

**MOBILE CLOUD COMPUTING FOR M-LEARNING APPLICATION**

M. O. Nizam<sup>1,\*</sup>, M. Mushahadah<sup>2</sup>, M. Z. Nurzaid<sup>1</sup>, P. Zulfikri<sup>1</sup>, O. Mahfudzah<sup>1</sup> and M. A. Shahrol<sup>1</sup>

<sup>1</sup>Universiti Teknologi MARA, Perlis, Malaysia

<sup>2</sup>Politeknik Tuanku Syed Sirajuddin, Perlis, Malaysia

Published online: 30 May 2018

**ABSTRACT**

Mobile cloud computing for M-learning application is the trend and has been introduced to overcome the crucial of mobile device storage, security and network performance issues. This paper presents the development of M-learning application integrated with cloud computing for Principles of Operating System course named OS Master. It was developed specifically for the educational purposes and helps the learner in the learning process by using a mobile device as a teaching aid tool. The development of OSMaster application used System Development Life Cycle (SDLC) by implementing the waterfall model as the methodology. A user acceptance test and network performance test were conducted to determine the effectiveness of the features provided by OSMaster application. The results were shown that OS Master application has a positive impact and to be well accepted by users, can assist, enhance and enrich the experience learning process of students.

**Keywords:** m-learning application; cloud computing; user acceptance test; network performance test.

Author Correspondence, e-mail: [mohdnizam@uitm.edu.my](mailto:mohdnizam@uitm.edu.my)

doi: <http://dx.doi.org/10.4314/jfas.v10i2s.78>



## **1. INTRODUCTION**

The increasing usage of mobile devices nowadays is likely corresponding with the importance of mobile devices to the human life. The capabilities of mobile devices such as smart phones grow immensely and its adoption and evolving used, is resulting in new consumer behavior and expectations related to consumption of information and services. Therefore, the mobile devices are becoming the predominant form and become the most effective and convenient tools for communication, entertainment or as a device to gain knowledge [1]. Besides, mobile phone was used in daily routine such as browse the web, write emails, watch videos and this also make the mobile phone similar to the ordinary personal computer [2].

Nowadays, there are many applications have been established in the market to provide the mobile user requirements and attract the targeted users to use their applications, especially for learning purposes known as mobile learning (M-learning). M-learning is the new learning approach using the advantage of wireless and mobile technologies for learning, teaching, accessing and exploring knowledge and information. M-learning is convenience since it is accessible virtually from anywhere and anytime. Besides, the advent of newest information and communication technologies makes it possible focusing on mobile learning through mobile devices, allowing learners to move about in a classroom or remotely learn from any location of their choice. However, increasing mobile device technology and application bringing to the several issues that related to the challenged of using mobile devices such as limited storage resources, security and network performance issues. In order to overcome these issues, mobile cloud computing has been established. Furthermore, the limitation of the device hardware resources can be eliminated by deploying applications in the cloud [3].

Mobile cloud computing is one of the trending technology which resources are provided to a local client based on-demand basis usually by means of the internet. It works when the data storage and data processing are happened on the outside mobile devices, it allows a user to access and receive data from cloud server using mobile devices at everywhere providing on-demand access. Therefore, mobile cloud computing is the combination of mobile computing, cloud computing and wireless network aiming to enhance computational capabilities of resource-constrained mobile devices towards rich user experience. Besides, more industries move their focus from investing into processing power to renting processing

