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Smartphone Augmented Reality for EFL learners

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This study details the development and application of two Augmented Reality (AR) activities designed for use in listening and speaking university EFL classes. The authors demonstrate how the HP Reveal smartphone application can be used with a low degree of complexity to create AR content to encourage physical movement, collaboration, and contextual learning. Furthermore, is it shown how current AR technology is compatible with language learning, and displays a relative advantage over conventional materials. Analysis of participant survey data and discussion of the teacher and learner experience of the AR activities is contextualized with practical observations concerning the use of HP Reveal. Conclusions include suggestions for future educational AR research and materials development, and emphasize the importance of the demonstration of the benefits and uses of AR technology for both teachers and learners.

本研究は、大学の EFL リスニングおよびスピーキングクラスで使用するために計画された 2 つの拡張現実 (AR) 活動の開発と応用に関するものである。発表者は、動作、共同作業および環境にそくした学習を促す AR コンテンツを作成するために、スマートフォンのアプリである HP Reveal がどのように複雑さの程度が低い状態で使用されるかを説明する。さらに、現在の AR 技術が言語学習とどのように適合しているかを示し、従来の教材を超えた相対的な優位性を示す。参加者に対するアンケート調査および AR 活動についての教員と学習者の議論の分析について、HP Reveal の使用に関する実践的な観察とともに説明する。結論では、将来の教育的な AR 研究および教材開発への示唆を含み、教員と学習者両者のための AR 技術の利益と使用の証拠の重要性について強調する。

Augmented Reality (AR) is a relatively new technology brought to public consciousness by the Pokémon Go! game in 2016 (Godwin-Jones, 2016). The technology is now at a stage where researchers can develop and evaluate AR learning experiences (Santos et al, 2014), without the use of coding. However, the usefulness of AR in education remains unclear (Radu, 2014), and the potential of AR for language learning remains under-researched (Godwin-Jones, 2016). The following paper will detail the development and application of two AR activities designed to serve the teaching of listening and speaking skills to EFL learners. Specifically, the authors will discuss how the smartphone application HP Reveal can be used to experience camera tracking, marker-based AR, utilized to encourage physical movement and collaboration, and provide contextual learning in a meaningful, real world situation. The paper will conclude with discussion of the teacher and student experience of AR technology and suggest possibilities for future directions in AR material development.

The current study utilizes Rogers' Diffusion of Innovation theory (Rogers, 1983) to demonstrate that current AR technology embodies many of the characteristics of innovations that are adopted into widespread use. Rogers (1983) identifies five characteristics of innovations that determine eventual adoption; relative advantage, compatibility, complexity, trialability, and observability. The relative advantage of AR, the degree to which it supersedes conventional means of the representation of information, and its compatibility to language learning, the degree to which it

is consistent with the values and needs of potential adopters, will be detailed below. The complexity, the degree to which it is difficult to use, and the trialability, the degree to which it may be experimented with, of AR technology will be illustrated in the Methods section, while the observability, the degree to which the results are visible to others, will be shown in the Results section.

The authors became interested in applying Augmented Reality (AR) technology to educational activities from using Quick Response (QR) codes. QR codes embody characteristics of mobile learning, by allowing meaningful information to be temporally and spatially independent (So, 2008). They allow the teacher to augment teaching materials by, for example, linking grammar explanations to online grammar quizzes. In this way, QR codes reduce the temporal and spatial distance between, and allow easy access to, different modes of informational content. The promise of AR technology for language learning lies in the ability to directly layer content upon existing content, that is, for the simultaneous alignment of multiple representations (Radu, 2014). For example, if you are practicing speaking in the language classroom AR technology allows for the audio of a conversation to be overlaid on to the transcript of the conversation, so that both modes may be accessed in the same space and at the same time. This is said to improve learning by reducing the cognitive load required to direct attention (Mayer & Moreno, 2003), and demonstrates the relative advantage of AR technology over conventional representations of information. Being able to so clearly direct attention to content is also said to improve performance and memory retention (Radu, 2014). Furthermore, activities that utilize AR technology in the augmentation of real-world environments encourage collaboration and increase motivation, while being compatible to theories of learning and second language acquisition that value contextual learning (Godwin-Jones, 2016).

There are, of course, issues that make AR technology inappropriate in some learning contexts, including, complexity, ineffective integration into learning goals, learner differences, and attention tunneling (Radu, 2014). The current research will show that the HP Reveal smartphone application can be used with a low degree of complexity to create AR content. It will also be demonstrated how AR content can facilitate learning goals, deliver multiple modes of presentation that may negate learner differences, and avoid attention tunneling through contextual learning. In short, the following study will demonstrate the compatibility of current mobile AR technology for teachers and learners in university EFL classes.

