

EFFECTIVENESS OF USING MOBILE CLOUD COMPUTING APPLICATIONS ON THE JORDANIAN EDUCATION UNDER THE COVID-19 PANDEMIC

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ABSTRACT— Recently, at the end of 2019, the COVID-19 virus quickly spread worldwide and caused changes in all aspects of life. Perhaps the most important change in the education sector that under the Corona conditions has involved remote education using several applications for mobile cloud computing. This paper aims to measure the effectiveness of these applications in Higher education in Jordanian universities, several levels of study in higher education: intermediate university education, Bachelor's and Postgraduate students and measuring the extent of its impact on online education through 540 questionnaires distributed and analyzed by Spss, effectiveness measurement in three categories "ease of use, storage, and reliability" In addition, more problems were encountered facing the educational process and trying to find solutions to it

Index Terms— COVID-19, mobile cloud computing, higher education, application

I. INTRODUCTION

The development of technology in the last century has made the smartphone a necessity, it has become apart of work, study, travel and social life. With the development of the smartphone, the applications used have evolved to cover the user's practical needs including distance education applications, education, sports, entertainment, and social media applications, in addition to cloud computing applications, this was part of our virtual life as the International Data Corporation (IDC) indicated that the number of shipments of smartphones and tablets reached 1.9 billion units worldwide [1]. The term cloud was used historically as an expression of the Internet, as the name was derived from graphs as a blueprint for the cloud, and since the beginning of the millennium, the cloud has begun to appear in the technology circles [2]. Cloud computing is a powerful, widespread, and complex computing technology that eliminates the need to provide expensive, customized, programmed devices [3]. All engineering and science applications, mathematical finance, games and social media, data mining, and other activities with intensive activities rely on cloud computing. Account, transaction, and corporate data, personal information, photos, movies, and videos can be stored in the cloud [4]. Mobile Cloud Component (MCC) is a combination of Cloud Computing and Mobile computing, in [5], Mobile Computing was defined as "an act of portable devices usage to run stand-alone applications and/or accessing remote applications via wireless networks".

It consists of three main components: Software: which represents the applications on the device, the hardware parts such as the screen and the battery, and finally the communications related to mobile networks [6]. In another definition MCC in [7] "infrastructure, application or process, where the data storage and processing migrated from smart mobile technologies to the distributed cloud servers". The use of mobile cloud computing in education has evolved to include training and teaching in schools and universities, as it has been used across many platforms in higher education as a support to the progress of the educational process and an aspect of development in keeping pace with technology.

As of March 12, 2020, coronavirus disease, 2019 (COVID-19) has been confirmed in 125 048 people worldwide, carrying a mortality rate of approximately 3 · 7%, 1 compared with a mortality rate of less than 1% from

influenza. On March 18, 2020, as a result of the rapid spread of the Coronavirus and social separation measures, schools, and universities in 107 countries around the world were closed [9]. Corona phobia has had negative effects on students who have experienced despair, fear, and anxiety on their educational projects [10]. This means that education has shifted from lessons and lectures in the classroom to virtual distance education, which put all educational authorities in a challenge to complete the progress of the educational process until the end of the epidemic.

All eyes turned to the use of mobile cloud computing applications to complete e-learning, including Jordan, the country that has faced the Coronavirus since March 2020 and imposed curfews. This paper presents questions about the effectiveness of using mobile cloud computing applications in universities in Jordan to continue the educational process through and whether these applications are effective enough to reduce the online learning gap. Among the following goals (i) measuring the use of cloud mobile applications for teachers and students, (ii) effectiveness of applications in the quality of the study process, and (iii) determine the problems that users face in the study process.

The research plan: First: Introduction to cloud computing and mobile cloud computing, Second: Background on patterns of cloud computing, the architecture of mobile cloud computing, the benefits of mobile cloud computing, the benefits and harms of mobile cloud computing on education, third: related work, fourth: methodology and sampling, fifth: data analysis, finally: recommendations and conclusion.

II. BACKGROUND

A. Models of Cloud Computing:

Software as a Service (SaaS): Applications and programs for the consumer, the client accesses the applications through an interface or an internet browser, and the client does not have the management and control of the basic cloud infrastructure of servers, operating systems or storage devices.

Platform as a Service (PaaS): It is the deployment of programming languages, the operating system, and tools supported by the service provider, but the client does not have control of the basic cloud infrastructure but can control published applications.

