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Implementing RFID Ubiquitous Learning Environment

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Abstract

There is need for learners to learn without intruding into the privacy of others in learning environments, as a result a RFID ubiquitous learning application has been developed to give users the required knowledge at the right time and at the right place. This paper implements a RFID Ubiquitous Learning system which provides an environment where learners interact with RFID tags attached to objects in a ubiquitous environment. Learners approach these objects with their mobile devices and get the information about that object from the microprocessor over Wi-Fi on their devices. This RFID mobile application (Ubi-learning) was developed on the android platform with a microprocessor (seeeduino board) that serves as a data store for this information. U-learning is a new approach to learning that is focused on delivering knowledge anytime, anywhere for ubiquitous learning environments.

Keywords*: RFID, Ubiquitous learning, NFC, Educational materials, Wi-Fi*

1. Introduction

Advancement in computing has positively affected the way individuals learn and acquire knowledge, bringing new approach to learning and the way information, knowledge and learning materials are delivered. Learning has evolved from classroom learning, electronic learning (E-learning), mobile learning (M-learning) to ubiquitous learning (U-learning). U-learning enables learning everywhere with mobile devices and tiny computers. Development in wireless communication and sensor technologies has brought advancement in ubiquitous learning.

With a wide range of mobile and communication technology options, mobile devices have evolved from just being used for making calls and sending text messages to learning. Communication and sensor technology are now integrated into smartphone and mobile devices, which has encouraged educators to utilize them as a learning tool [1]. Mobile devices are now built with sensors such as proximity sensor, location sensor (compass), gyro sensor, light sensor and accelerometers. Availability of sensors on mobile devices promotes ubiquitous learning.

Ubiquitous learning (u-learning) provides intuitive ways for identifying the right collaborators, the right contents, the right learning services in the right place and at the right time based on their immediate surroundings [5]. Ubiquitous learning environment utilizes a large number of corporative small nodes with computing and communication facilities such as handheld terminals, smart mobile phones, sensor network nodes, contactless smart cards, RFID (radio frequency identification), and mobile IP [3], which has shown promising solution to educational problems. Ubiquitous learning senses the situation of learners and the environment they find themselves and then provide adaptive supports to them. Context-awareness is an enabling technology for u-learning, which enables the situation or environment of a learner to be sensed [10]. Before the advent of Ubiquitous learning, class room learning place every student on the same level of learning, making it difficult for students to learn at their own pace; Learners are taught at the same

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pace irrespective of their learning capacity. Shy students are left out in classroom setting [7].

Ubiquitous learning provides a better way of learning, introducing new possibilities into how knowledge is processed and transmitted in an educational environment. The ability to deliver personalized learning based on the context of the learners *i.e.,* adapting learning to the learner's context. Ubiquitous applications assist students in learning *i.e.*, helping to find materials in the library, tutorial management, attendance control system, lab assistance system and assignment giving system, learners would improve their academic experience in a learning environment.

This paper implements a learning environment whereby learners can get the right knowledge and information about educational objects in that environment, which increases the knowledge of the learner about the object. Sensors in that environment communicate with learner's device to get personalized content based on their context, hence creating a ubiquitous learning environment.

2. Ubiquitous Learning

U-learning is a new approach to learning that is focused on delivering knowledge anytime, anywhere for learning environment. Ogata and Yano [8] defined u-learning by comparing four learning environments (desktop-assisted learning, m-learning, pervasive learning, and u-learning) and combined pervasive learning and m-learning as u-learning**,** , u-learning is widely defined as learning based on u-computing technologies such as Radio Frequency Identification (RFID) and Wi-Fi-enabled smartphones.

Based on these definitions, this study defines u-learning as a new learning paradigm that delivers knowledge through the use of connected devices, communicating with each other using wireless technology (Wi-Fi and NFC) anytime, anywhere based on the learner's situation using smart devices such as a smartphone, tablet PC, and smart PC.

