The Design of Immersive English Learning Environment Using Augmented Reality

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Abstract   The study uses augmented reality (AR) technology to integrate virtual objects into the real learning environment for language learning. The English AR classroom is constructed using the system prototyping method and evaluated by semi-structured in-depth interviews. According to the flow theory by Csikszenmihalyi in 1975 along with the immersive factors from Trevino and Webster in 1992, the proposed system uses the computer information systems with augmented reality technology to create flow experiences and embodied cognition. The effects of the English AR classroom are evaluated by semi-structured in-depth interviews. Based on the opinions of the domain experts, the AR prototype system validates the possibility of carrying out digital immersive language learning and embodied cognition. In addition, the concerns of the curriculum designs based on this system are discussed to show the intension of the practical uses.

Keywords   Digital Language Learning, Flow Theory, Augmented Reality

1. Introduction

To face the global challenges and opportunities, language skills become one of the most important factors of success, especially when English remains the most widely used common language in the world today. With the rapid-developing Internet technology, English has continually been the major language for international communications among various fields, including global politics, media, tourism, international trade and economic activities, and even education.

There are many types of teaching methods in the field of English learning. In order to provide students various authentic, attractive, challenging, but non-threatening conditions to boost their learning motivation [1-3], this study is based on the situation approach and the flow theory. The former used in language learning filed is known as the "Situational Language Teaching (SLT) approach, and the latter is a pioneering theory contributed by Mihaly Csikszentmihalyi which is focused on "the understanding of happiness, creativity, human fulfillment and the notion of "flow" — a state of heightened focus and immersion in activities such as art, play and work." [4]

Since AR has been applied to different research areas and proven to be effective [5], more and more researchers use AR technology as an innovative method of digital learning [6-9]. Most of them merely focused on creating objects to support teaching curricula. The uses of content-based AR enrich the learning content and stimulate learners' learning motivation. However, the applications are limited by the learning content, and furthermore, difficult to be duplicated for other classes. Therefore, this research stretches the AR implementation from content-based application to construct an AR-based interactive learning environment. Through the proposed framework, teachers can easily embed the learning content on the AR environment. In the meantime, students can experience immersive learning through the interactive AR-enriched learning content and curricula.

Based on the flow theory, the framework includes five main components, which are tutors, theme, media, operational area, and agents to carry out an AR-enriched curriculum. The virtual 3-D objects lively embedded to the learning environment create an immersive learning scene. Students can interact with virtual objects in the real learning environment.

This research uses augmented reality technology to create an immersive English learning environment, the AR classroom. The proposed AR classroom augments virtual 3-D objects to the real environment. The prototype AR classroom provides different functions to emulate the real environment of the learning subject in order to promote learning. The objectives of this research are listed as follows:

1. What is the feasibility of applying augmented reality to construct an immersive learning

environment for English learning?

2. How do the augmented 3-D learning objects carried out the curricula based on immersive learning theory?

2. Related Works

2.1. Digital Learning

In 1949, ENIAC – the first digital computer was born. In 1978, the first personal computer came to earth. Hence, at the beginning stage, digital learning has been defined as "any instructional practice that effectively uses technology to strengthen a student's learning experience." (The Alliance for Excellent Education and Center for Digital Learning and Policy) In 1993, here comes the World Wide Web! Once the Internet became more and more popular and applicable for the general public, most people started to consider digital learning should not only be focused on the use of computers but also on the "Internet." To be more concise, Digital Learning Now! and Florida's Virtual School define digital learning as "learning facilitated by technology that gives students some elements of control over time, place, path and/or pace." Therefore, the possibility of learning without the limitation of time and space has become the most prominent characteristic of digital learning [10].

In fact, digital learning is not only about providing computers with the Internet for learners or students. The combination of technological hardware, digital content software as well as instructional techniques and curriculum design stands for the major requirement of digital learning. Moreover, with the rapid development of technology, there is a wide range of voice or video digital archives available for the learners to download and then to listen or to watch. Since the major advantage of e-learning is the flexibility of time and space, it is especially favored and widely applied in distance learning, lifelong learning, and educational training [10].

