International Journal of Multimedia and Ubiquitous Engineering
Vol. 9, No. 11 (2014), pp. 99-110
http://dx.doi.org/10.14257/ijmue.2014.9.11.10

Augmented Reality for Blended Language Learning*

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Abstract

Although a lot of research is being conducted to apply augmented reality (AR) to education, there is little adequate research on how to design AR-based learning systems so that they foster deep understanding in learners. In this article, we present and exemplify a learner-centered instructional model that incorporates AR contents as a form of blended learning strategy. To this end, we divide the instructional model into lecture-type formal learning and purely self-directed form of informal learning, and go on to explain the methodology and process of designing instructional model according to each type. Through this approach, we show that the benefits of using AR extend into the realm of education, and verify that AR-based learning systems offer a potentially effective method for foreign language instruction.

Keywords: *augmented reality, blended learning, customized learning model, foreign language instruction, ubiquitous learning*

1. Introduction

The concept of augmented reality (AR), which had been unfamiliar to us until a while ago, has now become a popular tech term, due to the increased prevalence of mobile devices like tablet PCs and smartphones. Also, a lot of research is being conducted to apply it to education [1]-[9]. Pedagogy using AR is no longer considered novel in practice. An e-learning system based on AR, which allows one to experience virtual contents similar to real life and also enables problem-solving within actual contexts, is likely to lead to a new paradigm not only in foreign language education but also across the education sector.

In fact, it has already been quite a while since substantial amount of research has shown that foreign language education that uses information and communication technology (ICT) is effective in enhancing linguistic competence and performance. For example, in Portuguese education, self-learning models using voice-recognition technology like the global online foreign language education program Rosetta Stone, other online education programs that simulate realistic language use environments and provide scenario-based visual contents, as well as various forms of educational applications that run on mobile devices, are being developed and used. Through the use of ICT, it has now become possible to design and implement learner-centric learning models, which go beyond the previous instructor-centric models and are not constrained by time and space.

However, contrary to expectations, many have assessed ICT-based e-learning systems to be less than satisfactory in terms of their efficacy and effectiveness. Furthermore, when it comes to maximizing learning for foreign language learners, instructors' lecture strategy and

* This work was supported by Hankuk University of Foreign Studies Research Fund. / This paper is a revised and expanded version of a paper entitled "Designing a Mobile and Augmented Reality-Based Portuguese e-Learning Model Customized to the Learner" presented at International Conferences, UCMA, ACN, CST 2014, at Batam, Indonesia, occurred on June 19-22, 2014.

ISSN: 1975-0080 IJMUE

learners' competence in self-led learning and motivation have been argued as more effective in enhancing learning performance, notwithstanding the importance of learning contents, material and building of a learning management system (LMS) [10]-[13].

Therefore, recently, blended learning that combines classroom lectures based on traditional instruction methods and ICT-based e-learning systems with their various educational advantages is emerging as an alternative. Blended learning brings together interactive communication and engagement, which are advantages of traditional face-to-face instruction, and innovation of ICT, and is being pinpointed as the best solution to realizing individually customized learning models for learners of foreign languages. It also links the various learning elements and demands to their corresponding medium and methodology, and therefore, is being recognized as the ideal e-learning design strategy that leads to the best learning experience [14]-[16].

Against this backdrop, in a previous study [17], as a first step in designing AR-based language learning model, we discussed what educational potentials an AR-based learning system has to offer. Taking it one step further, in this study, we present and exemplify a leaner-centered instructional model that incorporates AR contents as a form of blended learning strategy, which can be deployed in parallel to face-to-face fieldwork learning. For this, we review some instructional method that are intended to foster deep learning. In this way, we look at realistic ways to systematically link and integrate AR-based learning models with traditional pedagogy.

2. Mobile AR-Based Learning System

AR refers to a next-generation interface technology that conveys information by superimposing virtual visual information onto real-world images and allows users to interact with the ICT through their actions of manipulating virtual objects real-time [18, 19].

