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The resource centre for ubiquitous learning & integrated pedagogy: Mobile learning solutions for next generation learners

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The Resource Centre for Ubiquitous Learning & Integrated Pedagogy: Mobile Learning Solutions for Next Generation Learners

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Abstract
With the advent of mobile technological enhancement, teaching and learning can now be brought beyond the four walls of the classroom. Mobile technologies are transforming the educational landscape so much so that teaching and learning can take place anywhere, everywhere and anytime, thereby creating a new innovation in the learning process known as ubiquitous learning. By identifying the potential of mobile applications to address pedagogical difficulties, the Resource Centre for Ubiquitous Learning & Integrated Pedagogy (ULIP) was established with funding from the University Grants Committee (UGC) of Hong Kong. ULIP offers app development solutions to solve specific pedagogical problems, acting as an agent of today’s education-technology movement to serve as an enabler of accelerated mobile learning. The “access anywhere” nature of the mobile app solutions allows for the user-participation in the dissemination of knowledge in new and creative ways. This then allows for more time in the classroom for optimized communication, interaction and connectedness, more fully engaging both students and faculty. Partnering with the Hong Kong Polytechnic University, the Centre develops user-friendly and aesthetically pleasing mobile apps for a range of courses to complement teaching through lectures. By continually exploring and evaluating innovative ways to use mobile apps and new pedagogies to engage students, the Centre is able to create apps that bridge the classroom with real world applications for expanded learning outside of the classroom.

1. Introduction to the Specific Objectives of the e-Learning Initiative
In today’s increasingly technology-dependent world, mobile applications are becoming more pervasive, impacting educational practices across different learning contexts, and subsequently changing the landscape of education (Khaddage, Lattemann, & Bray, 2011). Technology is continually advancing, and this change is moving into the educational realm by generating unique opportunities for enriched learning that is characterized as both mobile and ubiquitous learning (Bell & Dourish, 2007). Students today impact educational systems considerably by introducing new demands of learning, which permit educators to adapt to a technological world that allows for a more ubiquitous learning environment (Hsieh, Jang, Hwang, & Chen, 2011). As the advancement and affordability of mobile devices dramatically increases every year, so do the possibilities of educational applications (apps) running on those devices (Peng, Su, Chou, & Tsai, 2009). This in turn may explain why trends in teaching and learning are rapidly moving in the direction of mobile or ubiquitous learning, where growing portability allows for anytime and anywhere learning experiences (Yahya, Ahmad, & Jalil, 2010).

To this effect, the Resource Centre for Ubiquitous Learning & Integrated Pedagogy (ULIP) at Hong Kong Baptist University (HKBU), funded by the University Grants Committee (UGC) of Hong Kong, encourages the exchange of information and ideas, leading to the development of mobile applications (apps) across disciplines and subject areas that are of high functionality and pedagogical value, both to the HKBU academic community as well as cross-institutionally. Hence, a significant aspect of this project is to enable HKBU and partnering institutions to adopt necessary pedagogical changes and innovations to enhance teaching and learning. With this in mind, the Centre collaborates with instructors both in-house as well as across Hong Kong’s eight UGC-funded institutions, and offers carefully designed mobile learning apps to solve specific pedagogical
problems. Our primary aim is to not only position our Centre as a leader in today's education-technology movement by acting as an enabler of mobile learning innovation, but also to create a generation of learners who see the world as their classroom. We create apps that are also able to provide a bridge from the classroom to real world applications for expanded learning outside of the classroom.