2.2. Situational Language Teaching

Situational Language Teaching (SLT) was developed during the period of 1930 to 1960s by British applied linguistics. The focus of this teaching method is based on two major concepts: (1) Spoken language is the foundation of language, and grammatical structure is the center of speaking ability; (2) Britain structuralism emphasized that teaching materials should include a large number of situations within various grammatical sentence exercises [11].

To be more thorough, Situational Language Teaching focuses on providing a set of high frequency vocabulary items and major grammatical structure into sentence patterns, which is called "situational tables." Once the learners are so familiar with the target vocabulary words

and the grammatical rules, they will be able to produce oral response automatically and instantly. It is believed that fluent speaking skills will later lead to proficient listening, reading and writing skills.

2.3. Flow Theory

Flow theory was first proposed by a positive psychologist, Mihaly Csikszentmihalyi, in 1975. The term refers to "a mental state experienced during challenging activities in a comfortable zone between "anxiety" and "boredom," where the activity at hand is neither too difficult to be frustrating, nor too easy to be menial." [12] Based on Csikszentmihalyi's theory, human beings have the tendency to be attracted by this kind of challenging activities, usually games, so much that they would even forget about the time and physical needs. It is not uncommon to see people discussing the negative impact of this phenomenon especially regarding people playing online games. One of the major reasons about why people become addictive to certain activities or games should be relied on the level of pleasure (how fun it is). In other words, if an activity or even a class design is fascinating enough, students would be attracted into it, become fully involved, and even forget the time. This feature can also be seen as one kind of intrinsic motivation. [13] Hence, instead of merely worrying about the "loss of awareness" (neglect physical needs) and the "distortion of time," some educators actually see the possibilities of engaging learners in gaining knowledge [12, 14, 15].

Flow theory has been related to intrinsic motivation due to the "pleasurable" characteristics. Moreover, flow experiences are considered helpful for increasing level of concentration since it is relatively a human nature for being willingly to focus more on tasks when people enjoyed the process and when the level of difficulties is within a comfort zone. The later condition is similar to Vygotsky's "zone of proximal development" which is a classical theory in language learning and teaching field. Vygotsky [16] declares that lessons or tasks should be planned and designed slightly beyond the learner's current level to create acceptable challenge as well as to reinforce what the learner has already acquired. This theory is also corresponded with Krashen's Input Hypothesis, which emphasizes that the best condition "for language acquisition to occur is when the learner understands input language 'a bit beyond' one's current level of competence." [10, 17]. According to abovementioned features, both language learning and computer games are seeking for strong engagement, and challenging yet not threatening tasks. Hence, flow theory has been widely applied to studies of computer-related educational games and digital curriculum designs [14, 15, 18].

2.4. Application of Flow Theory

In 2003, Egbert [19] published a study investigating the

relationship between flow theory and language learning. Egbert reported that "flow does exist in the FL (foreign language) classroom and that Flow Theory offers an interesting and useful framework for conceptualizing and evaluating language learning activities." In 2011, Fanciosi [12] further extended his study by using Flow Theory to compare computer game and language learning task design. Even though the findings show out that "there are limitations on the appeal and capability of computer games as pedagogic tools, as well as technical and logistic issues," Fanciosi still suggested that "a productive focus of future research is the use of arcade-type computer games as exercises for supporting learner performance in tasks" [12].

Flow theory has been identified with seven renowned characteristics of flow [4]:

- A challenging activity that requires skills
- Merging of action and awareness
- Concentration on the task at hand
- Clear goals and feedback
- Paradox of control
- The loss of self-consciousness
- The transformation of time

Among them, some researchers considered the first four to be directly influential on student engagement [12, 14, 15, 18]. To echo with these researchers' point of view, Trevino & Webster [20] defined flow as "the linear combination of four characteristics: control, attention, curiosity, and intrinsic interest. However, along with the development of the modern technology, all the seven features were deliberately applied and elaborated in the AR classroom study.