Research has seen the integration of u-learning in various educational contexts. Some of this integration includes outdoor learning, integrating u-learning into traditional class room, library bibliography access and integrating into university campus. Applications include language learning, teaching material delivery, lab assistance system, and assignment delivery and performance evaluation system.

U-Learning or ubiquitous learning is an innovative concept that incorporates the best characteristics of both e-learning and m-learning, as well as other new advances in technology. U-learning is seen to be a massive boost to education as it provides adaptive learning for students, as well as providing a pervasive, omnipresent learning environment [11].

3. RFID Technology

Radio frequency identification (RFID) technology has gained popularity in recent years. RFID enables identification from a distance, and unlike earlier bar-code technology, it does so without requiring a line of sight. RFID tags support a larger set of unique IDs than bar codes and can hold additional data such as manufacturer, product type, and even measure environmental factors such as temperature [12].

There are majorly two types of RFID; active and passive. Active tags require a power source either connected to a power infrastructure or connected to a battery. The lifetime of an active RFID is dependent on the power source. The transponder on an aircraft that identifies its national origin is an example of an active tag. A passive tag on the other hand doesn't require a battery or maintenance. They are small and can fit into adhesive label with an indefinite operational life. A passive tag consists of three parts: an antenna, a semi- conductor chip attached to the antenna, and some form of encapsulation. The tag reader powers and allows communication with a tag. The tag antenna captures energy and transfers the tag's ID (the tag's chip coordinates this process). The encapsulation maintains

the tag's integrity and protects the antenna and chip from environmental conditions or reagents [4].

4. Related Works

Borrego-Jaraba, *et al.,* [2] implemented NFC (near field communication) technology, which is an implementation of RFID used by Liu *et al.,* [6] to build a customized system devoted to helping university students access, read and review the necessary bibliography sources for the development of their learning.

The system architecture is made up of a back-end system responsible for managing information about the teachers, students and teaching guides and a front-end system based on NFC enabled device. The front-end system is designed to be used by the students anytime and anywhere in a personalized way, but mainly in a university library. It is responsible for giving students access to the main and recommended specific contents of the bibliographic sources located in the library. In addition, the front end system allows students to search for personalized and generalized information about bibliographic sources, subjects, content and teachers' notes and recommendations, anytime and anywhere. A tool called Pinakes (Pervasive and

Intelligent system for the Awareness Elicitation for Students) was developed. Pinakes is used to access information about bibliographic sources which has NFC Tags attached to them.

Ogata *et al.,* [9] implemented TANGO. TANGO like EULER [6] employed RFID technology in creating a ubiquitous learning environment for vocabulary learning. Learners use PDA equipped with RFID tag reader. It was assumed that an everyday room can be an educational environment where RFID tags are attached to almost all real objects. The system was designed such that learners can learn vocabulary at anytime and anyplace using the products that have RFID tags. This paper focuses on the use of RFID and smartphones (NFC enabled) with a u-learning application installed that communicates with a microprocessor and sensors in a ubiquitous environment. It would provide an avenue for learners to increase their knowledge on object in their surroundings according to the context of the u-learning environment they find themselves.

5. Design of the Proposed System

The ubiquitous learning system is implemented using a RFID sensor, android application installed on an Android platform (mobile device), a microprocessor and wireless technology for communication (Wi-Fi and NFC). The sensor (RFID) is embedded in every object in the ubiquitous learning environment. This sensor s used to uniquely identify each object upon approach by a user's mobile device. On approach, the mobile device reads or senses this sensor and gets information about that particular object. The ubiquitous learning application (ubi-learning) is installed on a mobile device which would be connected to the microprocessor through Wi-Fi. Information about a sensor is sent to the microprocessor, and then the microprocessor in turn sends relevant information back to the user's device. The architecture of the system is shown in Figure 1.