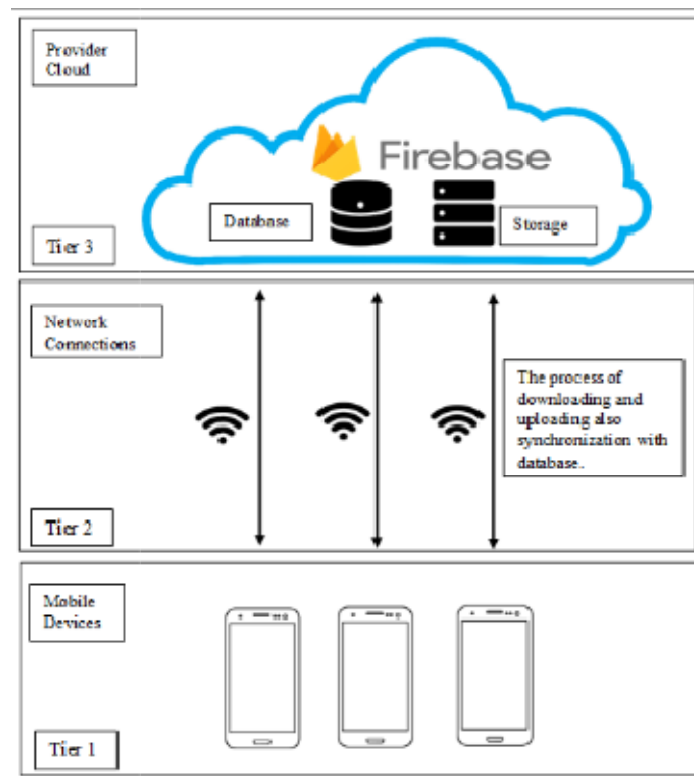
power from specialized vendor cloud that bringing more effectiveness in their industries. Hence, mobile cloud computing was implemented into most applications such as mobile healthcare [4-5] mobile commerce [6-7] mobile transportation [8], mobile gaming [9-11] and mobile learning [12-13].

Together with an explosive growth of the mobile applications and emerging of cloud computing concept, it can be implemented in the education field. With the new trend of learning based on mobile application, it brings the new way of learning in the education system that not just only focuses in the classroom. Compared to the traditional M-learning applications, there have a few limitations in terms of high cost of devices and network, low network transmission rate, and limited educational resources. Hence, mobile cloud computing for M-learning applications was introduced to solve these limitations, for example, utilizing cloud with the large storage capacity and powerful processing ability, the application provides learners with much richer services in terms of storage size, faster processing speed, and longer battery life [7]. Therefore, a mobile learning application integrated with cloud computing named OSMaster was developed for Principles of Operating System course. It was deliberately developed to help lecturers to deliver the contents of the course to the students effectively and increase the understanding of the course, besides the notes and slide prepared by lecturers traditionally.

## **2. METHODOLOGY**

### **2.1. Developing the Cloud Mobile Architecture for OSMaster Application**

Fig. 1 illustrates the cloud mobile architecture for OSMaster application. Basically, the architecture has three tiers and containing a few components or devices. The first tier made up from the mobile devices which every device is required to install the OSMaster application into the mobile devices. OSMaster application can be installed through Android Package Kit (APK) installation into mobile devices, while for the developer purpose Software Development Kits (SDK) were required to provide the ability to encapsulate users flows needed to access back end of application with the proper program development.



**Fig.1.** Cloud mobile architecture for OSMaster application

The second tier of the architecture is the network connectivity. Network connectivity is the key features of the architecture where it is a hub between mobile devices and cloud services to connecting. Network connectivity can be done through established internet connection of the mobile devices with the Wi-Fi or mobile network provider. Existing of internet connectivity can enrich the user's experience of the OSMaster application with full function's capabilities. Finally, the third tier of the architecture is the cloud provider environment. OSMaster application using Firebase services as the cloud provider to store all databases and contents of OSMaster application. Once the mobile device's connectivity established, the application will have synchronized the database in Firebase cloud services for the application. Meanwhile, for the learning purpose, the user will retrieve the contents of the application from Firebase cloud storage directly to their mobile devices.

## 2.2. Model Used for the Developing of OSMaster Application

The SDLC was used to develop the OSMaster application. SDLC is a methodology that describes overall processes and activities in a software development project. The process is associated with the waterfall model [14] which consisted of five phases such as analysis, design, implementation, testing and maintenance.

### **2.2.1. Analysis**

In this phase, all information, data and problems of the project were gathered by reading articles, journal and thesis from previous research. The current technology in mobile learning application was observed in order to determine the problem statement. From the information gathered, all the requirements and opportunities were recognized. Besides, the activities included were the identification of the hardware and software requirement in the development system, scope of project, schedule of activities such as Gantt chart and the total budget.

### **2.2.2. Design**

In this phase, the researcher designed the requirement needed in the system development. It implicates the plan for a solution which included the system components, system architecture, concept design, database conceptual schema and logical diagram design, graphical user interface design and storyboard.