2.5. Semi-Structured In-depth Interview

In-depth interview has been a popular and respected method for collecting qualitative data. It could be classified into three categories: structured interview, unstructured interview, and semi-structured interview. Semi-structured interview was applied into this study because it is a data collecting method between a structured and a non-structured interview design, and it is more focused on "a framework or themes to be explored" [22]. Before the actual interview, researchers need to deliberately scheme an outline based on research questions and purposes. The outline will also become a useful guideline during the interview [21]. By receiving the outline with clear directions, interviewees will be better prepared and more possible to provide profound insights about the issue. Unlike structured interview, the interviewer, however, may not need to follow the guideline completely or the exact order of the questions. Moreover, during the interview, semi-structured interview allows the interviewer to make reasonable adjustment in accordance with the actual situation. Therefore, it is more flexible and beneficial for social science experiments.

In addition, even though the interview may follow the same guideline, researchers should be able to collect data from various types of interviewees due to the flexibility and natural personal differences. Moreover, respondents may react very differently due to their awareness of the problem itself and the different personal experiences.

2.6. Augmented Reality

Augmented Reality (AR) is a technology of real-time streaming computation. It generates a view between real reality and virtual reality called mediated reality. Through the recognition of objects appearing in the live video, the virtual objects can be inserted to the video at the corresponding positions. [23] Users also can interact with the virtual objects in the video by pre-defined actions. Since the property of AR is to enhance user's current perception of reality by processing the captured images, the technology can either add virtual objects to the image or remove objects from the image.

Augmented Reality has been applied to many different areas. Other than education, it can be used for commercial, art and entertainment applications. For the education applications, AR is commonly used to augment multi-media or 3-D objects to traditional materials such as textbook, flash cards or textbook. [24, 25] Through the embedded AR markers, students can use AR devices such as mobile phone or tablet PC to interact with computer-generated agents or learning objects. Maier, Tönnis and Klinker [26] implemented an AR application for Chemistry to visualize the spatial structure of a molecule and interact with virtual 3-D models that appears on AR markers. Kuo [27] applied AR to a library exhibition about the lifecycle of mosquito and contagious disease control. AR applications for education complement traditional curricula with rich interactively multi-media and virtual objects mixed in the real environment [28].

Although AR has been applied to many educational applications, most applications are limited to the specific learning content and curricula. [29] Stand-alone application can only present for one class or one topic. It is difficult to extend or reproduce these kinds of content-based AR applications. In consideration of making AR educational applications efficiently, this research designs the AR application from content-based to framework-based. The research proposed a framework building a learning environment with AR technology. Using this framework, teachers could focus editing the learning content without worrying about AR technology. In the meantime, student can acquaint the AR technology and the corresponding functions under the same framework for different classes.

3. AR Classroom

3.1. System Model of AR Classroom
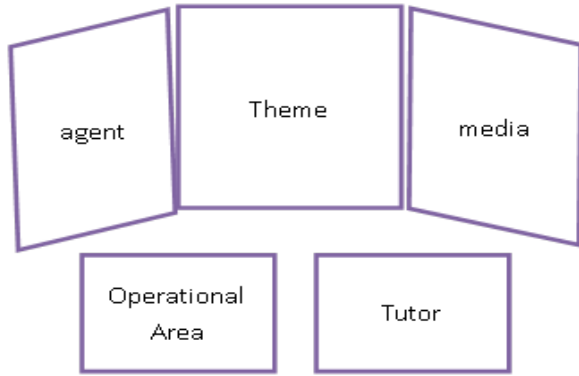
Figure 1. AR classroom system model

Based on the flow theory, in order to create an immersive learning environment, [30] this research proposed a framework called AR classroom using AR technology. AR classroom tends to create the similar short-term immersive learning scene like English village without the costly facilities. The system model is shown in Fig. 1.