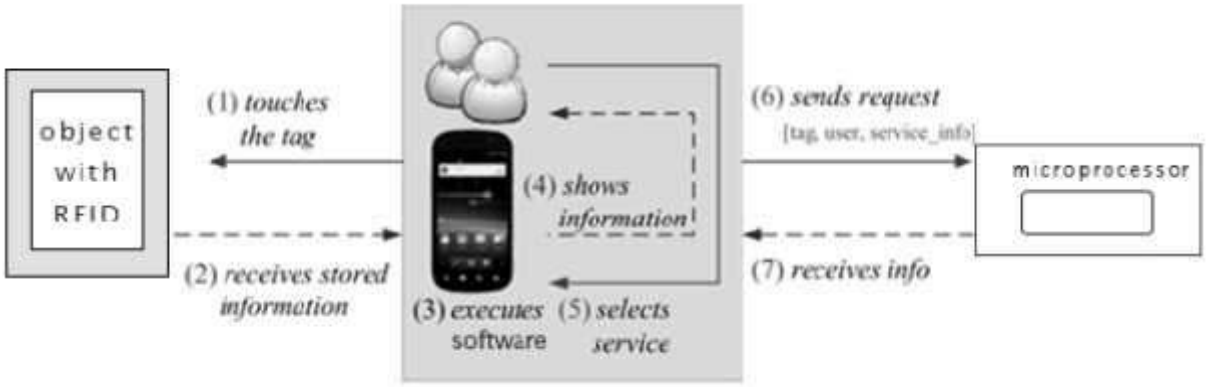


Figure 1. System Architecture (Adapted from Borrego-Jaraba et al., 2013)

6. System Implementation

The system is implemented as a mobile application for an android platform with a microprocessor serving as the data store for the information needed. On approaching the object, the object id is read by the mobile device and then sent to the microprocessor. The microprocessor in turn responds with information already stored on the SD card in XML format over Wi-Fi. This information will be displayed by the mobile device for the learners' information.

The microprocessor functions as a server for serving file that contains the information needed by the application and learners. The microprocessor (seeeduino board) has other modules attached to it (Wi-Fi module and SD card module). The SD card module and the Wi-Fi module are connected to the seeeduino board. The SD card holds the data in form of XML file while the Wi-Fi module creates a means of connection over Wi-Fi. Figure 2, shows the microprocessor set-up. The system is implemented at Department of Computer Science, Federal University of Technology Akure (FUTA), Nigeria. RFID tags are placed on the doors leading to the software and hardware laboratories (see Figure 3a). A learner approaching the door of the lab with his/ her device will get information displayed about the lab *i.e.,* schedules, practical time and materials to read *etc.*

