Developing an Educational and Promotional Augmented Reality Learning Game Smartphone Application

Samuel Taylor
Language Education and Research Center
Kyushu Sangyo University, Japan
taylorsamueljohn@gmail.com

Adam Stone
Language Education and Research Center
Kyushu Sangyo University, Japan
adamstone711@gmail.com

Neil Witkin
Language Education and Research Center
Kyushu Sangyo University, Japan
nswitkinksu@gmail.com

Abstract: The development of an Augmented Reality (AR) campus guide learning game smartphone application (app) at a Japanese university is intended to provide a tool for the efficient use of AR materials in instructional settings, and is characterized by the balancing of educational and institutional goals. AR technology and learning game design are utilized to encourage engagement, physical movement, and the contextual learning of content. The early stages of the development process are concerned with defining the scope of the app, the learning goal, the technical requirements, and establishing a method of development that simplifies a process restricted by a limited budget. A major goal of the research is the integration of a Computer Assisted Language Learning (CALL) game, to be used as part of an instructional sequence, to facilitate the investigation of the appropriateness of instructional design that utilizes AR technology and contextual, game-based learning in Japanese EFL contexts.

Background

The decision to develop an AR smartphone app was informed by research undertaken by the authors on the use of AR materials in EFL classes at a Japanese university. AR materials were designed to encourage physical movement, collaboration, and contextual learning, and implemented in campus-situated, task-based activities. The research indicated that AR technology is compatible with language learning, and that learners have a positive experience of its use (Taylor & Stone, in press). Designing and implementing AR campus-situated tasks with an AR app that made for cumbersome and inefficient use in language classes led the researchers to imagine the development of an original AR campus guide app. Such an app would allow for the efficient use of AR materials in instructional settings. The application for a grant to develop an app attracted the attention of university administrators to the potential of the research to be used as a promotional tool in open campus events, and as a tangible means of showcasing and promoting the university's Language Education and Research Center (LERC). The promotional goals of the university should be viewed in the current Japanese context of universities competing over a shrinking pool of high school graduates (Kuwamura, 2009) while diversifying and increasing capacity in a drive to internationalize (Brown, 2014). Therefore, the research is characterized by attempts to balance the needs of administrators and researchers.

Augmented Reality

Augmented Reality is defined as, 'the real time integration of digital information with a user's environment' (Rouse, 2016). It's position, between the real and the virtual (Milgram & Kishino, 1994) gives AR great potential to transform learning (Santos et al, 2014) by allowing learners to engage with existing environments in new ways. Depictions of AR in mass media show how it encodes space with multiple channels of information, and reveals some kind of previously hidden truth (Norman, 2018). The magic of AR in revealing content increases learner interest (Godwin-Jones, 2016), and contributes to a positive learner experience (Taylor & Stone, in press). The layering of information is also a vehicle for clearly directing attention to meaning, which can improve comprehension and retention (Radu, 2014) by reducing the cognitive load required to direct attention (Mayer & Moreno, 2003); and demonstrates a relative advantage of AR technology over conventional representations of information. Marker-based smartphone AR can be used to encourage physical movement and contextual learning because it ties content to physical objects whose locations can be specified. In a campus-situated activity, the AR content creator can directly place learners in situations where the use of the target knowledge is required. For example, information about university library entry procedures can be accessed at the entrance to the library in an AR campus guide.

Scope and Goal

The primary goal of the app is to create a memorable game-like experience for students and visitors to the university campus. The learning objectives are the identification of important campus services, the understanding of what each service entails by matching services to problems commonly encountered by students, and the application of knowledge of the services to personal preferences or experiences. These objectives are mapped onto a three-level game design informed by Bloom's taxonomy, which indicates the level of cognitive skill required to complete each objective (Armstrong, 2019). App users will travel to important locations on the university campus using a map of the campus to locate markers that launch AR content that provides information on a particular location in the form of a learning game. Upon successful completion of a learning game, users will be rewarded with a score and a collectable in-game item. A high score leaderboard and in-game collectables are included to encourage repeat use, and the knowledge contained in each learning game is accessible once each level is cleared to enable the app to function as an informational guide. The use of a learning game, defined as a game designed to help players develop knowledge while being engaged in a learning process that is fun and involves an abstraction of reality or element of fantasy in the teaching process, to deliver content is justified by research that has shown this to be a more effective means of instruction that a conventional presentation of information (Boller & Kapp, 2017). Narratives will be used to create abstraction, through the use of a character with whom the player interacts, and also to encourage players to relate content to their own lives, through the use of multiple-choice narratives, which require players to state preferences, in the latter game levels designed for the application of knowledge.

The Development Process

Outsourcing development was explored as a result of the perceived pressure to produce an app of a standard expected by university administrators. However, the prohibitive cost, estimated at approximately US$27,000, and the perceived value to the researchers of developing the app entirely themselves led to the adoption of the principles of agile development (12 Principles Behind the Agile Manifesto, 2019). This approach assists in simplifying what is a complex process made even more challenging by the restrictions of a small budget (approximately US$5,500), by stressing the goal of creating, at the earliest possible stage, a Minimum Viable Product (MVP), and prioritizing the prompt delivery of a functional product and the provision of time to deal with the occurrence of technical problems in short uninterrupted sprints of development. The Unity software development kit and the Vuforia Engine plugin were chosen for development due to their relative ease of use and their compatibility with both iOS and Android operating systems. Unity is a versatile tool for developing digital environments and Vuforia provides a developer portal website where AR markers can be prepared and compiled as a database and then imported to the app in Unity. The successful discovery of the AR markers is critical to the user experience of the app; therefore, the design of user navigation is an important technical consideration. GPS technology allows for location tracking and is available as a Vuforia plug-in, but is unreliable at the scale of a university campus. Therefore, detailed to-scale maps of marker locations will be used to enable users to accurately locate AR markers. Solutions are required for how best to integrate AR technology with the learning game. The goal is for AR assets to consist of simple marker-based AR,

however, difficulties in enabling Extended Tracking capabilities, which improve the user experience by enabling content to be viewed without the requirement to keep a marker in the camera frame, led to experimentation with features of Markerless AR technology. The utilization of a smartphone's camera, gyroscope and accelerometer to track an environment allows for AR content to be instantiated upon ground planes, which once instantiated, remains in situ.