### ULIP's Mission

**Supporting** the strengthening of higher education institutions by fostering an awareness of the educational possibilities recent mobile technologies present, and facilitating the incorporation of ubiquitous learning and pedagogy into teaching and learning practices;

**Creating** a teacher-friendly infrastructure with technology, design, and instructional design expertise for designing and implementing attractive, rich educational experiences in a medium ideally suited for today’s students;

**Freely** disseminating educational apps, their source code for others to adapt, and corresponding pedagogical strategies, thereby, benefiting the larger higher education system and facilitating educational knowledge transfer among institutions;

**Facilitating** the study of these new approaches to learning, leading to publications in the scholarship of teaching.

Figure 1: ULIP’s mission

ULIP brings a unique methodology and collection of resources to its pursuit of creating mobile apps across all disciplines and subject areas. The Centre is able to design and create mobile apps with media-rich learning content, subsequently engaging students in an immersive learning environment, thereby allowing learning to take place anytime, anywhere, so that students learn while on the go. This ‘access anywhere’ nature of the mobile app solutions we develop not only allows for user participation and dissemination in new and creative ways, but also optimizes communication, interaction and connectedness, thereby fully engaging both our students and faculties. Prior investigation confirms that there is improved learning when students possess the means to physically move their own learning environment with them and consequently, seamlessly adapt to the new environment in order to access information within the context of their learning. Hence, it is the ultimate goal of the Centre to ensure that all students will have enabling, self-paced resources which enable them to compensate for information they currently lack, and to eventually exceed their own performance expectations.

ULIP’s aims (shown in Figure 2) and objectives (show in Figure 3) underpin the Centre’s services and mobile solutions, by striving to help university instructors explore learning opportunities, using custom-made mobile apps and new integrated pedagogies to better reach their students.

### ULIP’s Aims

- **Bringing innovation to tertiary education**, by creating pedagogically sound mobile apps that support, enhance and transform teaching and learning;

- **Designing**, developing, implementing and evaluating mobile apps that are of interest to and have value for students from multiple fields and disciplines across institutions;

- **Allowing** seamless, just-in-time learning across formal and informal learning spaces through mobile apps that support visual learning and presentation of content in dynamic ways;

- **Making** education fun by creating gaming elements that allow for student self-assessment, challenge and on-demand access to learning anytime and anywhere that is convenient to them.

Figure 2: ULIP’s aims
We believe teaching and learning are about effective student engagement, collaboration and communication. Our apps are specifically designed to provide a unique and intuitive touch interface, delivering a consistent user experience. We design, implement, and evaluate new mobile apps and believe these can improve teaching and learning. Moreover, the primary advantage of using educational mobile apps is the ease of repeated opportunities available to the learner to engage in a task or learning activity (Hirsh-Pasek et al., 2015). Today’s students are accustomed to mobile learning environments supporting highly interactive content. For example, in a lecture, students cannot ‘pause’ to define or translate words, review previous concepts or ‘rewind’ to hear a topic particularly difficult for them to grasp. We are acutely aware of not only where students encounter roadblocks around a topic or concept, but also have our finger on the pulse to determine what might help them overcome these hurdles. By continually exploring and evaluating innovative ways to use mobile apps and new pedagogies to engage students, we are able to create apps that bridge the classroom with real world applications for expanded learning outside of the classroom.

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<th>ULIP’s Objectives</th>
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<td>Providing support for instructors’ most difficult pedagogical problems;</td>
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<tr>
<td>Lowering students’ resistance to engaging these problems through fun, structured mobile apps;</td>
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<tr>
<td>Enabling the use of technology to disseminate information and construct knowledge in media rich, content-specific formats, running on devices students enjoy using and habitually carry with them at all times.</td>
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Figure 3: ULIP’s objectives

2. The Infrastructure

- Establishment of the Resource Centre for Ubiquitous Learning & Integrated Pedagogy (ULIP) including space allocation, equipment selection and purchase of office materials and renovations/installation of all components for the Centre’s infrastructure.

- Logo design and digitization - targeted visual elements and focus on these elements to communicate our Centre’s branding for our mobile apps. Additionally, we designed a brochure to promote our services and capabilities.

