

A Literature Review on the Application of Ibeacon in Education Settings

Xiaojing Song

Marketing Trading Centre, Xizang Province, People's Republic of China

Email: huaiyuweiyu@gmail.com

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ABSTRACT: *With the advent of iOS 7, a new technology from Apple called iBeacon appeared, iBeacon made a significant step forward in the Internet of Things (IoT) (Townsend, 2023). As technology is becoming a more central part of people's lives, people's devices start to talk to each other more and iBeacon helps a device figure out what is nearby and what it can talk to. Currently, iBeacon is also widely applied in education settings, which promotes heated discussion on its potential in education sector application (Spachos & Mackey, 2018), many publications have also been issued in the academia on the application of iBeacon in education settings, but so far, there has not been any review on these studies. This article presents a literature review of the studies on the application of iBeacon in education settings published from 2016 to 2020, aiming to discuss the widespread application of iBeacon in educational contexts, and shed light on its innovative potential and revolutionary potential; the discussions on using iBeacon in smart green building courses, context-aware ubiquitous learning environments, flipped classroom learning, and smart campus classroom attendance system show that iBeacon can efficaciously support teachers' instructional activities and students' learning activities, help teachers quickly obtain students' learning situation in classroom and then may adjust their instructional approaches or contents, and help pupils effectually engage with their daily learning and develop their learning skills.*

KEYWORDS: literature review, iBeacon, education settings, Bluetooth Low Energy (BLE)

INTRODUCTION

The iBeacon technology was proposed by Apple Company (Townsend, 2023), its mobile apps (running on both iOS and Android devices) query iBeacons in the real world via listening for signals and reply corresponding actions, iBeacon technology allows mobile apps to get their position on a micro-local scale, and send hyper-contextual content to users based on location. BLE is the underlying communication technology for iBeacon (Townsend, 2023), it is a wireless data protocol that connects devices together over a short distance; iBeacons with BLE are an attractive solution for a plethora applications for IoT due to lesser power energy they require than conventional Bluetooth (Spachos & Mackey, 2018), BLE is a vital component of billions of products on the IoT market (Townsend, 2023).

At present, iBeacon is widely applied in education settings, which promotes heated discussion on its

potential in education sector application (Spachos & Mackey, 2018), many publications have also been issued in the academia on the application of iBeacon in education settings, but so far, there has not been any review on these studies. This article presents a literature review of the studies on the application of iBeacon in education settings published from 2016 to 2020, aiming to discuss the widespread application of iBeacon in educational contexts, and shed light on its innovative potential and revolutionary potential.

LITERATURE REVIEW ON THE APPLICATION OF IBEACON IN EDUCATION SETTINGS

iBeacon, a new technology of wireless near-field communication, which can be applied to build up a ubiquitous learning context in order to automatically provide appropriate learning information to support learning activities. Wu et al. (2016) used emerging man-machine interaction technologies, such as iBeacon and Quick Response (QR) codes to develop a ubiquitous situated learning system based on the Science, Technology, and Society (STS) teaching framework, to teach the science, technology, and society aspects of smart green buildings; the iBeacon-based ubiquitous learning environment in smart green building courses can transmit relevant knowledge about smart green buildings and IoT to learners' mobile devices so that they can learn the knowledge in the right place and right time by associating the knowledge with the devices that use the technologies; in addition, learning through the mobile devices can help students to benefit from ubiquitous learning by enabling them to link the knowledge placed in the context with the related knowledge in the real world, as a result, this kind of learning is capable of reducing the mental workload for learners; furthermore, the interesting novelty of interactive learning through smart phones can also help to promote learning interest and better learning results (Wu et al., 2016).

Additionally, the use of BLE iBeacons is becoming widespread for context-aware learning environments, which can be used in indoor and outdoor settings such as museums, shops, home, and schools in order to identify the location of learners and their contexts, specifically, in the constructivist view of learning, learners can use such sensing technology for constructing knowledge and experiencing learning at any time, anywhere. To enable BLE iBeacons to provide indoor and outdoor context-aware environments in order to through inquiry-based learning activities to guide learners' desired places and construct knowledge, Ahmed et al. (2018) developed and implemented Lib-Guide (an indoor application in which students can obtain guidance about their desired books in the library, constructs knowledge about it using their smartphones) and M-DISTIL (an application is designed for students who can visit their school garden and perform learning activities) two applications. The development and implementation of Lib-Guide and M-DISTIL show that the use of BLE iBeacons in pedagogical settings to provide indoor and outdoor context-aware environments functions can effectively enhance students' motivation towards learning along with the domain understanding of students and their problem-solving skills, and efficiently through inquiry-based learning activities to guide students' desired places and construct knowledge (Ahmed et al., 2018).