### **2.2.3. Implementing**

The process of converting the whole requirement and blueprints into mobile application was done where the real code is written and compiled using Android Studio version 2.2.3. In the development of OSMaster application, it was integrated with the mobile devices and Firebase cloud service as the main server and storage. Firebase cloud service is a mobile and web application development platform that provided for the developers of mobile or web application with complementary features that developers can use to fit their needs.

The Firebase cloud service served as a cloud provider, which all databases and contents of OSMaster application have been stored. Once the mobile device's connectivity established, the application will have synchronized the database in Firebase cloud services. Meanwhile, for the learning purpose, the users will retrieve the contents of the application from Firebase cloud storage directly to their mobile device.

### **2.2.4. Testing**

Debugging and testing of the program for fixing bugs or errors of the design were done in this phase. Then, the system was evaluated to determine the system performance and to ensure all requirements accomplished. User acceptance test was done by testing the application towards target users to ensure that users can perform the tasks respectively. Besides, the network performance test within cloud services and mobile devices was conducted.

The OSMaster application was tested and conducted at UiTM Perlis. The target respondents of this study were the computer science students who enrolled the Principles of Operating System course. In order to evaluate the effectiveness of the application, user acceptance test was conducted. A quantitative approach was taken, and a survey questionnaire was the data collection instrument for this study. A total of 30 survey questionnaires were distributed and received for the analysis. The questionnaire consists of 12 questions and categorized into 3 parts. The first part was comprised of the perceived ease of used (PEU). The second part focused on the content of the application (COA) and finally, part three investigate the integration of cloud computing (ICC). The data were analyzed using arithmetic mean technique based on the ranking score value. Then, overall mean was calculated and classified into three categories which is negative, neutral and positive based on the range of mean value in between zeros to five as shown in Table 1.

**Table 1.** Range of mean value

Category	Range of Mean
Negative	0.00 – 1.66
Neutral	1.67 – 3.33
Positive	3.34 – 5.00

Furthermore, the network performance test was conducted on network response time and network success rate. This testing is significant to the users because it will show the network performance between mobile devices and cloud services. Network response time is the time between application and the content in the cloud when the request is made and when the response is fully received. Meanwhile, the network success rate is the percentage of successful responses compared to total response failure.

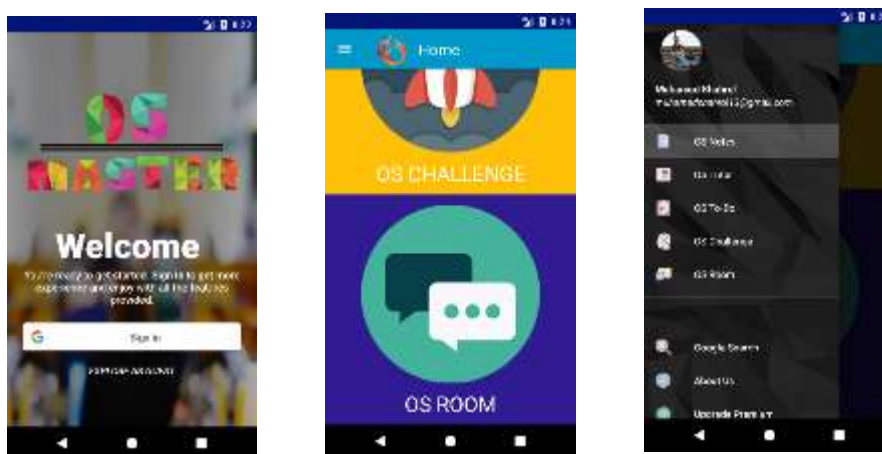
### **2.2.5. Maintenance**

After testing phase, minor refinement was done to integrate corrections of bugs and the user's feedback which was focused mainly on fine-tuning of system, configuring, installing and usability issues.