AR classroom includes five areas in consideration of common language learning curricula. The five components are listed as follows:

1. Tutor: In this area, the AR classroom augments the 3-D avatar onto the AR marker. The 3-D avatar plays the role of lecturer tutoring the students. Teacher can design the avatar tutor based on the corresponding content. Tutors who are the characters from the learning content can lead students to concentrate on tasks easily. Moreover, through the lecturing, the learning goal can be clearly delivered and guided step by step.

2. Theme: Merging of action and awareness is always the key factor of the flow theory. To create the immersive environment, the theme area uses AR technology to embed learning object to the learning scene. It can be tiny as the structure of the molecule or large as a dinosaur or the entire galaxy. The augmented learning environment creates the immersive environment to provide students the vivid experience regarding to the learning content.

3. Media: Multi-media are commonly used for language curriculum to express a situated learning content. The media area in AR classroom mounts the multi-media onto the media marker that allows teacher to play multi-media like a screen on the classroom wall. When students focus on the media, the loss of self-consciousness and the transformation of time thus can generate the flow experiences for students.

4. Agent: In addition to tutor, AR classroom facilitates agent area to augment agents to the learning scene. Different from lecturing, the agent avatar acts as a learning companion who could provide hints and emotional support for the learners. In flow experience, the AR agents could help learners on intrinsically rewarding and reminding the concentration on tasks.

5. Operational area: Learning by doing is always the effective way of gaining the knowledge. AR classroom designs an operational area where the operational questions could be carried out. Students could interact with the AR objects to complete the assignment or the assessment. The rewards could be employed to stimulate the flow experience.

Table 1 concludes the characteristics of flow theory and Trevino and Webster's [20] immersive factors for the corresponding area in the AR classroom. In consideration of taking flow theory and immersive factors, the framework adopts the advantages of AR technology to facilitate flow experiences and create short-term immersive learning without building the real environment.

Table 1. Characteristics of flow theory

Module	Functionality	Flow theory	Trevino& Webster immersive factors
Tutor	Lecturing	Concentration, clear goal	Concentration, curiosity and fun
Theme	3D learning object	Merging of action and awareness, clear goal	Sense of control, concentration, curiosity and fun
Media	Multi-media learning content	Loss of self-consciousness and the transformation of time	Concentration and fun
Agent	Guiding	Intrinsically rewarding,	Fun, sense of control
Operational Area	Assignment and assessment	Instant feedback, rewards	Concentration, curiosity and fun

3.2. Implementation of AR Classroom

Based on the proposed framework, this research implements an English learning AR classroom to validate the research objectives. Related AR objects and avatars are augmented into five areas of AR classroom. The learning content and multi-media are also implemented in the AR classroom. Fig. 2 shows the demo system of the English learning AR classroom. The AR markers are made reflecting each area designed by AR classroom framework. The corresponding APP is also implemented to carry out the curriculum. Students use the handheld devices to interact with AR objects and avatars.

Figure 2. English learning AR classroom

Fig. 3 demos the tutor in the AR classroom. When students start this class by launching the mobile app, the 3-D avatar tutor will show up above the tutor AR marker and start the introduction. Since the demo learning lesson is related to military, the tutor appears in the character of soldier to create the immersive environment. After the tutor finishes the introduction, the tutor will guide students to the next area or switch between different scenes. The tutor in this class will guide students to the theme area and use 3D object to elaborate the class. The designed curriculum leads students focusing on the given target and concentrating on the task to create flow experience.
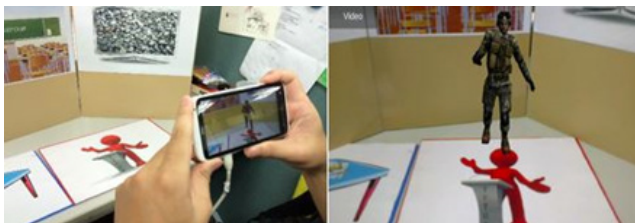