- Developed a comprehensive website (http://ulip.hkbu.edu.hk/) to accurately position our Centre as a support system for University-wide cross-institutional collaborations and contributions to plan and initiate projects with support for both technology and pedagogy. The ULIP website is aimed at providing access to information, such as authorship, data collection and copyright policy, our apps, tools and resources and comprehensive information (i.e., publications, awards and press releases) on the ongoing efforts of the Centre.

- Developed guidelines on authorship, data collection and copyright policy (http://ulip.hkbu.edu.hk/copyright/).

- Designed ULIP mobile app screen sequences (i.e., splash screen, “why this app?”, terms of use, password [optional] and main screen) for a well-designed responsive app launch flow, and a consistent branding and usage experience across different apps, to enable users (students) to fully understand the apps’ benefits towards their study of specific course materials.

- Invited and facilitated instructors to identify and clarify their own course-specific pedagogical issues, through institutional as well as cross-institutional support. Consultations, discussions, meetings, bi-weekly conversations and monthly briefing sessions provide impetus to help
instructors explore and evaluate innovative ways in using mobile apps and new pedagogies to engage their students. This experience has enabled us to expediently develop prototypes (shown in Figure 4), proof of concepts (i.e., User Interface (UI) mock-ups, so that the app looks as real to the final version as possible) or simple apps, which serves the valuable purpose of moving from a conceptual idea to a demonstrable app, allowing the instructor(s) to actually experience how the app functions.

**Figure 4: Example of prototype**

- Carried out design conceptualization and wireframes (i.e., page layouts of the apps content), comprising of discussions and meetings on the design requirements for developing the apps. The number of layers (i.e., user-interface elements, navigation and interaction design and application logic) of the apps was also decided. Regular meetings and discussions with our Hong Kong Polytechnic University counterparts included a broad set of issues related to the
app development process, comprising app workflow development (shown in Figure 5), support on design (i.e., visual look, user flow, navigation, typographic style, ensuring the consistency of the app, etc.), mobile app user interface designs involving the depth of layers and app hierarchy as well as screen usage and programming, based on common web development languages such as HTML5, JavaScript and CSS3. Design elements that were consistent across screens and different apps were also carefully considered, including layout, and interaction design, color usage, and typographic elements.

- Enrolled in Apple Developer Program and Google Play Developer account under our Centre’s name “ULIP” to develop, test, submit and release our iOS and Android apps and updates.
Our suite of apps (shown in Figure 6) are available for Apple and Android devices, and optimized for both tablet and mobile phone screens. We continue to design and build native mobile apps across different disciplines and subject areas, optimized for both tablet and mobile phone screen sizes, and disseminated via Apple’s App Store and Google Play. Moreover, the integration of appropriate gaming elements, coupled with pedagogical considerations which combine both logic and creativity, make learning a more challenging, rewarding and interactive experience.

Carried out the following three phases of development:
- Phase 1 – Development: during this phase, apps were built, fully tested by loading on devices multiple times to test and retest for functionality, design and bug testing and submitted to approval committee for quality assurance;
- Phase 2 – AdHoc: during this phase, we tested our apps as if they were downloaded from the App Store or Google Play. This is to ensure that everything is ready for posting for Apple/Google review of our apps.
- Phase 3 – Distribution: once the apps have been fully tested in the AdHoc phase, it is then ready for download in the App Store and Google Play.

We continue to distribute our apps for testing after submitting to the App Store and Google Play for approval and upload of metadata (i.e., app icons and launch images, specifying which devices and operating systems our apps support).

We continue to conduct ongoing User Acceptance Testing (UAT) throughout the design and development process, including testing on mobile devices. A series of usability observations for prototype versions of our apps are performed and a usability test moderation guide is developed to measure the steps of actions and time taken by the users in performing the given tasks using the prototype versions. The testing phase investigates the overall look, performance, and usability of the constructed mobile app. Other areas considered in the moderation guide include whether users can easily comprehend the contents and screen elements, for example readability of text, and understanding of buttons or links labels. Functionality and usability is also tested on multiple devices taking into consideration the
operating system and version and screen size.