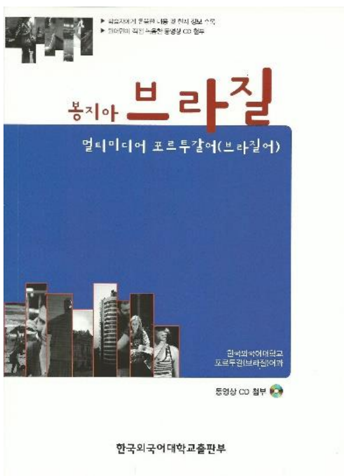
Therefore, various hardware components are needed to deliver AR, including a display device installed with a camera. Display devices can generally be divided into wearable devices and handheld devices. Major forms of wearable display devices include head-mounted displays (HMD), which actually have some disadvantages such as users' discomfort of having to wear something and the need to add on expensive auxiliary devices. Considering these limitations, this study will focus on smartphones - handheld display devices that are the most widely penetrated as well as having all the necessary features to render AR, thereby allowing interaction that goes beyond time and space, as well as diverse learning experiences through self-led learning.

There are two major ways of recognizing real-world information, which is the most basic feature in generating mobile-based AR – namely, the vision-based method and the geolocation-based method. In this article, both methods are used respectively, to link each method with learning contents of existing textbooks, and thereby to design two separate forms of learning – classroom method as a form of blended learning and purely self-directed independent learning. Through this process, a learning system that optimizes performance by aiming at convergence between theoretical and systematic formal learning, and practicable and contextual informal learning, is designed.

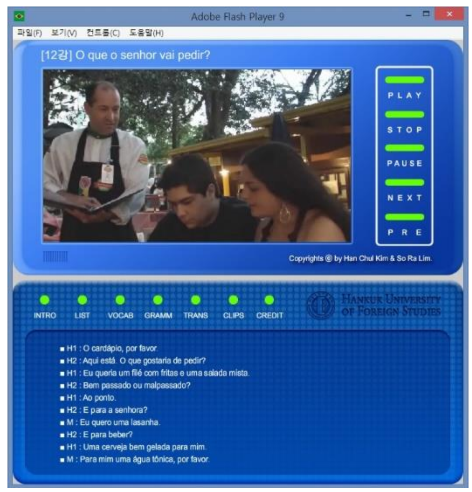
Bom dia Brasil: Multimedia Brazilian Portuguese was used as the software for designing an AR-based life-like learning material. As a specialized multimedia content, *Bom dia Brasil* was newly developed in 2010 with support from the university this research team is based in. It was developed in the form of a textbook and a scenario-based multimedia learning content to be used in conjunction with the textbook, and is currently being used in educational practice through a blended learning system.

The textbook, focusing on Brazilian Portuguese, is organized into 24 lessons, composed of actual situations that can be experienced on the ground in Brazil. It starts with pronunciation and goes onto basic terms, useful expressions, simple and clear explanation of grammar and exercise questions based on dialogue appropriate to each theme and situation. Each lesson has been made into a scenario-based multimedia content, in order to avoid one-way rote learning and to allow beginners in Portuguese to engage themselves in the study with more interest through useful expressions and live information (see Figure 1 (a)).

The multimedia contents are based on an educational program tool developed directly by this research team, and the diverse learning contents in the multimedia program tool reconstruct and simulate the textbook dialogues to be used in classrooms, language labs or personal computers. It also provides useful cultural information through videos directly filmed in Brazil and image slides, thereby focusing on stimulating the imagination of students and motivating them. Furthermore, it has a feature alongside the sentences of the textbook that allows users to repeatedly listen to pronunciation of actual Brazilians Portuguese, and also enables customized learning according to the different competence levels of learners (see Figure 1 (b)).



(a)



(b)

Figure 1. Textbook of *Bom dia Brasil: Multimedia Brazilian Portuguese* (a), Scenario-Based Multimedia Content (b)

However, on the other hand, in the case of existing multimedia learning materials, videos have to be played on a projector after the lights are turned off, so using such programs in actual situations can disrupt the flow of the class or leads to the loss of concentration. Also, since they run on ordinary computers, they show limitations when used in mobile learning environments, and because they are designed to offer only simple pre-class preparation and after class revision as an extension of offline learning, they can negatively lead to the loss of interest and immersion on the part of the learner.

Many have pointed out the same problems for other online video education programs and various educational applications that run on mobile devices. Even in the case of Rosetta Stone, a learning model that provides relatively more diverse contents and interactive features compared to other materials, repetitive learning contents and limited interaction are seen to hinder continued interest and deep immersion of the learner.

In this regard, Aldrich [20] discussed three main types of content we need to consider when designing simulation models for learning: (a) linear content, (b) cyclical content, and (c) open-ended content. Simulation models for learning can take various forms depending on the content characteristics, but it is also possible to seamlessly combine all of the content types in one simulation (see Figure 2).