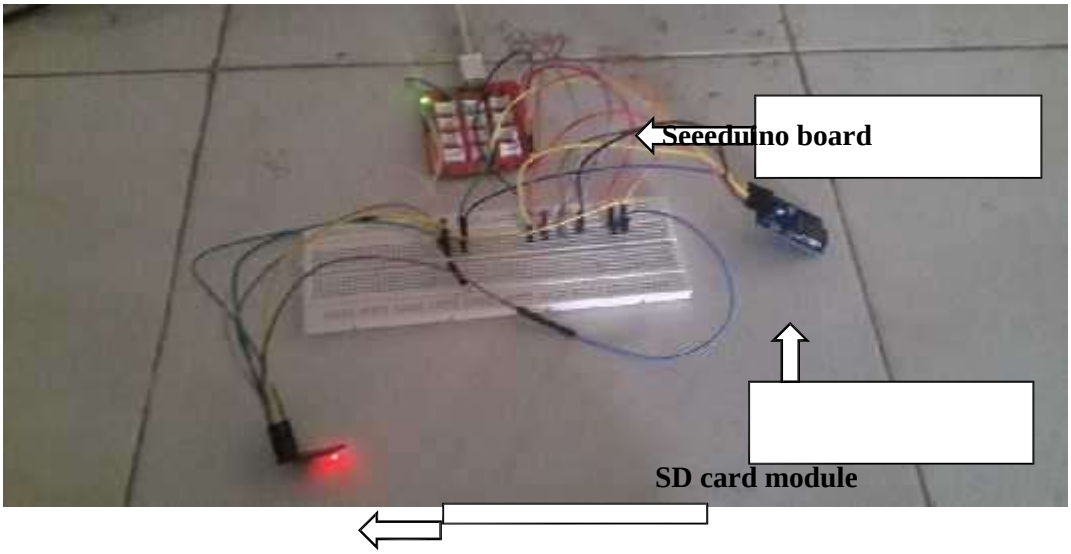


Figure 2. Microprocessor Set-Up

6.1. System Components

The Ubi -learning system is made up of five views with which learners can interact:

Object search page
Object details page
Description page
Navigation page
General information page

The Figure 3a, and Figure 3b, show a learner approaching the tags attached to the objects (software and hardware lab doors) at the Department of Computer Science, FUTA.

Figure 3a. Device Approaching Figure RFID Tag

3b. Device Approaching RFID Tag

Object Search Page

Figure 4, shows the welcome page. Figure 5, shows device searching for an object with RFID tags. Figure 6a, and 6b show the object search page after searching for an object with RFID tags.