Infrastructure as a Service (IaaS): Providing the necessary software and hardware to handle energy, networks, storage

space, etc. The client here can control, publish, and operate the necessary application programs [11].

Backend as a Service (BaaS) : sometimes referred as mobile backend service (MBAas), It is a cloud service model that allows outsourcing in mobile applications, activities are pre-written such as saving data on a cloud, it connects the mobile phone to a background cloud to enjoy the features offered such as social network integration and instant notifications[12].

B. The architecture of MMC:

Dinh et al. [13] Show the mobile cloud architecture in abbreviated form as in figure 1.

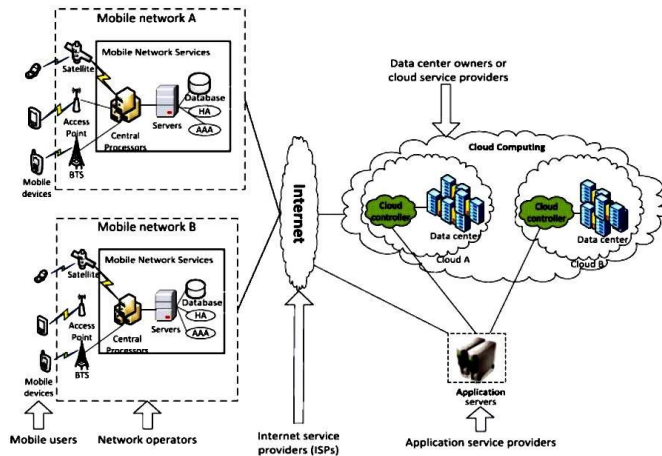


Figure 1: Architecture of MMC

“In Figure 1, mobile devices are connected to the mobile networks via base stations (e.g., base transceiver station, access point, or satellite) which establish and control the connections (air links) and functional interfaces between the networks and mobile devices. Mobile users’ requests and information (e.g., ID and location) are transmitted to the central processors that are connected to servers providing mobile network services. Here, mobile network operators can provide services to mobile users as an authentication, authorization, and accounting based on the home agent and subscribers’ data stored in databases. After that, the subscribers’ requests are delivered to a cloud through the Internet. In the cloud, cloud controllers process the requests to provide mobile users with the corresponding cloud services. These services are developed with the concepts of utility computing, virtualization, and service-oriented architecture (e.g., web, application, and database servers).”

C. Benefits of MMC:

There are several advantages of mobile cloud computing, some of which are mention in [14]:

- 1- Overcoming limitations imposed on mobile devices such as processing power and data size
- 2- It prolongs battery life, by transferring the implementation of applications to the cloud
- 3- Increases security by centrally monitoring and maintaining applications
- 4- It provides many technical services such as positioning and providing payment services

5- Shares data and increases its size.

D. Uses of MCC applications in education:

There are many uses, including:

- Provide lectures
- Submission of duties
- Store lectures, information, and notes
- Electronic exams
- Virtual meetings
- Conversation

E. Advantages and Disadvantages of MMC in Education:

Cloud computing refers to the infrastructure that enables portable devices (such as laptop computers, tablets, and smartphones) to access various computing resources anytime and anywhere which enables the student and the lecturer to: Take advantage of the storage service provided by the Android, JOS, and Blackberry system like Dropbox, iCloud, SkyDrive, and Google Drive benefits from syncing data like "files, documents, pictures, videos, and calendars", the ability to share files between the lecturer and the student [15].

The authors of [16] have put a number of advantages in implementing mobile education through mobile cloud computing such as low cost through free applications, the presence of many applications for learning, and these applications support the mobile phone, improving reliability by reducing data loss as all data is a cloud bug that can be accessed anytime.

The dependence of education on mobile cloud computing applications has several challenges that relate to the lecturer, students, and services provided on these applications: The most important of these issues and challenges, as discussed by the authors of [17] are:

- 1- Privacy: Because the data is on the cloud and you may lose its privacy through multiple access.
- 2- The possibility of interactive operation: This is due to the different versions of mobile phones used, which are not suitable for the permanent update of the application.
- 3- Security: that may pose a risk of exposure to viruses, Trojans, and Malware.