### 3. RESULTS AND DISCUSSION

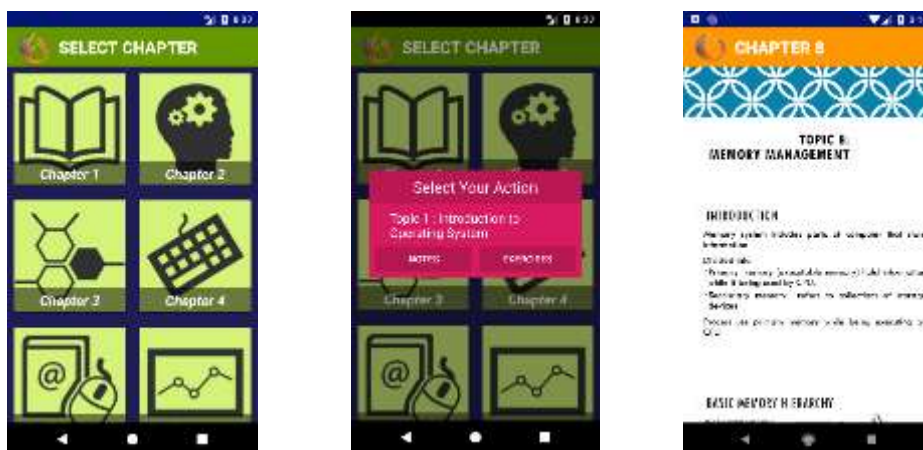
#### 3.1. Interfaces of the OSMaster Application

This section explains about the interfaces of OSMaster application. Fig.2(a) shows the greeting screen for users to register by using the existing Gmail account in order to fully access all contents provided by the application. Besides, users can enter the application as a guest with the limited access to the contents. Then, the user will be redirected to the home screen with five images buttons and one floating button at the top right of the screen as shown in Fig.2(b) and 2(c). The image will be redirected users to five different sections such as the OS notes, OS Tutor, OS To-Do, OS Challenge and OS Room.



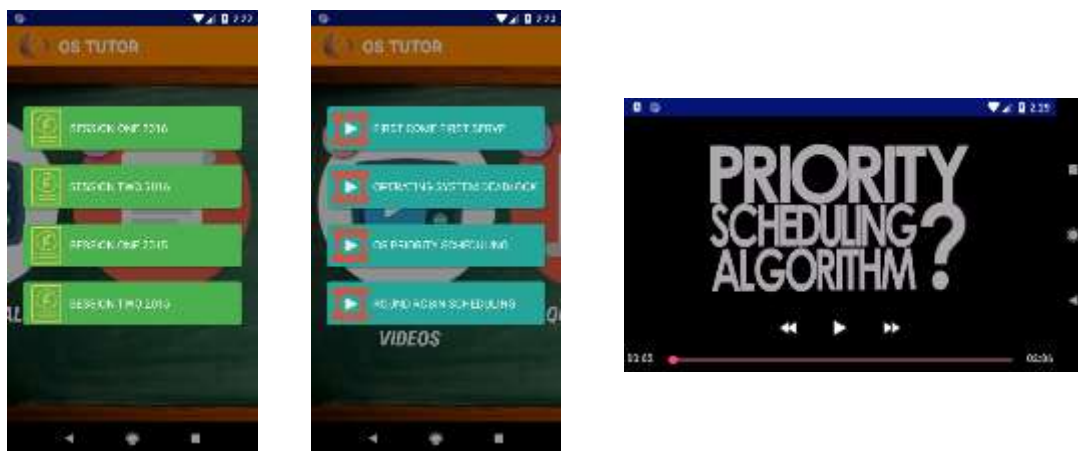
**Fig.2.**Interface of the application in (a) greeting and registration, (b) home screen, (c) floating button

The first section of OSMaster application is OS Notes as shown in Fig.3(a), 3(b) and 3(c). This section provides all chapters of notes for Principles of Operating System course. Besides, to enhance and evaluate the understanding of users towards the specific topics, this application also provides an option button for exercise based on the chapter selected. Meanwhile, when users click the notes button, they be able to read the note selected.