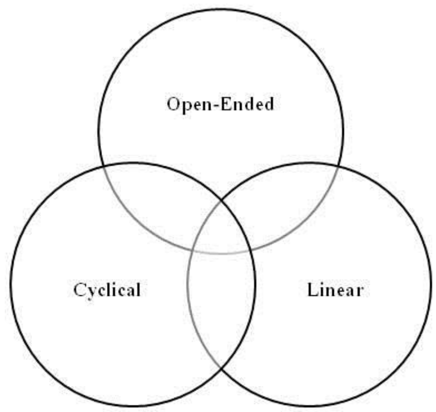


Figure 2. Simulation's Primary Environments

Aldrich notes that all three categories are necessary to develop properly educational materials. At the same time, however, he indicates that open-ended environments and its transferability from one situation to another are the most desirable properties to carry out personalized learning as an interactive and immersive experience.

In this context, there are four reasons why existing ICT-based learning environments, which simply consisted of linear or cyclical systems, fail to be more effective as seen above. First, they fail to engage the learner more proactively in the learning activity. Second, interactivity, necessary for stimulating engagement in the learning process, is used only in a very limited way. Third, they focus excessively on merely relaying learning contents rather than on the kind of performance that would be possible as a result of the learning process. Fourth, they simply try to apply technology to already established conventional classroom methods.

The above are the results of the fact that, until now, discussion on ICT-based learning environments focused mainly on technical aspects, rather than on what kind of design methodology would be appropriate from the instructor and learner perspectives. The circumstances are not very different when it comes to the discourse on AR-based learning environments. In fact, some have pointed out that in order to develop the next-generation learning technologies, a new perspective is needed to design learning models [21].

Therefore, in an effort to solve and reapply the issues of existing multimedia learning materials that fail to draw the users' interest and thereby hinder immersion into the learning process, we suggest an AR-based framework that combines education with entertainment using properly linear, cyclical, and open-ended learning simulations, according to the different competence levels of learners, and then derive ways to design and operate an efficient learning environment.

2.1. Designing an Operational Model for AR-Based Learning Using Vision-Based Method

The vision-based method refers to the way real-world images on the screen are recognized using image recognition technology. In this method, markers – patterns that trigger recognition of real-world information – are often used. So the image of a marker would be recognized, and the inputted database inside would be overlaid onto the screen. This marker is stuck to the textbook, and the user would run multimedia videos or other contents that previously could only be played on a computer CD, and would be able to directly handle the contents through voice recognition or tangible interface, allowing more intuitive communication (see Figure 3). This handling of the marker entails direct manipulation of the learning material or object of observation, thereby forming a participatory information-using environment. Therefore, the learner, who directly participates in the manipulation activity, engages more proactively in learning rather than passively receiving information.

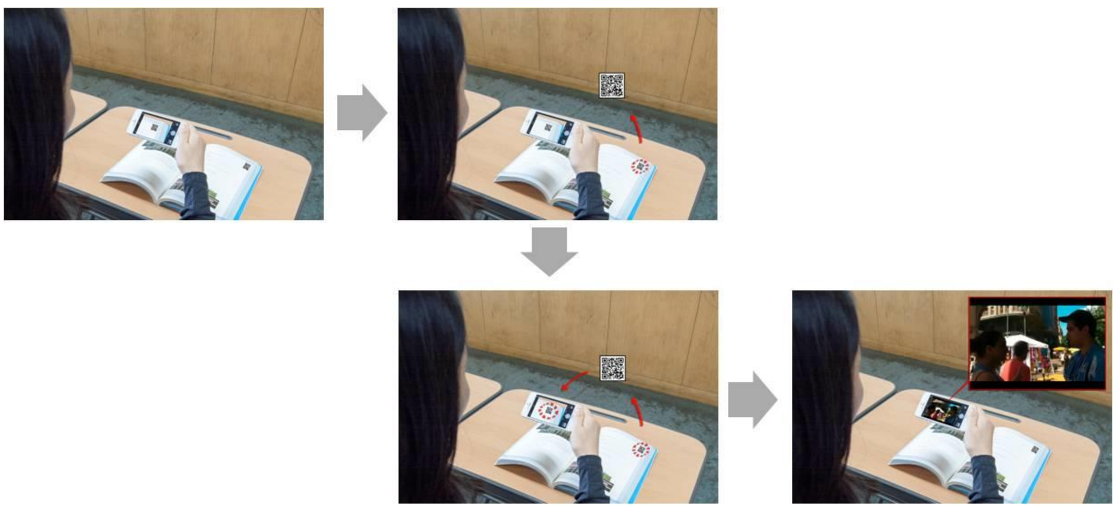


Figure 3. Example of AR Contents Rendered through Marker Recognition

Evidently, hardware capacity of smartphones is not yet sufficient, and an image database has not been accumulated enough to analyze the random points of interest (POI) of smartphones used outdoors, so the use of vision-based method is still quite limited in scope.