- Continue to attend and present papers on the development progress as well as pedagogical and design considerations of our apps, with the aim to inform practice in the scholarship of teaching and learning, leading to publications and conference presentations.

3. The Challenges
One key challenge has been the systematic monitoring and evaluating of our progress and achievement through both usability testing and assessment of learning. Determining which aspects of the mobile app, such as the overall design and features of the system, students’ attitudes toward use of it, and students’ perceptions that the mobile app content is useful to students’ tasks (i.e. revealing a broader and deeper understanding of the issues at hand), enable us to effectively address the design features to make the use of our apps more engaging for students. We comprehend that students will have a better response to our apps, if they deliver an impression of ease of use and appeal, besides being considered as attractive, unique, flexible, challenging and engaging apps.

Another key challenge has been identifying fundamental elements of game design that foster student engagement, involvement, concentration and interest. By identifying these key elements and understanding how they motivate students, we are subsequently enabling students to learn through activities that are challenging and of interest to them. Based on positive user feedback, our completely original and appropriately challenging game concepts with detailed in-game statistics make learning exciting and rewarding. Moreover, the need to capture and maintain the players’ attention through visual experiences and audio designs is also a vital element in the design of our apps. When students are engaged in game-based apps of this nature, they are not only developing and reinforcing their cognitive skills, but also constantly drawing connections between text, images and sounds.

How the initiative was received by the users or participants
The uptake of our mobile apps by students is impacted by their confidence in using our apps and their awareness of how the apps can assist their learning. The users’ experiences within an app transcend multiple dimensions. In certain cases, these depend on the app’s design and how different features of the app appeal to each user. Specifically, one way to address the challenge of assessing student learning effectiveness is through data collection and analysis of responses to questionnaires, feedback gathered through structured interviews as well as comments from our users through the App Store and Google Play.

App user satisfaction has exceeded our expectations. Acceptance of our apps has been impacted by users’ positive feedback and confidence, ranging from having a visually appealing design to a seamless, responsive and user-friendly interface. To date, the feedback and data received for both our iOS and Android versions have been very positive and the usage statistics confirm that our apps are becoming the preferred channel of engagement. We continue to systematically monitor and evaluate our progress through usability testing of UI design, control elements, overall layout and the look of the app, thereby ensuring app users get the best possible user experience.

User experience has been consistent between iOS and Android platforms. For optimal user experience, all our apps function identically across different mobile devices, and the app’s usage requires no internet connection once downloaded and installed. Our apps are optimized for both tablet and mobile phone screen sizes, and disseminated via Apple’s App Store and Google Play. Mobile app analytics have been essential for monitoring the quality of our apps. Moreover, we track
app statistics regularly to collect data to better understand the geographic distribution (see Figure 7) of our users, and monitoring user downloads.

For example, our Interactive Phonetics app was downloaded more than 2,000 times (see Figure 8) within the first three months of being available on Google Play. We are confident that our students/users are compelled to download our apps because they offer rich and relevant content, combined with unique gaming elements, which other apps that are available on the market may not offer.

The Learning Outcomes
Hong Kong Baptist University's strategic plans and outcomes-based initiatives are the institutional means of ensuring commitment to improving the quality of student learning, from which pedagogically-driven approaches to mobile learning can emerge. Ultimately, we feel our students being digital natives, are better suited to learn with mobile devices. With this in mind, the Resource Centre for Ubiquitous Learning & Integrated Pedagogy (ULIP) continues to offer app development solutions to solve specific pedagogical problems. With a thorough understanding of pedagogically-driven approaches to mobile learning, we are able to explore the ways in which mobile app solutions are able to support, enrich and transform learning outcomes for a diverse community of learners and consequently, implement pedagogical practices more effectively. Moreover, we are able to
bring a unique methodology and collection of resources to our pursuit of creating mobile apps across disciplines and subject areas.