**Fig.3.**Interface of the application in (a) select chapter, (b) selection button, (c) notes

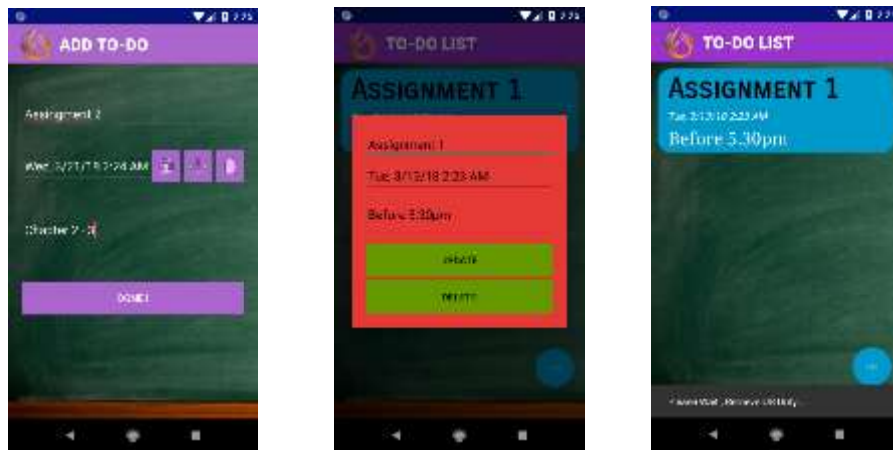
The second section of the OSMaster application is OS Tutor. This section was divided into two categories. They are OS tutorial video and the past year examination questions. The main objective is to provide the users with extra examples of the tutorial related to the specific topic and give an easiness for user to review and access the previous past year examination questions. Fig.4(a), 4(b) and 4(c) show the OS Tutor screen.



**Fig.4.**Interface of the application in (a) past year exam, (b) video tutorial, (c) an example of video tutorial

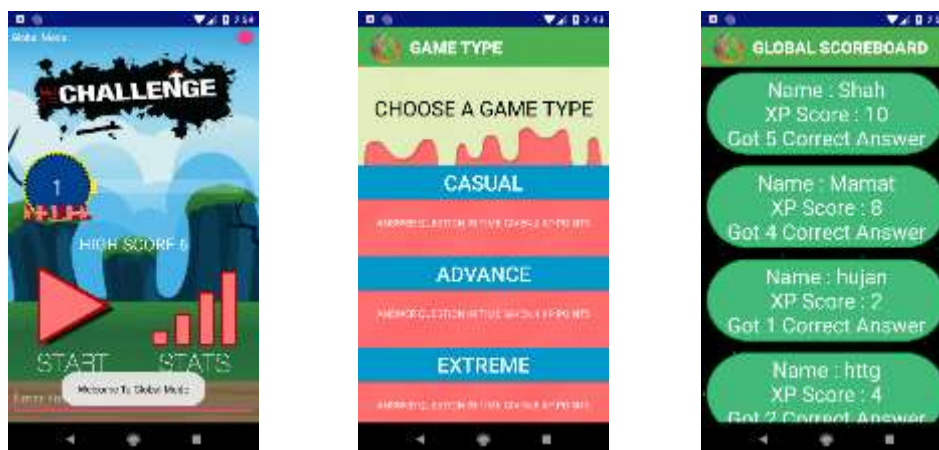
The third section of OSMaster application is OS To Do which give the users capabilities to save their own notes or tasks given to them as shown in Fig.5(a) and 5(b). Moreover, the users can retrieve all their save notes when the internet connection was established as shown in Fig.5(c).





**Fig.5.**Interface of the application in (a) to add and save notes/tasks, (b) to edit and delete, (c) to retrieve all notes/tasks

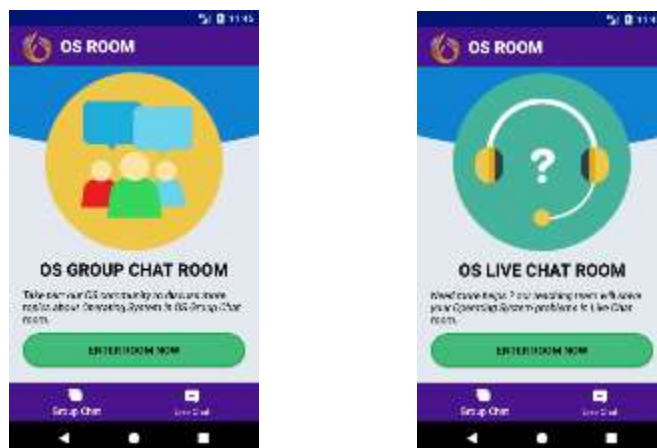
The fourth section of OSMaster application is OS Challenge, which provides the users with quizzes related to the specific topics. The challenge is setup on the offline and global modes. The users do not require the internet connection in offline mode, but it is needed in global mode to play the game challenge. The main different between two modes is in global mode the users have capabilities to share their performance to the Global Leaderboards and they can keep track their performance with other users. Meanwhile, the offline mode was provided to the users as a personal training toward the specific challenge and does not have capabilities to share their performance score. Fig.6(a), 6(b) and 6(c) show the screen interfaces.