Methods

Materials design

Two activities were created using HP Reveal, a smartphone application (app) for iPhone and Android devices, that enables the user to create camera tracking, marker-based AR content (Hawkinson, 2014). It is marketed to businesses as a means of creating engaging consumer experiences, is free to use, and has a simple interface. The app allows the user to create AR content through the selection of ‘triggers’ and ‘overlays’. Triggers must be unique, detailed, 2D images or surfaces. At the time of use, overlays were limited to video, image, or 3D animation files. The images and surfaces chosen by the authors to be triggers were photographed using the HP Reveal app camera. The overlays to be assigned to each trigger were videos recorded by the authors using a smartphone camera. The video overlays were then assigned to each trigger using the HP Reveal app interface, which is similar to one used when attaching a file to an email. Once saved to the app, triggers and the corresponding overlay content are viewable to the creator’s in-app followers. A follower is then able to use the in-app camera to view a trigger. Once the camera detects a trigger, the video overlay is displayed on the trigger, so that it appears as if a 2D image or surface has become a video screen.

The first activity, a campus treasure hunt, was game-like and required teams of learners to collect a set of passwords contained in videos located around campus. The authors chose ten locations on campus and photographed a unique, 2D surface at each location to be used as a trigger, such as an information board or work of art. The authors then recorded ten videos explaining the position of these locations, to be used as overlay content. The language in the videos included prepositions of place that students had studied in their course textbooks. Each video also contained a password and directions to the next location. The last location had

directions to the first location, making a loop. This design enabled contextual learning using familiar real-world places, and allowed for the integration of the activity into a review of prepositions of place. Liu & Tsai (2013) use GPS-enabled AR technology in a similar activity, while Richardson (2016) found the HP Reveal application to be a good means of creating a location-based, task-completion game.

The second activity, a conversation jigsaw, was classroom-based and required teams of learners to reconstruct a conversation from its separate parts. The authors wrote and video recorded a conversation about their winter holiday, to be used as overlay content. The conversation included culturally appropriate activities, images of which were selected to be used as triggers. The authors then split the video file at every change of speaker and assigned the separate parts of the conversation to the triggers. This design encouraged collaboration, provided scaffolding for speaking practice, had a natural focus on conversational turn-taking, and was integrated into a winter holiday-themed speaking class. Antonopoulos (2016) shows how HP Reveal can be used to create such an activity. This activity took advantage of one of the benefits of AR technology, that triggers can be portable. The images used as triggers were printed on pieces of paper and attached to the walls of the classroom, and then taken down and used in a different classroom with a different set of students.

Participants

Participants were 175 students (n=175) of compulsory English listening & speaking classes at a Japanese university, consisting of two distinct proficiency levels. Level one students (n=87) were false beginner/elementary, or the equivalent of CEFR A1. Level two students (n=88) were upper elementary/lower intermediate, or the equivalent of CEFR A2. Learners in both levels are categorized by the Council of Europe as being basic users who “can understand sentences and frequently used expressions related to areas of most immediate relevance” (Council of Europe, 2001), a feature which influenced the decision to ground the activities in the contexts of the university campus, in the treasure hunt activity, and typical winter holiday activities in Japan, in the jigsaw activity.

Procedures

After the design and creation of materials the activities were administered in one-off classes at the end of the second semester. Both activities were preceded by a short instructional session during which all students downloaded the HP Reveal app onto their smartphones. During the treasure hunt activity, which was administered to a total of 66 participants, 29 from level one and 37 from level two, students were put into small groups, and each group was given directions to a different trigger in the loop. In this way, each group started from a different position, meaning that, because they were not all moving around the loop together, all groups were engaged with the task of collecting the passwords. Students accessed the triggers using the HP Reveal app, watched the video overlays, and wrote down the passwords contained within them, then followed the directions to the next trigger. Once groups had collected all the passwords they returned to the classroom.

During the jigsaw activity, which was administered to a total of 109 participants, 58 from level one and 51 from level two, the students worked in small groups to move around the classroom, watch each part of the conversation, and identify the correct sequence of the eight separate parts. They were then required to practice and perform their own conversation using the provided conversation as a model. Therefore, the AR content and the accompanying worksheet, which contained a further trigger to a video overlay of the complete conversation, acted as scaffolding for speaking production. At the end of each class all students were provided with a QR code link to an anonymous online survey, which they completed on their smartphones in class.

Survey design

The survey was created using Rogers’ (1983) characteristics of innovations in order to gauge the readiness of learners to be adopters of AR technology. Survey items were written based on interpretations of Rogers’ characteristics (Table 1). A further two items were added in order to measure student interest in AR technology. A 5-point Likert scale was used, where one indicated strong disagreement, and five indicated strong agreement.

Table 1: *The correlation of survey items to Rogers' (1983) characteristics of innovations*

Characteristic	*Interpretation*	*Survey item*
Relative advantage	Improves English	AR can improve my English level.
Compatibility	Helps Learn	Using AR is compatible with how I like to learn.
Complexity	Complicated	This AR activity is too complicated.
Trialability	Need AR	This activity could be done without AR.
Observability	Understand Goal	The goal of this activity was clear.
	Enjoy	I enjoyed using this AR activity.
	Want AR	I want to use more AR activities to learn English in class.