Our core focus is relevant, high quality educational content and user-friendly apps that enhance the teaching and learning process. The core and direct beneficiaries of this UGC-funded project are our UGC students. We aim to meet the learning needs of the new generation of students by leveraging the latest user interface designs and development methodologies and subsequently creating iPhone, iPad, Android and web-based mobile applications that support and encourage learning of the content/concepts in engaging and meaningful ways. Thus, it would follow that students may well learn more on their smart phones commuting to a lecture than they do in the lecture itself. Ultimately, this leads to spending less valuable class-time disseminating information in lectures and providing more time towards building higher-level cognitive skills. The team at ULIP team achieves this by studying instructor’s pedagogical needs and offering intuitive, aesthetically built mobile app solutions (see Figure 9) with innovative and engaging content that is pedagogically sound, ensuring careful monitoring of content and clear guidance on the quality of content. This is based on the following design principles:

Creating apps that are pedagogically-driven
- Focusing content that clear, focused and pedagogically significant;
- Designing content that can be seamlessly incorporated into an app in respect to scaffolding the student’s learning needs;
- Balancing engagement and learning.

Creating apps that sustain student’s interest and learning
- Designing challenging quizzes and/or gaming elements constructed to test various skill sets;
- Providing goals and rewards (e.g., point systems and/or the awarding of badges) to drive desired outcomes among users;
  Providing levels to indicate the proficiency of the user in the overall gaming experience over time;
- Providing immediate feedback is used to keep students aware of their progress and/or failures in real-time.

Moreover, a better understanding of the potential of lower/higher order skills that each mobile app may afford, not only assists us in evaluating our mobile apps but also assists educators in integrating more effective mobile solutions that promote a taxonomy of lower to higher-order thinking skills.
While we have a large amount of analytic data and observational evidence surrounding motivation and engagement, we also have a large amount of data which suggests measurable learning benefits from using our apps. We have had instructor accounts which describe higher levels of student motivation and engagement, but the question arises, are students really learning? Evidence-based practice is necessary to determine if our apps actually improve learning outcomes. To address this question, we conducted studies to evaluate learning outcomes and students’ perceptions of selected variables of competence (COM), challenge (CHA), choice (CHO) and interest (INT), based on students’ behavioral intentions to use (BIU) our apps, i.e., the degree to which students have formulated a conscious plan to perform or not perform a specified future behavior. The constructs in the model represent the user’s knowledge, skills and capabilities and the user’s beliefs and attitude toward the app.

For example, our “Interactive Phonetics - An Audio-Visual IPA Reference” app developed for the Department of English Language and Literature at Hong Kong Baptist University, is specifically designed to provide a unique and intuitive touch interface with clear graphic, high quality audio and textual descriptions of speech sounds, comprehensive coverage of the consonants, vowels and tonal symbols and cross-section animations illustrating the articulations of the speech sounds (see Figure 10).
Speech pathologists and linguistic students must have a firm grasp of the physiology and anatomy associated with speaking. In learning phonetics, it is very important when students are learning sounds, that they are able to see the mouth and tongue as it is making the sound. The visual presentation of articulations in this app is distinguished by its use of sagittal cross-sections of the mouth with accompanying sounds articulated in the throat. Being able to “see” cross-sections of the mouth, complete with a lip-synced animation and detailed phonetic descriptions, represents a powerful learning tool for students learning how to produce speech sounds.