**Fig.6.**Interface of the application in (a) main screen OS challenge, (b) types of challenge, (c) global scoreboard

The fifth section of OSMaster application is OS Room, which provides the users to get involves with community who registered for this application. There are two parts, which is OS Group

Chat and Live Tutor Chat. OS Group Chat provided the users to post their problems by creating the discussion room and posts their related problems. Meanwhile, the Live Tutor Chat directed the users to the tutor group, and users could upload their specific problem documents to the live chat tutor for the solving process by the professional tutor. Therefore, the individualized touch between users and tutor will be addressed as a classroom learning style environment. Fig.7(a) and 7(b) show the screen interfaces.



**Fig.7.**Interface of the application in (a) group chat, (b) live chat

### 3.2. User Acceptance Test

To evaluate the user acceptance test on OSMaster application, it was tested with 30 computer science students who enrolled in the Principles of Operating System course. The study was successfully done to evaluate the effectiveness of the application with regards to perceived ease of use (PEU), content of the application (COA) and integration of the cloud computing (ICC). The score value with scale 1 to 5 was given for each type of criteria identified. Each scale is represented as strongly disagree (1), disagree (2), neutral (3), agree (4) and strongly agree (5).

**Table 2.** The user acceptance test results of the OSMaster application

No.	Criteria	Score (1-5)					Mean	Mean Category
		1	2	3	4	5		
Part 1: Perceived Ease of Use (PEU)								
1	OSMaster is easy to use.			3	16	11	4.3	Positive
2	My interaction with OSMaster was clear and understandable.			5	14	11	4.2	Positive
3	Learning using OSMaster would be fun and interesting.			2	15	13	4.4	Positive
4	Using OSMaster would enhance the effectiveness of mastering the Principles of Operating System course.			2	19	9	4.2	Positive
				Total Mean (PEU)			4.3	Positive
Part 2: Content of the Application (COA)								
5	I like the idea of OSMaster bringing for their user to learn the Principles of Operating System course.			2	15	13	4.4	Positive
6	The tutorial section provided very helpful for my study.			4	15	11	4.2	Positive
7	The chat room section provided very helpful for my study.				10	20	4.7	Positive
8	I like the contents and graphics in OSMaster.			3	11	16	4.4	Positive
9	I intended to use OSMaster as my guidance in learning the Principles of Operating System course.			2	16	12	4.3	Positive
				Total Mean (COA)			4.3	Positive
Part 3: Integration of Cloud Computing (ICC)								
10	Integrations of cloud computing as back			2	20	8	4.2	Positive

	end of mobile application are improved data backup services/disaster recovery.					
11	With cloud computing in mobile application can reduce mobile storage issues.	3	13	14	4.4	Positive
12	Uploading and downloading content from cloud didn't give any problem for me.	9	13	8	4.0	Positive
					Total Mean(ICC)	4.2 Positive
					Overall Total Mean	4.3 Positive

The study has successfully done for each type of the criteria to evaluate the effectiveness of the OSMaster application. Table 2 summarizes the results for the identified criteria and total means for each category respectively. The results shown that the target respondents were satisfied and positively accepted all functionalities and features provided by OSMaster application. This can be proven when the total mean for each category (PEU, COA, ICC) was calculated above the point of 4.0. Besides, the overall total mean for the user acceptance test is 4.3 which mean positive feedback from the users. Therefore, this indicates that the users were accepted the OSMaster application.

### 3.3. Network Performance Test

The network performance test was conducted on the network response time and network success rate to evaluate the performance between the mobile devices and cloud services. Table 3 shows the results for both tests.