However, if the vision-based method is used indoors as a supplementary medium, jointly with conventional face-to-face instruction, then the level of current technology is advanced enough not only to render AR contents but also to be effective in deepening the level of the learner's sensitive immersion in comparison to existing multimedia learning materials. In particular, if this AR-based experiential learning model is applied, to exercise questions in the form of simulation, which usually involves application and deepening of the contents, then it can lead to accumulation of knowledge through more profound understanding or physical experience, not through simple rote learning. In fact, according to a research study that targeted university students in regard to educational application of virtual reality technology and immersive CAVE display, pedagogy using virtual reality was reported to be more effective in learning a particular content than the entire course, and more useful in previously defined learning than in cases where knowledge has to be newly constructed [22].

For instance, when studying the expressions on finding or guiding the way, it is possible to learn appropriate expressions on asking for and answering directions, and then deepen the learning process by rendering images of real streets through marker-based AR. In such a situation, simple user information including age, gender and interests, can be inputted into the system, based on which the learner can receive tasks individually customized to him or her, or select an intelligent agent in the form of a character that helps complete the given tasks. Furthermore, the tasks can also be adapted to real-world related topics and situations other than the one currently being implemented, in a more complex, level-differentiated manner.

In order to make more efficient these instructional processes, we present and elaborate an instructional simulation containing game features. Our learning model is consistent with the Input-Process-Outcome Model of Garris, Ahlers and Diskell [23], who identified an inherent instructional model that incorporates certain characteristics of games, and then illustrated it by using a simple diagram that describes game-based learning processes (see Figure 4).

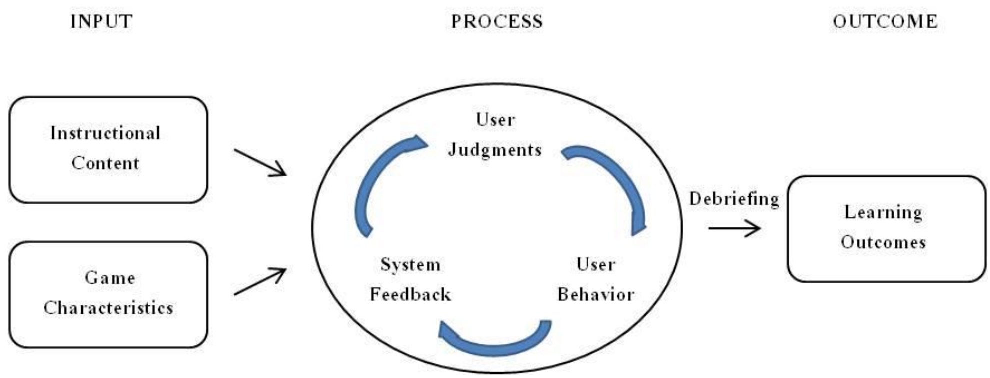


Figure 4. Input-Process-Outcome Game Model

According to Garris, Ahlers and Diskell, the debriefing process mentioned in Figure 4 is a fundamental link between simulation/game experiences and learning. It enables the learner to reflect on what occurred in the simulation/game experience, analyze why it occurred, and learn from his or her mistakes and experiences to make improvements in the future. In short, through this debriefing process, the learner transforms his or her simulation/game experiences into learning. It also could be key to making the learner's experiences applicable to the real-world contexts.