III. RELATED WORK

• After the increasing number of COVID-19 infections and several countries announcing the suspension of all forms of education, Basilaia and Kvavadze [18] studied, the increasing number of cases in Georgia, showed the success of online education using educational applications. The results of this paper confirmed the success of the rapid transition to online learning and indicated the possibility of benefiting from this experience in the future, especially those with special needs, and taking advantage of new skills acquired after the epidemic.

Among the results of the research is that the next generation will be more experienced and aware of the use of applications, but the exams still suffer from a lack of credibility and a lack of culture to deal with the principle of the open book. This study did not address the details of confirmation of educational methods, as the main objective was to verify the success of the rapid transfer of online

education and follow-up, concerning the need for research to cover the entire country and not just private schools.

- In another study, Zhou et al. [19] presented a paper on China's experience in converting 270 million students to online education, after the spread of the COVID-19 in China and its declaration from the World Health Organization as a pandemic, China faced great challenges that required an urgent solution, but it succeeded in facing the major emergency especially the academic conditions where It provided high quality, varied, testable applications covering all parts of the country. This paper indicates the reason for the success and effectiveness of online education and mobile cloud computing applications to prefabricated infrastructure and ongoing reforms.

The paper also pointed out the problems that faced online education such as the lack of interaction, and the lack of the ability to self-learn. The paper also stressed the need to take advantage of online education to integrate school and home education to increase the effectiveness of education.

IV. METHODOLOGY AND HYPOTHESES

The questionnaire was adopted as a method of data collection, to measure the use and effectiveness of MCC application in higher education for students and lecturers, and to know the most common problems facing them. The evaluation criteria were classified into three main categories. Each category included several key questions (table 1). Each question was evaluated within the numerical scale from 1 to 5, where 1 was the lowest score and 5 the highest score, respectively. In addition, to asking about the difficulties and problems facing the MCC application in Jordan. The data will be analyzed through Google form and statistical package for the social sciences (spss).

V. SAMPLE SIZE AND SAMPLING TECHNIQUES

The data was collected by a questionnaire, which was formulated by Google Form, and distributed via social media to several levels of study in higher education: intermediate university education, Bachelor's, and Postgraduate students to obtain results from several perspectives within a random sample.

The research aimed at diversity in the random sample and a higher quality in terms of information.

The results are based on an analysis of the 540 answer questions

VI. HYPOTHESES

The hypotheses in this paper are to increase using of MCC applications in higher education in Jordan and study the effectiveness of the same applications during certain situations like the pandemic of COVID-19.

Table 1: categories of evaluation

category	Evaluation aspects
Ease Of use	Q1-Ease of access to materials "audio recordings video image files." Q2- Ease of communication between the teacher and the student Q3- Ease of teamwork and participation among students Q4- The ability to add comments, interactions, and notes Q5- Time flexibility by accessing educational content anytime and anywhere Q6- Taking into account levels of learning through students 'ability differences" through the possibility of returning the educational material
Storage	Q7-Help reduce space on the device Q8-Big data access Q9-Extend battery life Q10-Backup and share files
Reliability	Q11-Ensure that the educational material is not lost Q12-Keeping tags and notes confidential Q13- Confidentiality and reliability of examinations Q14- Keeping tags and notes confidential

VII. FINDINGS

The prominent results indicate that students and lecturers in higher education in Jordan increased their use of mobile cloud computing applications in the study process by 54.6% as an average utilization rate, and 20.7% as a high utilization rate, (Figure 2). This confirms the validity of hypothesis 1, which indicates that the exceptional circumstances imposed by Covid-19 prompted students and lecturers to increase the use of mobile cloud computing applications to meet the needs of the educational process remotely.

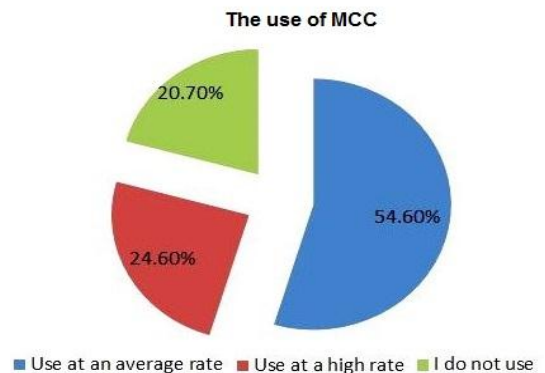


Figure 2: rate of use MCC

VIII. RESULTS AND DISCUSSION

Data analysis after distributing the questionnaire to students and lecturers in higher education indicated the following:

1- The results of the questionnaire show that the lecturers are the ones with the highest use of mobile cloud computing applications in the educational process at a rate of 50%. This indicates that the lecturer relied on these applications to deliver the educational content to his students, and that shows the important role that clouds computing applications took at this stage (Figure 3).