Figure 3. AR Tutor

In the middle of the AR classroom, Fig. 4 demos the theme area where the aircraft is shown in this class. The vivid 3-D object is augmented to the theme area to complement the curriculum. Unlike multi-media and virtual 3-D objects, students can use handheld devices to observe the augmented 3-D objects. It provides the similar experience of observing the real object.
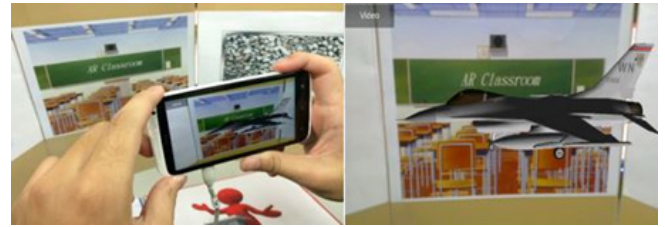

Figure 4. Theme area

After the AR tutor finishes the lecture, the tutor will ask students to switch to the media area where the multi-media will play to give the further information of this class. Fig. 5 shows the demo of playing multimedia in the AR classroom. Multi-media nowadays are common tools to provide student-centered learning materials for student to learn on their own. The multi-media learning materials could take several learning theories such as behaviorist, cognitive and constructivist into consideration that promotes students' concentration on the task on the task. Meanwhile, the multi-formats of media could lose students' self-consciousness and the transformation of time, which are the key factors of adopting flow theory.
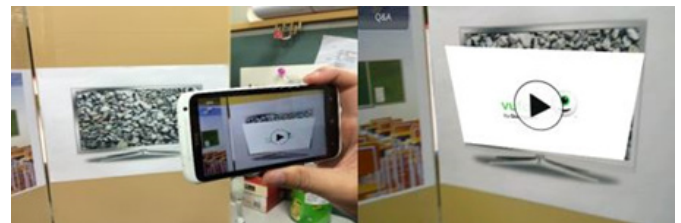

Figure 5. Media area

Another important area of the English AR classroom shown in Fig. 6 is the operational area. Assignment and assessment are always the key phases of the learning cycle. The assignment in AR classroom can be designed as step-by-step experiment or the observation of the real objects. The assessment could be also carried out in the same manner. Using of AR objects makes the assignment and assessment more interesting and precise. The learning process not only could be recorded but also repeat the flow experience.
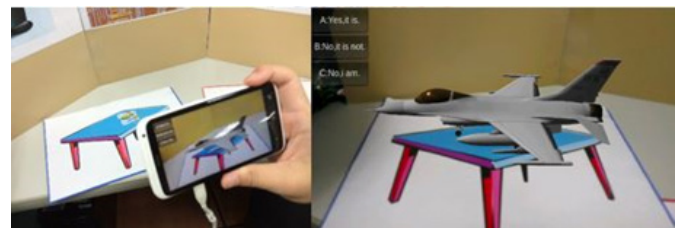

Figure 6. Operational Area

Last but not least, the AR classroom implements an agent area shown in Fig. 7 to augment 3-D avatar in the learning scene. In the real learning environment, the virtual agent can be seen and interact with. This mixed reality provides a novel and interesting way of learning. The agent in the

learning scene acts as the learning companion who gives learners emotional support. At the same time, the agent triggers the learners' sense of controls and fulfills the intrinsic satisfaction. Rewards from or for agents could be designed in the area based on the curricula.