Moreover, iBeacon can be combined with web-socket technology to develop an interactive student response system for applying in flipped classroom activities in classroom. Tsai et al. (2019) developed

an interactive student response portfolio (ISREP) system with iBeacon and web-socket technology, which supports flipped-classroom learning activities in traditional classrooms, it offers APPs and web-interface two functions for students and teachers, respectively. Students' APP can scan iBeacon devices in classrooms and then automatically upload their identification information to the cloud space, therefore, students' presence in classroom can be recorded automatically. Teachers employ web-interface function the system provides to promote high interaction in classroom via displaying questions on the front screen in classroom, meanwhile, it simultaneously pushes (multicasts) these questions to students' smartphones via web-socket technology, subsequently, students send their responses for questions to the cloud space by the APP, during answering questions, the system presents temporary histograms of students' responses and counting-down statuses of a timer on the screen in classroom, the timer can be synchronized with students' APP by the web-socket technology. This ISREP system can improve students' learning effects, interaction, learning interest, learning attitude, and learning satisfactory, so that students can enjoy learning pleasure in quiz-like activities; and it can also help teachers quickly obtain students' learning situation in classroom and then may adjust their instructional approaches or contents (Tsai et al., 2019).

Besides, BLE indoor positioning technology can renovate the conventional method for recording student attendance (Puckdeevongs et al., 2020). Student attendance during classroom hours is important because it impacts the academic performance of students, the attendance sheet is one of the most common ways to record student attendance, students are required to manually sign their name on an attendance sheet every time they attend a class, but this method may cause some problems, such the time unnecessarily consumed by the students to find and sign their name on the attendance sheet, some students may mistakenly or purposely sign another student's name, and having the attendance record in a hardcopy form is that a lecturer may lose the attendance sheet, therefore, scholars proposed the smart campus classroom attendance system. However, most smart campus classroom attendance systems require additional expensive devices, in order to deal with this problem, Puckdeevongs et al. (2020) proposed a smart campus classroom attendance system based on the BLE-based student positioning framework that can automatically record student attendance in classrooms, because it only relies on the connection of Bluetooth signals from student mobile phone and student mobile phone's wireless network, which can achieve satisfactory positioning accuracy, even in a classroom environment with typically high signal interference.

CONCLUSION

This literature review discussed the application of iBeacon in several educational contexts, shedding light on its innovative potential and revolutionary potential. The review mainly concentrates on iBeacon's utility in the following educational settings:

- Smart green building courses: iBeacon, a new technology of wireless near-field communication, which can be applied to build up a ubiquitous learning context in order to automatically provide appropriate learning information to support learning activities. Wu et al. (2016) used emerging man-machine interaction technologies, such as iBeacon and QR codes to develop a ubiquitous

situated learning system based on the STS teaching framework, to teach the science, technology, and society aspects of smart green buildings.

- Context-aware ubiquitous learning environments: The use of BLE iBeacons is becoming widespread for context-aware learning environments, which can be used in indoor and outdoor settings such as museums, shops, home, and schools in order to identify the location of learners and their contexts, specifically, in the constructivist view of learning, learners can use such sensing technology for constructing knowledge and experiencing learning at any time, anywhere. To enable BLE iBeacons to provide indoor and outdoor context-aware environments in order to through inquiry-based learning activities to guide learners' desired places and construct knowledge, Ahmed et al. (2018) developed and implemented Lib-Guide and M-DISTIL two applications.
- Flipped classroom learning: iBeacon can be combined with web-socket technology to develop an interactive student response system for applying in flipped classroom activities in classroom. Tsai et al. (2019) developed an ISREP system with iBeacon and web-socket technology, which supports flipped-classroom learning activities in traditional classrooms.
- Smart campus classroom attendance system: BLE indoor positioning technology can renovate the conventional method for recording student attendance (Puckdeevongs et al., 2020). Puckdeevongs et al. (2020) proposed a smart campus classroom attendance system based on the BLE-based student positioning framework that can automatically record student attendance in classrooms, because it only relies on the connection of Bluetooth signals from student mobile phone and student mobile phone's wireless network, which can achieve satisfactory positioning accuracy, even in a classroom environment with typically high signal interference.

In conclusion, the benefits of applying iBeacon in educational contexts consist of transmitting relevant knowledge about smart green buildings and IoT to learners' mobile devices so that they can learn the knowledge in the right place and right time by associating the knowledge with the devices that use the technologies (Wu et al., 2016); using BLE iBeacons in pedagogical settings to provide indoor and outdoor context-aware environments functions can effectively enhance students' motivation towards learning along with the domain understanding of students and their problem-solving skills, and efficiently through inquiry-based learning activities to guide students' desired places and construct knowledge (Ahmed et al., 2018); the developed and implemented ISREP system can improve students' learning effects, interaction, learning interest, learning attitude, and learning satisfactory, so that students can enjoy learning pleasure in quiz-like activities, and it can also help teachers quickly obtain students' learning situation in classroom and then may adjust their instructional approaches or contents (Tsai et al., 2019); and the developed smart campus classroom attendance system based on the BLE-based student positioning framework can automatically record student attendance in classrooms (Puckdeevongs et al., 2020).

Disclosure Statement

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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