Average use is shown in the highest index among middle school students at a rate of 59.3%, while the lower utilization rate appears higher for Bachelor's students by 24.1%. It can be predicted that the reason for the low rate may be due to a decrease in the impact of sensitive interest from these applications, or perceived ease of use, a previous study conducted in Malaysia [20] indicated that the rate of use of cloud computing applications for undergraduate students was affected by the value of the benefit for these applications and the circumstances surrounding them.

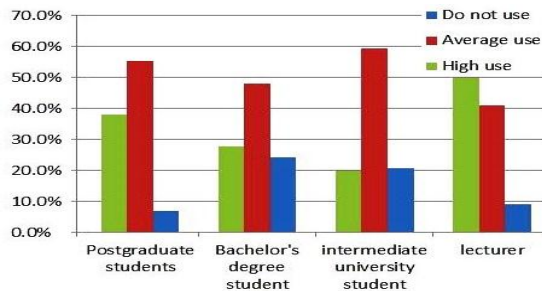


Figure 3: rate of use for each user

2- After processing the data and adjusting the question data in each category to facilitate the handling and analysis through a statistical analysis program spss to measure the effectiveness of each standard in the use of mobile cloud computing applications in higher education, it was found that reliability is the highest arithmetic mean followed by ease of use.

Where the reliability standard appeared at a rate 3.3, the ease of use at a rate 3.2, finally storage 2.9

This indicates that the most usage of MCC applications in higher education was due to the confidence of the lecturer and student in these applications in online education, as a way to ensure the quality of education and maintain its standards (table 2).

In addition to the ease of use, the standard that distinguishes these applications, a previous study [21] indicated that there is a direct relationship between security, and the perceived reliability in these applications with the desired benefit from it, which may increase the use of these applications.

Table 2: statistical analysis

	Ease of use	Storage	Reliability
Valid	540	540	540
Missing	0	0	0
Mean	3.2	2.9	3.3
Std. Deviation	1.1	1.2	1.2
Range	4.00	4.00	4.00

3- When focusing on analyzing the effectiveness of the ease of using MCC applications in higher education, we find that the top indicator was for "easy access to the educational material, easy communication with the lecturer, ease of adding comments", those activities enrich the educational process and compensate for part of the lecture activities in the classroom (table 3).

Table 3: results of ease of use

	Scale from 5	% Scale
Q1	3.4	67.11%
Q2	3.3	65.04%
Q3	2.8	55.85%
Q4	3.3	66.00%
Q5	3.3	66.89%
Q6	2.9	58.58%

The lowest indicator was "ease of communication with colleagues within the group, taking into account individual differences in learning". This could be explained by the need for students to communicate directly in study groups rather than being hypothetical, and the need for students with individual differences to address the problems they face in The educational material in which these applications did not help them very effectively.

Among the solutions that could enhance cooperation between students in online learning, a study [22] conducted in four American universities suggested a mobile system based on the cloud (MyMOOCspace), to the aim of increasing the effectiveness of cooperation between students, and the results were positive in terms of managing interaction and cooperation between students and ease of use.

4- The effectiveness of storage in applications was measured in terms of "device space, huge data access, backup storage" etc.

Indicators of storage effectiveness in applications were fairly close and of medium efficacy, but lower compared to reliability and ease of use standards. The reason may be that the current conditions and state of fear that dominated students due to the transformation of the entire education into distance education, made them focus on other aspects of these applications reliable and easy to use, to cover the gap that no prior measures have been prepared (table 4).

Table 4: results of storage

	Scale from 5	% Scale
Q7	2.9	58.59%
Q8	3.1	65.67%
Q9	2.6	55.41%
Q10	3.0	59.00%

5- The effectiveness of the reliability appears to be higher than the rest of the criteria, as data analysis showed a high degree of reliability of preserving the educational material and not being afraid of losing it, in addition to the flexibility of saving marks and information (table 5).