Designing for CALL

A major goal of the research is the design and inclusion of a language learning game, accessible at the LERC, that will enable the use of the app in an instructional sequence as a tool of CALL. As games are particularly adept at training players in the transfer of skills (Klopfer et al, 2018), this game will target the learning, and transfer to English classes and wider contexts, of language knowledge or skills. The target users of the game are lowly motivated, CEFR A2 proficiency level learners in compulsory English courses (Council of Europe, 2001). Therefore, a game with the intended goal of engaging learners in the language learning process, language learning strategies, or developing a willingness to communicate, may be more suitable than a game targeting the learning of discrete language items (Wu et al, 2012). The goal of the researchers is to include a CALL game while avoiding a higher degree of complication in the design of the app. The inclusion of a CALL game requires its integration to the campus service content. The most elegant design would consist of a common learning game dynamic to which the learning content, informational and CALL, from all campus locations can be fit in order to create a unified, immersive experience. Evaluation of the CALL game will use judgmental and empirical analyses to argue the degree of appropriateness of its use in Japanese EFL contexts (Chapelle, 2001). Judgmental analysis will focus on the design of the software and learning game. Empirical analysis will benefit from the appropriate use of data mining tools to be included in the software.

Future Directions

As the app is currently under development what has been stated above will inevitably be subject to change but can be seen as representative of the major concerns of the authors at the early planning and development stages. Once completed, the successful deployment of the app as a promotional tool could lead to future iterations with features designed to increase immersion, such as a shared leaderboard, and the tagging of user comments to AR content. Its success as part of an instructional sequence could lead to the CALL game being integrated into the university e-learning system as a required part of the curriculum, and could possibly justifying the further use of instructional design that utilizes AR technology, and prioritizes contextual, game-based learning.

References

12 Principles Behind the Agile Manifesto. (2019) Retrieved from https://www.agilealliance.org/agile101/12-principles-behind-the-agile-manifesto/

Armstrong, P. (2019). *Bloom's Taxonomy*. Retrieved from https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Boller, S. & Kapp, K. (2017). *Play to Learn: Everything You Need to Know About Designing Effective Learning Games*. Alexandria, VA: ATD Press.

Brown, H. (2014). Contextual Factors Driving the Growth of Undergraduate English-medium Instruction Programmes at Universities in Japan. *The Asian Journal of Applied Linguistics*, 1(1), 50-63.

Chapelle, C. A. (2001). *Computer Applications in Second Language Acquisition.* Cambridge: Cambridge University Press.

Council of Europe. (2001). *Common European framework of reference of languages: Learning, teaching, assessment*. Retrieved from: https://www.coe.int/en/web/common-european-framework-reference-languages

Godwin-Jones, R. (2016). Augmented Reality and Language Learning: From Annotated Vocabulary to Place-Based Mobile Games. *Language Learning & Technology*, 20(3), 9–19. Retrieved from <http://llt.msu.edu/issues/ october2016/emerging.pdf>

Klopfer, E., Haas, J., Osterweil, S., Rosenheck, L. (2018). *Resonant Games: Design Principles for Learning Games that Connect Hearts, Minds, and the Everyday*. Cambridge, Massachusetts and London, England: MIT Press.

Kuwamura, A. (2009). The Challenges of Increasing Capacity and Diversity in Japanese Higher Education Through Proactive Recruitment Strategies. *Journal of Studies in International Education*. doi:10.1177/1028315308331102

Mayer, R. E., & Moreno, R. (2003). Nine ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist*, 38(1), 43-52.

Milgram, P. & Kishino, F. (1994). A Taxonomy of Mixed Reality Visual Displays. *IEICE Transactions on Information Systems*, E77-D(12).

Norman, J. (2018). *L. Frank Baum's "The Master Key" Imagines a Kind of Augmented Reality*. http://www.historyofinformation.com/expanded.php?id=4698. Accessed November 14th, 2018.

Radu, I. (2014). Augmented Reality in Education: A Meta-Review and Cross-Media Analysis. *Personal and Ubiquitous Computing*, 18(6), 1533–1543. doi:10.1007/ s00779-013-0747-y

Rouse, M. (2016). *Augmented Reality (AR)*. Retrieved from https://whatis.techtarget.com/definition/augmented-reality-AR.

Santos, M. E. C., Chen, A., Taketomi, T., Yamamoto, G., Miyazaki J., Kato H. (2014). Augmented Reality Learning Experiences: Survey of Prototype Design and Evaluation. *IEEE Transactions on Learning Technologies*, 7(1), 38-56.

Taylor, S. & Stone, A. (in press). Smartphone Augmented Reality for EFL learners. *2018 PanSIG Journal*.

Wu, S., Franken, M., & Witten, I. H. (2012) Collocation Games from a Language Corpus. In Reinders, H. (Eds) *Digital Games in Language Learning and Teaching*. New York: Palgrave MacMillan.

Acknowledgements