Results

The survey data was anonymized, and incomplete entries were discarded before analysis began. The small sample size (n=175) necessitates a cautious interpretation of data, and requires any results to be followed up with a more rigorous experimental design. Descriptive statistics showed a positive response to the activities. The Enjoyment, Helps Learn, and Improves English items all received mean scores of over 4 (Table 2), with the highest being Enjoyment (M=4.21). ANOVA analysis was used to investigate whether the student experience differed across activity type and proficiency level. The student experience showed no significant differences across activity type in Enjoyment, Helps learn, Improves English, or Understand Goal. However,

Table 2: *Descriptive statistics*

	M	SD
Complicated	2.506	1.195
Enjoy	4.210	0.989
Helps Learn	4.006	1.039
Improves English	4.057	1.007
Need AR	3.063	1.256
Understand Goal	3.835	1.070
Want Again	3.892	1.093

there were significant differences, whereby Want AR was scored higher by the Treasure Hunt participants ($p<0.05$), and Complicated and Need AR were scored higher by the Jigsaw participants (both $p<0.05$). Considering the student experience by proficiency level, there were significant differences in all categories. Level two students rated the activities higher than level one students for Enjoyment ($p<0.05$), Helps learn ($p<0.05$), Improves English ($p<0.05$), Understand Goal ($p<0.05$), and Want AR ($p<0.05$). Whereas, Level one students rated the activities higher than level two students for Complicated ($p<0.01$), and Need AR ($p<0.05$).

Discussion

Student experience

The descriptive statistics show that students enjoyed the AR activities (M=4.21), and that the AR activities helped them learn (M=4.006) and improved their English (M=4.057). This suggests that students view AR technology as compatible to learning. In contrast, students were unsure of how complicated the AR technology was to use (M=2.506). It was observed by the authors that most problems in using the technology arose at the stage of enabling the AR technology. To reach the stage where they were ready to access the AR content required the students to complete the following four tasks; download the app, create an account in the app, which required the creation of a username and password, search for the teacher account in the app, follow the teacher account in the app. This is an area in which the complexity of the technology could be reduced by simplification of the set-up procedure.

The degree to which the activities required AR was rated relatively low (M=3.063). This could reflect a lack of understanding of the relative advantage of AR technology. However, this result could also be explained by an issue involving the previewing of triggers in the HP Reveal app. The authors noticed a student during the Jigsaw activity viewing overlays using triggers displayed on the smartphone of classmate sitting next to them,

thereby negating the need to move around their environment to access the overlays. The ability to preview triggers thereby endangers one of the means by which location-based AR enables interaction with real world environments.

The strongest result of the ANOVA analysis concerned the difference in how complicated students found the activities. Students of lower proficiency found both activities more difficult than students of higher proficiency ($p<0.01$), and suggests that learners at the A1 level found using the AR technology and completing the linguistic task more cognitively demanding. Whether this difference is due to either or both of the cognitive demands of using the AR technology, or of completing the linguistic task is unclear. Future research may focus on varying the task difficulty to determine whether there is a proficiency level-related threshold whereby the use of AR technology in its current state becomes too demanding.

Teacher experience

The process of creating AR content in HP Reveal was quick and simple. The biggest issue concerned the requirement of unique surfaces for the creation of reliable triggers. This meant it took consideration and time to find suitable triggers for both activities. However, The HP Reveal app slightly negates this difficulty by displaying a bar below the camera screen that indicates the suitability of the image by moving from red to green as the uniqueness of the image increases. The testing of the AR content for the treasure hunt activity was time consuming as it necessarily involved walking the route and accessing the overlays using a specially created HP Reveal account. This process could be made more efficient by using two smartphone devices, one to assign overlays to triggers, and the other to test that the overlays are accessible.

Conclusions

This study has shown that AR technology, particularly in the form of the HP Reveal smartphone application, in Rogers' (1983) terms, is compatible with language learning, and can be used with a low degree of complexity in the development of language learning materials that take advantage of its relative advantage over conventional learning materials. It has also been demonstrated that learners have a generally positive experience of AR technology. Improvements to the measure of the learner experience could include the use of open response survey items to allow for a greater degree of qualitative analysis.

Future AR language learning materials development could include the development, and integration into language courses by means of the incorporation of student-generated content, of the Treasure Hunt activity, and the development of smartphone apps that allows for teachers and learners to create AR content in ways that avoid the complexities involved in current technology, as mentioned above. Nickerson et al (2014) show how adopter beliefs regarding the characteristics of an innovation are positively associated with adopter categories. Therefore, educational AR research should be concerned with demonstrating the benefits and uses of AR technology for language learning to both teachers and learners, as well as the development of the means of measuring the effect of AR technology on teachers, learners, and the learning process. The more teachers and learners adopt AR technology, the greater its potential to advance the effectiveness of language instruction and learning will be realized.

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