were not within the scope of the current study, yet seem likely to have a measurable effect on motivational and learning outcomes, include: age, gender, previous cross-language experiences, and length of application session time.

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