The above-mentioned kinds of instructional simulation-based AR contents that incorporate some of the elements of game, can perhaps best be understood with the help of an example. Suppose a 20-year old woman learner, who likes shopping, is performing a task regarding finding her way around. The learner, having received the address of a shopping mall, a map and a certain amount of 'learning e-money' depending on the task level, is asked to perform a task in which she has to find her way to a shopping mall to buy a dress and shoes to wear to a weekend party. When performing such a task, the learner can use the given information or learning e-money to walk or use public transport to get to her destination, and if needed, she can ask, in Portuguese, an intelligent agent how to use public transportation or ask her way around. There is no time limit to complete a task. The learner has to decide if and how she wants to react to each situation. If she successfully reaches her destination, level one task has been completed, and she receives additional learning e-money to perform a task in level two. The learner can decide whether to use learning e-money or not, and unused e-money is added to the amount newly received at each level and is continuously accumulated. Also, when the learner is performing a task at a certain level and decides to do an optional task by choosing an additional situation – such as using public transport – they then receive extra learning e-money. Learning e-money can be consumed as the learner wishes in different situations within the AR content, such as for shopping, at the restaurant, or for travelling. The learner is also categorized into different levels according to the accumulated amount of e-money, which leads to more internal motivation to learn. When level two task begins, a new situation and task are given regarding shopping, and the learner can spend her e-money to buy clothes and shoes of her choice. She can directly compare and choose her dress and shoes according to their price, style, color etc., and use them to personally adorn her cyber character. This is a form of a trigger that can stimulate more interest in her learning content (see Figure 5).

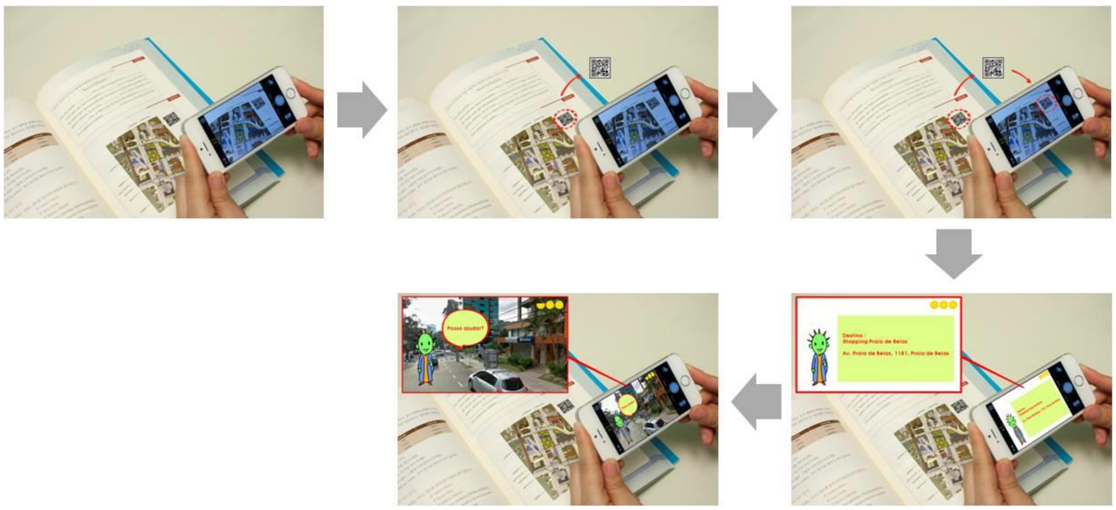


Figure 5. Example of a Practice Question on Finding one's Way using AR Contents

As such, AR-based experiential learning contents that are used as supplementary material together with conventional face-to-face instruction or in applied learning allow learners to directly handle virtual objects and lead their learning process, with much more effectiveness, since the process becomes more interesting and immersive.

2.2. Designing an Operational Model for Intelligent Customized Learning Using Geolocation-Based Method

With a smartphone, a mobile device, a learner's scope of activity becomes much wider, and AR contents can be used more effectively during independent self-directed learning or fieldwork learning outside the school. Already, many smartphone applications use GPS – a feature widely used to track location. GPS tracks the current location of the user as well as real-world images that appear on the screen and then augments reality. Generating AR contents using GPS can greatly contribute to enhancing the sense of presence of the learning activity thanks to its just-in-time character, whereby the learning contents are provided real time using location-based information. If such contents are developed based on learning agent and used jointly with big data – gaining much attention nowadays – then the data formed during the learning process can be analyzed and enable real-time intelligent customized learning. Such contents offer an effective alternative to the issue of insufficient feedback in an instructorless informal learning environment.

In fact, although based on instructorless informal learning environment, the intelligent customized learning model described above involves different phases of instruction. Based on the instruction model of Gagné [24], we extended the previously mentioned Input-Process-

Outcome Model to incorporate into our AR-based learning model, which is summarized in Figure 6.