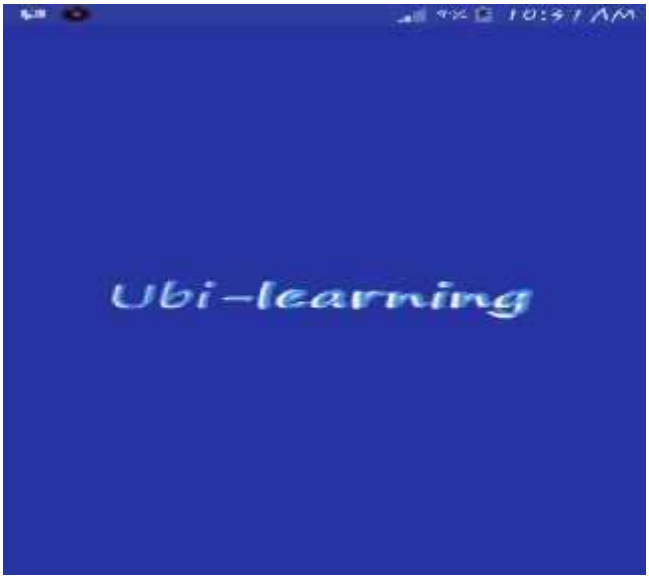


Figure 4. Welcome Screen of the Application

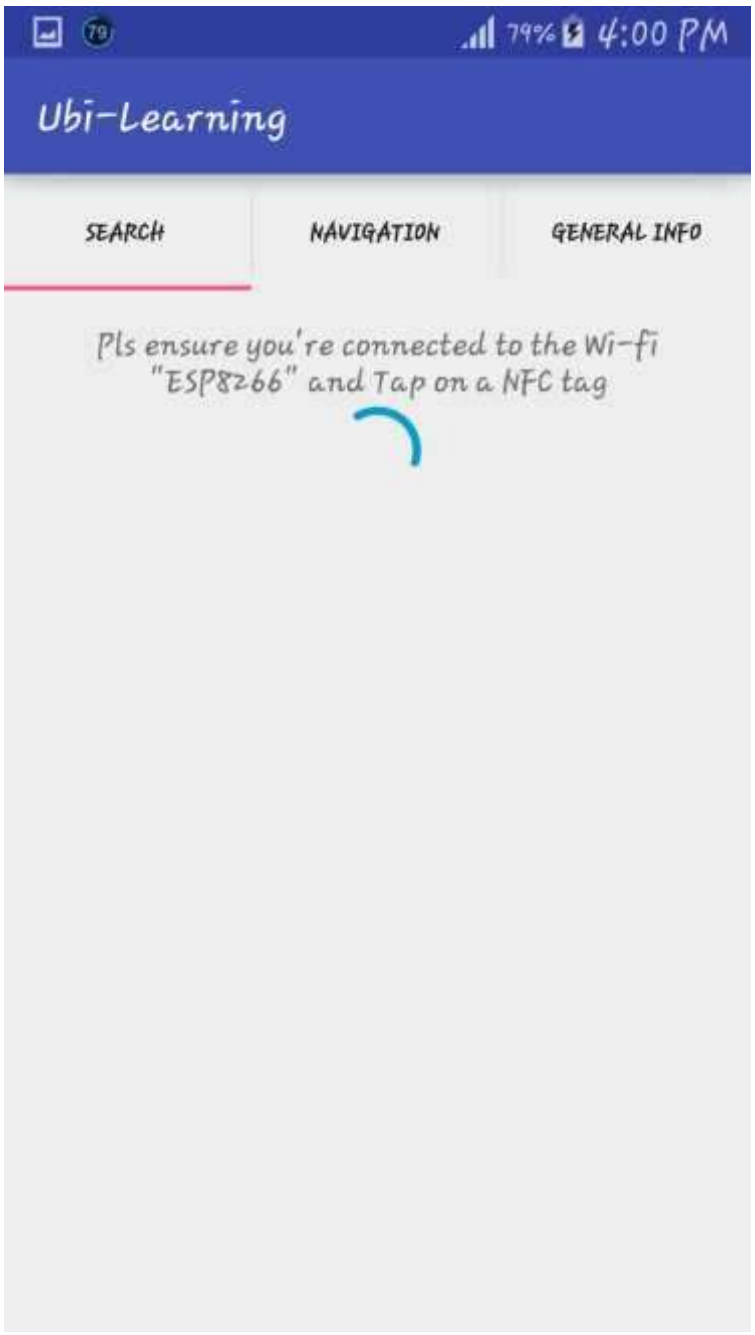


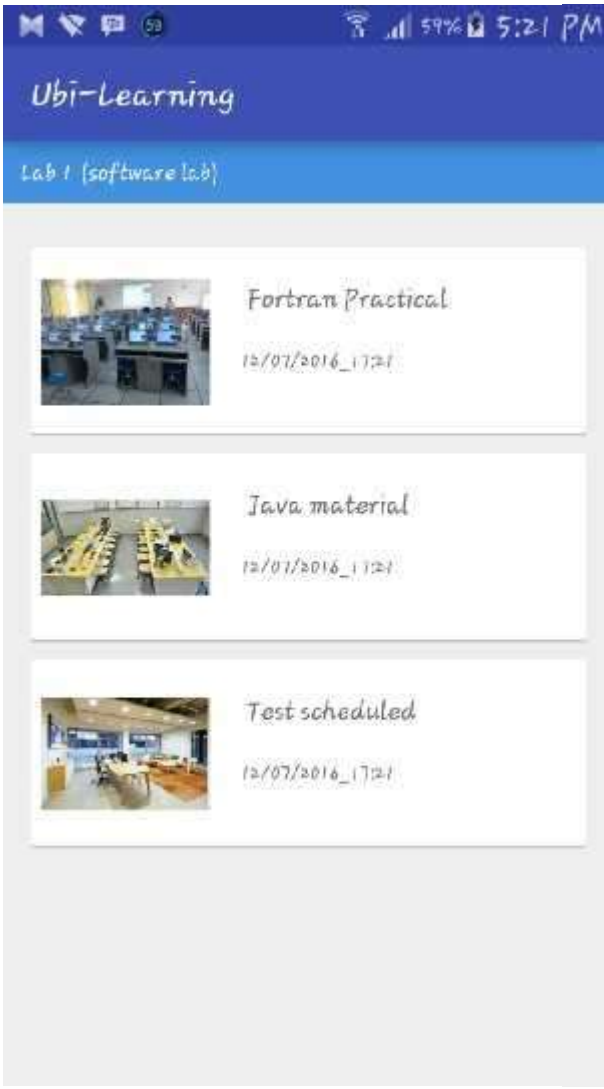
Figure 5. Object Search Page before Searching for an Object with Tag