**Table 3.** Network performance test of the OSMaster application

Network Performance/Device	Samples	Response Times	Success Rate
Samsung Galaxy Prime	19	5.89 second	100%
Android Network Emulator	31	3.59 second	100%

Table 3 shows the result for several network response times between the real device, which is Samsung Galaxy Grand Prime and the android network emulator. Each of the devices allocated response time median 5.89 seconds for Samsung Galaxy Prime with 19 samples and 3.59 seconds for android emulator with 31 samples. Besides, another part of testing has been covered

on the network success rate, and the result collected shown that 100% of the network success rate were not failed when the user used OSMaster application. Thus, it was proven that network performance testing had successfully tested and reliable.

#### 4. CONCLUSION

This paper has presented some insight on user technology to construct and integrating the mobile learning application with the cloud computing to enhance and enrich the learning process for Principles of Operating System course. Therefore, OSMaster application provides a convenience way of learning through the use of mobile devices especially phone, which is a common personal communication medium for most students.

To measure the effectiveness of the application, user acceptance test was conducted to evaluate the performance of the application used questionnaire method. Based on the results and analysis, the overall application was measured to be positively accepted by the target users. The functions provided by the OSMaster application are well-functioned and most of the respondents satisfied with the features provided. Besides, the network performance test on network response time and network success rate was shown a good result and acceptable.

In conclusion, the integration of mobile learning application and cloud computing was able to assist, enhance and enrich the experience learning process of students. Furthermore, it can be a reference and teaching aid for them to study the Principles of Operating System course.

#### 6. REFERENCES

- [1] Asmara WAHWM, Aziz N H A. SMS flood alert system. In Control and System Graduate Research Colloquium 2011, pp. 18–22
- [2] Hamrén O. Mobile phones and cloud computing: A quantitative research paper on mobile phone application offloading by cloud computing utilization. 2012, <http://www.diva-portal.org/smash/get/diva2:562483/FULLTEXT01.pdf>
- [3] Butoi A, Tomai N, Mocean L. Cloud-based mobile learning. *Informatica Economica*, 2013, 17(2):27–40
- [4] Hanen J, Kechaou Z, Ayed MB. An enhanced healthcare system in mobile cloud computing environment. *Vietnam J Comput Sci.*, 2016, 3(4):267–277

- [5] Doukas C, Pliakas T, Maglogiannis I. Mobile healthcare information management utilizing cloud computing and android OS. In Annual International Conference of the IEEE Engineering in Medicine and Biology, 2010, pp. 1037–1040
- [6] Gupta P, Seetharaman A, Raj J. The usage and adoption of cloud computing by small and medium businesses. *International Journal of Information Management*, 2013, 33:861–874
- [7] Prasad MR, Gyani J, R K Murti P. Mobile cloud computing: Implications and challenges. *Journal of Information Engineering and Applications*, 2012, 2(7):7-15
- [8] Bitam S, Mellouk A. ITS-cloud: Cloud computing for Intelligent transportation system. In IEEE Global Communications Conference, 2012, pp. 2054–2059
- [9] Shea R, Liu J, Ngai EC H, Cui Y. Cloud gaming: Architecture and performance. *IEEE Network*, 2013, 27(4):16–21
- [10] Lundberg M. Evaluation of a backend for computer games using a cloud service. 2017, <http://www.diva-portal.org/smash/get/diva2:1078558/FULLTEXT01.pdf>
- [11] Perry D, Rickeby C. User save data management in cloud gaming. United States patent application US 15/011,283., 2017
- [12] Khemaja M, Taamallah A. Towards situation driven mobile tutoring system for learning languages and communication skills: Application to users with specific needs. *Journal of Educational Technology and Society*, 2016, 19(1):113–128
- [13] Kumar A, Karie N M. Development of basic learning and communication system for school children with speech disabilities using mobile platform. *International Journal of Advanced Research in Computer Science*, 2014, 5(6):188–191
- [14] Bassil Y. A simulation model for the waterfall software development life cycle. *International Journal of Engineering and Technology*, 2012, 2(5):1–3

**How to cite this article:**

Nizam M O, Mushahadah M, Nurzaid M Z, Zulfikri P, Mahfudzah O, Shahrol M A. Mobile cloud computing for m-learning application. *J. Fundam. Appl. Sci.*, 2018, 10(2S), 1055-1068.