Table 5: results of reliability

	Scale from 5	% Scale
Q11	3.3	65.30%
Q12	3.4	68.30%
Q13	3.2	63.41%
Q14	3.4	68.41%

Within the Reliability Criteria analysis, the reliability and confidentiality of the online exams were relatively less than the rest of the reliability metrics, with tests being the most difficult factor in online education. Although there are benefits in online exams through: reducing the teacher’s time and effort, immediate feedback to student performance, and reducing the cost of the scientific institution, it has challenges that have a negative impact on the student through unprepared infrastructure and the student’s lack of experience in dealing with the exam [23].

As mentioned above of analysis data from the survey, the MCC application was effective in online education, which conforms to hypotheses 2.

IX. RECOMMENDATION

Several problems arose through the use of mobile cloud computing applications in higher education in Jordan, through which it is recommended to find solutions to them, as these solutions will contribute to improving the level of the effectiveness of using mobile cloud applications in the Coved-19 crisis. The problems that were mentioned:

- ❖ Limited space within the app.
- ❖ Difficulty in accepting change in dealing with these requests.
- ❖ The presence of technical problems.
- ❖ Weakness in mastering application skills.
- ❖ The need for the Internet.
- ❖ Limited safety.

The most prominent of which was the continuous need in these applications to the Internet, as the percentage reached 62.2%, due to the weak infrastructure on the Internet in Jordan, not fully prepared to embrace online education. For this primary reason, it is recommended to maintain networks and expand the Internet to increase the effectiveness (Figure 4)

In addition to the previous problems, new problems were mentioned that students suffered from, such as:

- Sometimes mobile devices do not support the constant updates of mobile cloud computing applications which have been a major impediment to continuing education.
- The increasing cases of cheating in exams and not having the appropriate practice in dealing with applications has led to frustration and permanent fear among students

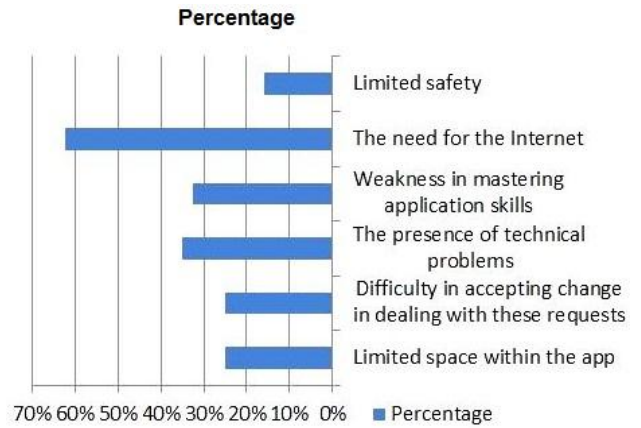


Figure 4: percentage of problems

X. CONCLUSION

COVID-19 epidemic, rapid spread, and cases of infection that were increasing in the world, made curfews imposed and changed in all aspects of life. Jordan is one of the countries that recorded its first case in March 2020, which soon led to a state of emergency and the suspension of all official and private agencies from working. Students and lecturers suddenly found themselves face to face with the online education imposed by universities and schools, to ensure the continuation of the teaching process in the period of the embargo that may be prolonged, which in turn led to the increased use of MCC applications in online education to take advantage of its multiple advantages and characteristics. This paper presented a study on a questionnaire that was conducted on students and lecturers of higher education in its various stages of intermediate university college, bachelor, and postgraduate studies, and the data was analyzed using a statistical program (SPSS) with the aim of measuring the effectiveness of MCC applications in higher education in Jordan under conditions COVID-19.

The study showed the increasing use of MCC applications in higher education to take advantage of the ease of use, reliability, and storage and was the indicator of the greatest effectiveness of the reliability of these. Also presented in this paper were the most important problems that students and lecturers faced in using applications, the most important of which was their constant need for Internet, which was difficult due to the lack of infrastructure in Jordan, in addition to problems in the lack of knowledge in use and the presence of mobile devices that do not keep pace with application updates. In future studies, more categories will be focused on assessing effectiveness MCC applications, in order to obtain more accurate information on the strengths to take advantage of, and the weaknesses to repair them. Where it is possible to take advantage of MCC applications in improving education in Jordan, after COVID-19 by supporting education with additional duties and lectures on MCC applications to enhance education and raise the level of communication between the lecturer and the teacher.

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