Figure 6a. After Searching for an Object with Tag

Figure 6b. After Searching for an Object with Tag

Object Details Page

The mobile device should be connected to the learning system Wi-Fi network (see Figure 5). Approaching an object (see Figure 3a), this page (see Figure 6a), is invoked, when the object is selected. Information about this object is sent to your device (see Figure 7a). Approaching another object (see Figure 3b), the page (see Figure 6b), is invoked when the object is selected, then data about this object is sent to your device (see Figure 7b).



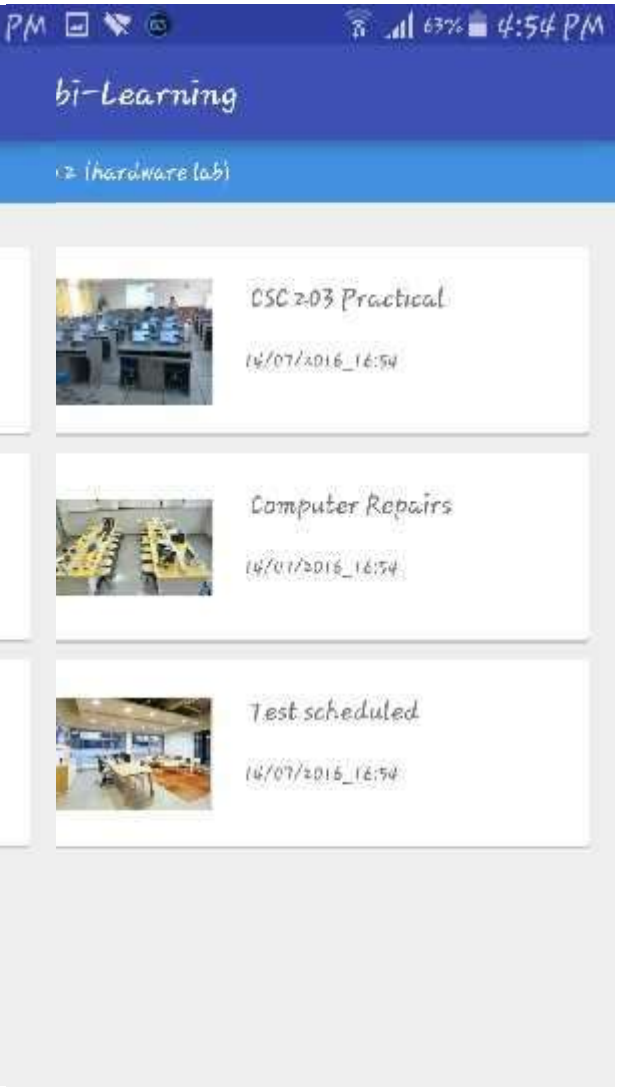


Figure 7a. Object Details Page **Figure 7b. Object Details Page**

Description Page

Every object contains information, each of this information would be displayed on this page (see Figure 8a, and Figure 8b).