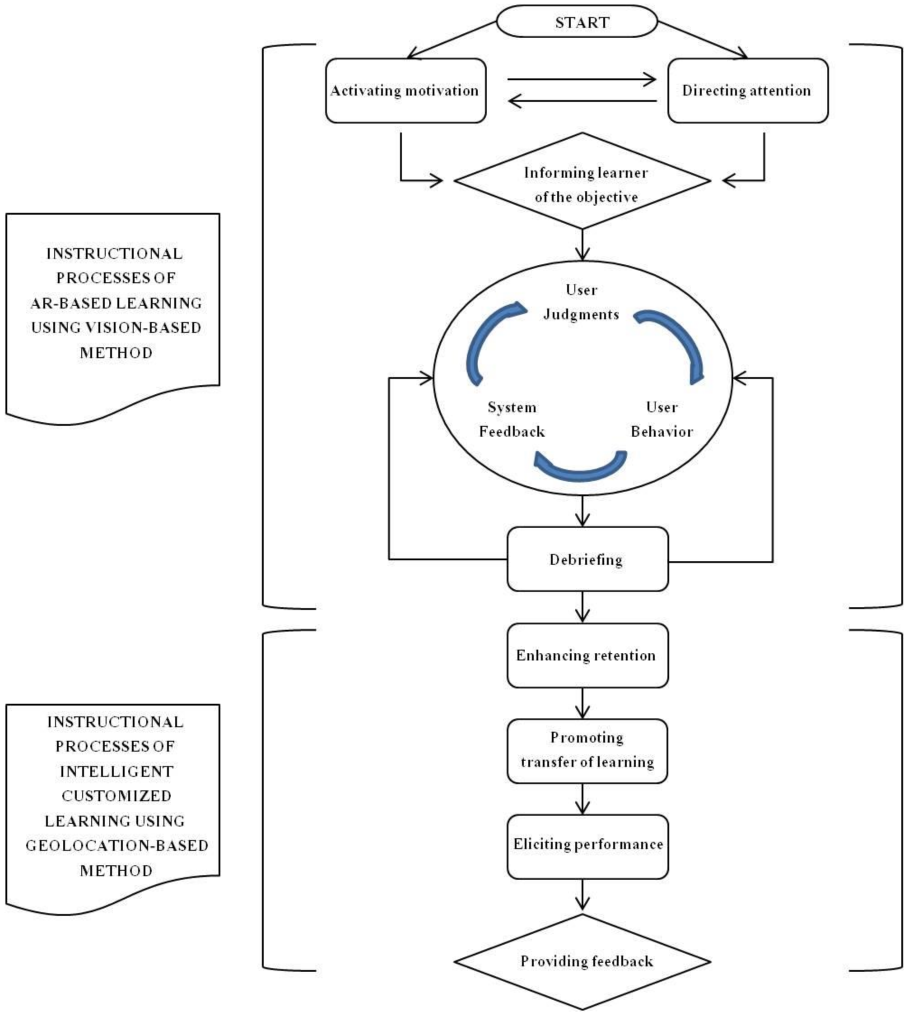


Figure 6. Instructional Processes for Providing Support during each Phase of AR-based Learning

The following example serves to make it clear what was demonstrated by the figure above. For example, data regarding a learner's learning history, such as what has been learned, exam results, time taken to complete tasks or answer questions, the number of incorrect answers, request for hints *etc.*, can be collected, and his or her learning objectives, interests, competence and performance analyzed. This information can then be fed back to the learner real-time, so that his or her performance is more effectively managed and the learner's self-directed learning can achieve more. In other words, it is using a form of educational big data to collect and analyze the real-time variables of the learner's learning activity in order to provide a curriculum that is more customized to the learner's competence level. Or, if supplementary learning is necessary, then a learning agent can be used to naturally induce more learning in areas that lag behind (see Figure 7).

Figure 7. Elements of Intelligent Customized Learning System used in Conjunction with Big data, and Data Flow

Another reason why GPS-applied AR is receiving attention is that it can enhance context awareness of an observation object during fieldwork learning. It provides additional information about the object or place the learner is observing, thereby increasing the realness of the observation and stimulating the learning activity. Such context awareness can increase interactiveness of the learning content, and is thus expected to be quite effective educationally. In fact, AR is being used in a way not only to facilitate understanding by providing the learner additional information about the scene under observation but also to increase interaction that takes place during the learning process. If big data is used here as well in conjunction with AR, then the learning process becomes all the more effective since the database of information observed and accumulated by others can also be used.