Moreover, the gaming element (see Figure 11 for Example) in our apps combines both logic and creativity, producing greater learning outcomes than traditional rote learning or text-based pedagogy. Students take pulse of their learning through a challenging game component crafted to test various skill sets in phonetics. Penalties, coupled with rewards and achievements make an engaging learning experience through the effective and appropriate use of drill-and-practice approaches for learning speech sounds and visual recognition of phonetic alphabets, until mastery is achieved and learning outcomes are attained. By identifying and responding to discipline-specific pedagogical needs and, by placing pedagogy and content ahead of technology, we are able to ensure that the apps we build support learning outcomes.
Figure 11: Interactive Phonetics app illustrating gaming elements (i.e., the use of drill-and-practice approaches for learning speech sounds and visual recognition of phonetic alphabets)

4. Plans to Further Develop the Initiative

We view the Centre as primarily a vehicle of momentum. After three years, the Centre will have created and disseminated dozens of high quality apps with coordinated pedagogies, published papers on their combined effectiveness, and will provide a repository of open source code for others to adopt and build their own apps. With a variety of apps in different disciplines already existent and freely available, the cost/manpower to develop new apps would be considerably lowered. Thus, it will have fueled the capacity for development and promotion of ubiquitous learning throughout different universities, to facilitate the continuation of activities. We also plan on organizing a conference in 2017, to share and disseminate new developments and contributions to help keep up the momentum. Moreover, with a large library of code and pedagogical ideas, Teaching Development Grants (TDG’s) may be another possibility for continuation of the work, with institutions absorbing the Centre’s key personnel into their own existing structures. Ultimately, we believe this initiative will represent the future focus of tertiary education reform and development and continuous work and funding will be inevitable as the wave propagates.

Moreover, we continue to actively engage in faculty presentations, person-to-person exchanges/demonstrations, as well as regional conferences and publications detailing the successful combinations of our apps and integrated pedagogy, with implications for wider impact in the region’s educational landscape. In addition, through its working in collaboration with instructors, there is a cascading impact as individual departments are also actively sharing research on mobile technologies and app development at local and regional conferences by facilitating the study of these new approaches to learning.

Acknowledgements
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References


Bibliography


### Author Biographies

**Professor Christopher J. Keyes** received his doctorate in composition and piano at the Eastman School of Music in 1992. He currently teaches at the Hong Kong Baptist University and is the director of Laboratory for Immersive Arts and Technology and the Resource Centre for Ubiquitous Learning & Integrated Pedagogy (ULIP).

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**Dr. Ronnie H. Shroff** is the Assistant Director of the Resource Centre for Ubiquitous Learning & Integrated Pedagogy (ULIP) at Hong Kong Baptist University. Ronnie holds a Ph.D. in Information Systems from The City University of Hong Kong. His professional interests include the use of mobile technologies to support teaching and learning environments.

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**Eric H. C. Chow** is a senior mobile application developer at Hong Kong Baptist University, the Resource Centre for Ubiquitous Learning & Integrated Pedagogy (ULIP). Eric obtained his M.Phil. from The Hong Kong University of Science and Technology. His current work focuses on interaction design and user testing of e-learning and mobile learning applications.

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**Dave Fung** is a Mobile Software Engineer of the Resource Centre for Ubiquitous Learning & Integrated Pedagogy (ULIP) at Hong Kong Baptist University. He received his BSc in Web Technologies from The Open University of Hong Kong. His professional interests include mobile software engineering, web technologies and immersive technologies.

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**Dr. Gino Yu** is the Director of Digital Entertainment and Game Development and Founding Head of the Multimedia Innovation Center at the Hong Kong Polytechnic University, where he is currently an Associate Professor. His main area of research focuses on the application of media technologies to cultivate creativity and promote enlightened consciousness.
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<tr>
<th>Name</th>
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<tr>
<td>Dr. Hanna Wirman</td>
<td>Research Assistant Professor of the School of Design at the Hong Kong Polytechnic University where she leads a MSc study stream in game design and development. Hanna researches marginal and critical ways of playing and making games.</td>
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<tr>
<td>Sathya Naidu</td>
<td>Principal Designer at the School of Design, Hong Kong Polytechnic University and Project Associate of the Resource Centre for Ubiquitous Learning &amp; Integrated Pedagogy (ULIP). His background in the design of serious and commercial games has led to the implementation of design standards, game design and game mechanics for mobile applications.</td>
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