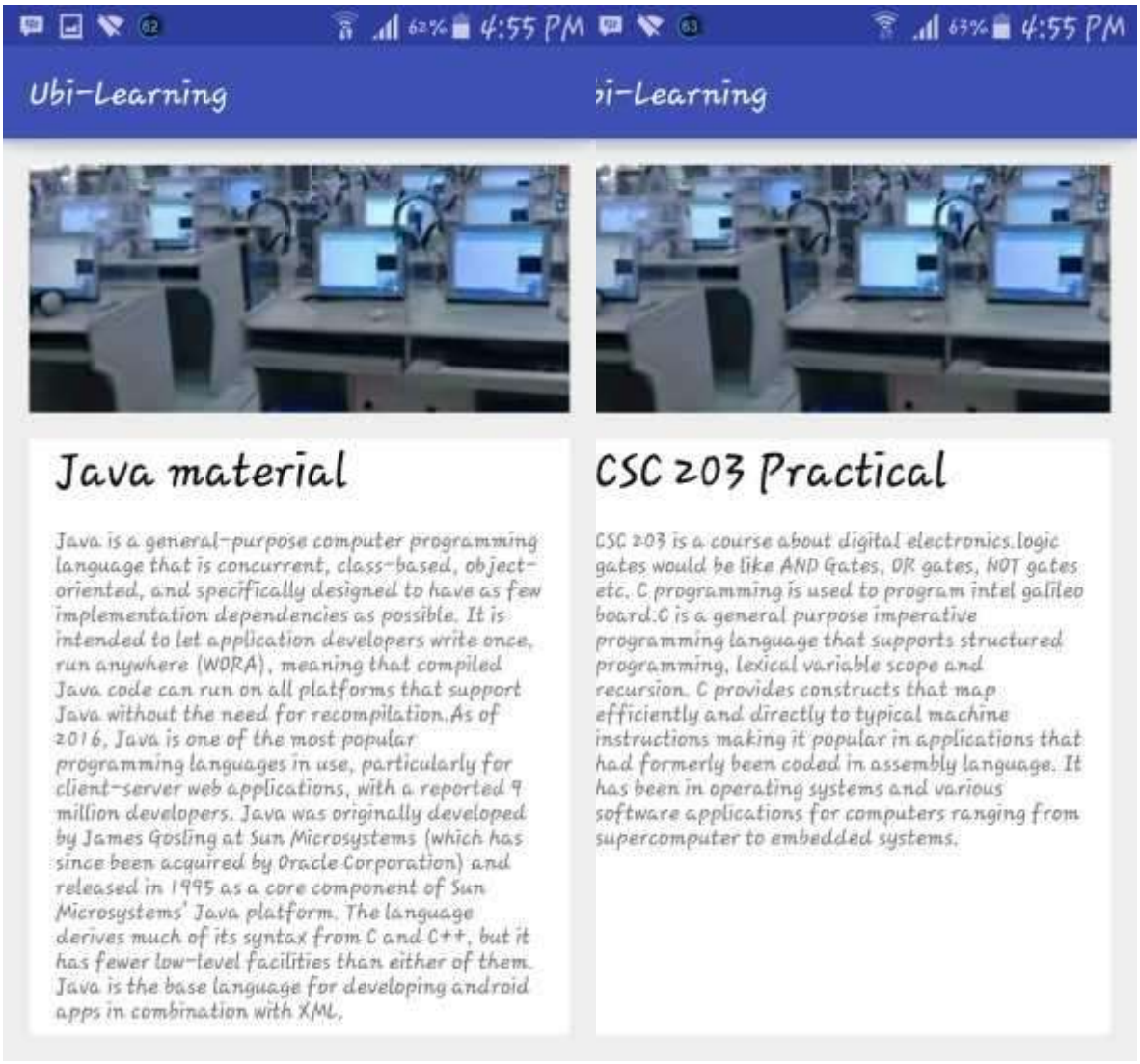


Figure 8a. Description Page **Figure 8b. Description Page**

Navigation Page

The navigation page shows instructions on how to successfully use the system (application). It points out steps in getting the information needed.

General Information Page

This displays general information to everyone using the application. On viewing this page, you get general information that are passed to everyone in the environment. Figure 9 shows the general information page.

Figure 9. General Information Page

7. Conclusion

Ubiquitous learning (u-learning) provides intuitive ways for identifying the right collaborators, the right contents, the right learning services in the right place and at the right time based on their immediate surroundings. In this paper, an RFID ubiquitous learning system has been implemented which enables learners to get the right information about objects in a ubiquitous learning environment at the right time and at the right place. The benefits of RFID in ubiquitous learning environment have been shown. This system allows students to get the right information about the objects without having any physical contact with the instructors. The users must have a NFC enabled phone and there are limited online resources available for programming

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