For example, suppose a learner goes to Brazil to learn Portuguese and arrives at the airport with his or her smartphone. If they want information about public transportation to the city center, they can use the smartphone to capture images of various public transport modes outside the airport or building, at which the GPS will track the present location and what kind of information is needed. They can then receive information about where to use public transport, as well as the fare, route, departure time, duration etc. If big data is also used, then the smartphone can collect and analyze real-time SNS messages or web postings of others who had used the same airport or public transportation, and relay the necessary information to the learner. Also, a learning agent can be used to retrieve important situation-by-situation words and phrases that have already been studied, or features such as a voice-recognition dictionary or an auto-translator can be activated to inform the learner new expressions they are likely to come across in that situation (see Figure 8).

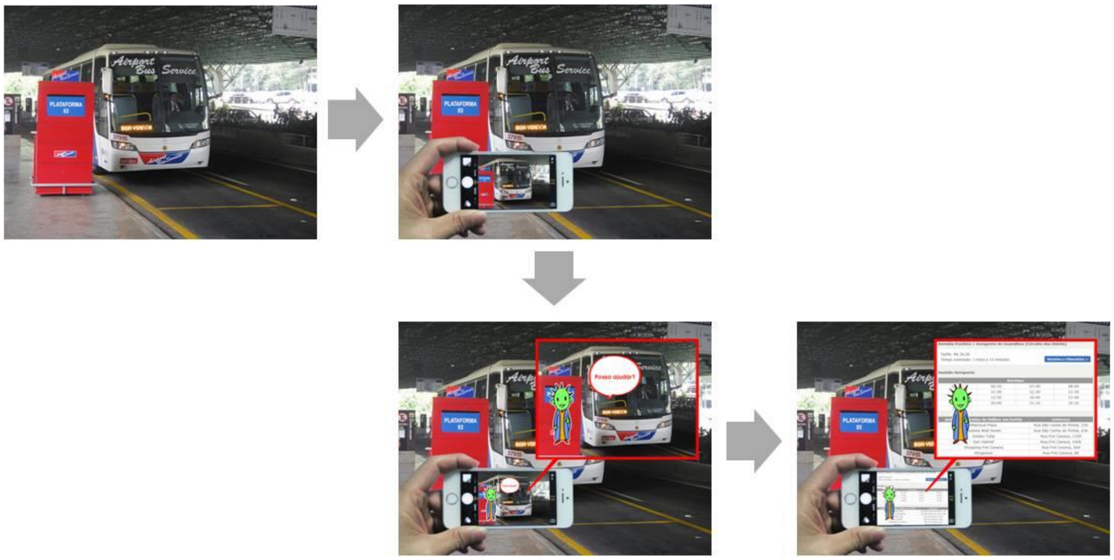


Figure 8. Example of Applying AR Contents to Fieldwork Learning

As such, if geolocation-based AR contents are used in conjunction with big data, it would be possible to design a learning model that directly and indirectly supports a learner's adaption to actual situations.

3. Conclusion

In order to propose a blended language learning model using AR, this research looked at theoretical characteristics of AR learning systems as well as their composition and mode of operation. To this end, it incorporated the existing instructional methods that are widely used in instructional design into our AR-based learning model. The type and the method of implementing the learning contents were divided into lecture-type formal learning and purely self-directed form of informal learning, and we went on to explain the methodology and process of designing learning contents according to each type. From the above process, the significance of applying a mobile AR-based learning model to foreign language education can be summarized as follows:

• It is possible to trigger more interest and sensory immersion into the learning process.

• It enables experiential learning through direct manipulation.

• Mobile and ubiquitous learning becomes possible.

• Because of its just-in-time characteristic, presence in the learning process is further enhanced.

• It offers individually customized learning through educational use of big data.

• Because it relies on context awareness, it is possible to design a learning model that supports fieldwork learning.

Although the learning model of an AR-based learning system proposed here has limitations in that it has not been positively verified, it is important to note that this research shows that the benefits of using AR extend into the realm of education, and verify that AR-based learning systems offer a potentially effective method for foreign language instruction. In this sense, this approach for the design and implementation of AR-based learning systems is expected to contribute to forming a foundation on which more research on AR-based learning systems can be based in the future.

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