Figure 7. Agent Area

4. Interview Transcript Analysis

In order to produce a meaningful and practical AR teaching model for English learners, university professors from three departments were invited to be interviewed representing three dimensional perspectives. The interviewees from the Department of Applied Linguistics and Language Studies were carefully chosen based on their specialties. Since this study aims to create an AR classroom for teaching and learning English, professional experts on English teaching as well as curriculum design are strongly in need on the interviewee list. On the other hand, professors from both the Department of Information Management and the Department of Information and Computer Engineering were also invited for giving comments and suggestions regarding the AR classroom design and creation.

Prospective interview list had been cautiously inspected and screened. After several discussions and meetings, six interviewees were confirmed, and then were given relevant information, such as the purpose and the guideline of the interview, and possible interview questions, in advance.

The main outline of this study can be divided into three categories, which are as follows: the feasibility of this study, the personal feelings and suggestions regarding each region of the AR English Classroom, and; the usability of this teaching method.

Based on professor A's comment, the system looked interesting and eye catching. However, during the demonstration, some technical problems appeared, which caused the delay time of the interview. Hence, professor A suggested that the stability of the system should be increased.

As to professor B's suggestions, since they are all related with curriculum design, researchers would modify the scenes as well as the flow path to be consistent with academics-recognized curriculum. Simultaneously, the AR technology-based materials can be better highlighted. In respect of the transition design, some experts in digital teaching will be inquired and consulted in order to create a promising outcome, that the transition mechanism can enhance the effectiveness of learning and increase motivation instead of causing confusion.

Regarding Professor C's suggestions about multimedia playing function, it has gradually been modified and improved with the intention of completing multimedia features. Another suggestion regarding part of the multimedia feature is about the captions.

Both professor D and professor E considered adding captions or subtitles on the stage or screen when tutoring is essential. Professor D suggests a full coverage of the caption while professor E preferred timely and striking reminders of key vocabulary or important ideas. The future improvement of this issue is well-expected.

Last but not least, professor F considered the design is innovative and attractive, but the curriculum design seems to be superficial and rough. Professor F believed that the system should be very useful if the connections between each region were refined.

Table 2. Key suggestions for improving the system and the study

	Key suggestions for improving the system and the study
Professor A	This can be a useful teaching aid if the stability of the system itself were strengthened.
Professor B	The course needs to be re-designed. Based on the current model, the curriculum design, the combination of the scenes, and the transitions between scenes are problematic.
Professor C	The video function could be improved in order to allow the introduced information to become clearer and more precise.
Professor D	Courses subtitles can be added to enhance comprehension, and then to reinforce reading skills as well as listening skills.
Professor E	Some important keywords or important concept can be shown as captions to assist students' listening comprehension.
Professor F	The concept of the design is innovative and attractive, but the curriculum design seems to be superficial and rough. The system should be very useful if the connections between each region were refined.

5. Conclusions

In this study, the application of modern technology of augmented reality (AR) is combined with ever popular Flow Theory and situation learning to provide immersive digital learning environment for English language learners (ELLs). Similar to the purpose of creating English Villages, this study aims at creating an AR English classroom in order for conscious and subconscious learning to occur within a joyful, pleasant setting. The major differences between the English Village and the AR English classroom lie on the much less budget and much more potentiality.

When a government is trying to build more English Villages for engaging students to learn English, the budget becomes a major concern. How many different types of scenes should be included? How many foreign staff would be required, and how about their salary? Moreover, how many students can use the facility at the same time? And how frequently a student can use the amazing facility? These questions could all be easily solved as long as our ideal AR English Classroom model completes. Not only can it provide seemingly authentic English learning environment without spending enormous amount of money, but also can the content be reproduced and modified by different instructors under various conditions.

In short, once the AR English Classroom model accomplished the ideal, it can also be applied for other languages, or even other subjects and areas. Computer-mediated instruction (CMI) has been changed and improved rapidly due to the speedy technology development. Starting with one personal computer, current CMI may include smart phones, tablets and pads. In the future, more devices with more efficient and convenient multi-functions may come out sooner than most people expected. At that time, AR English Classroom model may become a standard classroom around the world.

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