Integrating Mobile Devices in Classrooms to Enhance Collaborative learning and Classroom Management

دمج أجهزة الموبايل في الغرف الصفية لتحسين التعليم التشاركي وإدارة الغرف الدراسية

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أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

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نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة شئون البحث العلمي والدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحث/ **عبدالفتاح صبحى عبدالفتاح أبورضوان** لنيل درجة الماجستير في كلية *تكنولوجيا المعلومات* برنامج <u>تكنولوجيا المعلومات</u> وموضوعها:

دمج أجهزة الموبايل في الغرف الصفية لتحسين التعليم التشاركي وإدارة الغرف الدراسية
Integrating Mobile Devices in Classrooms to Enhance Collaborative learning and Classroom Management

وبعد المناقشة العلنية التي تمت اليوم الأحد 05 ربيع الأول 1438هـ، الموافق 2016/12/04م الساعة الثانية عشر والنصف ظهراً في قاعة المؤتمرات بمبنى القدس، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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د. نــاجي شــكري الظاظـا	مناقشـاً خارجيـاً	....

وبعد المداولة أوصت اللجنة بمنح الباحث درجة الماجستير في كلية *تكنولوجيا المعلومات/ برنامج* تكنولوجيا المعلومات.

واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق ،،،

نائب الرئيس لشئون البحث العلمي والدراسات العليا

أ.د.. عبدالرؤوف علي المناعمة

Abstract

The large growth of mobile technology has changed our computing life. Mobile technology could change the future of classrooms, including learning, collaborative activities and classroom management. Several solutions have been proposed to exploit mobile devices to enhance educational and management activities inside classroom. However, these solutions often did not address the specific requirements of both instructors and students in the classroom. In addition, little effort has been done to assess the use of mobile technology for learning and teaching in the classroom in practice. Existing solutions focused mainly on the presentation of mobile-based features while neglecting the assessment of these features in practice. In this work, we present a mobile-based system for classroom management. The proposed system supports a wide range of activities that facilitate information share, transfer, classroom management and collaborative work in the classroom. The system was evaluated by both instructors and students. We reported on the observational study we conducted in which the proposed system was used in realistic classrooms to teach lessons in Java programming. All actions performed in the classroom were recorded. Recordings were then analyzed thoroughly for the purpose of assessing the system's functionalities in terms of frequency of use and duration. Subjective comments were also gathered from both students and instructors by means of questionnaires. Results showed that most of the system's features were intensively used in the classroom and made the classroom activity more interactive and manageable. Results also revealed that the system did not replace the traditional instructional approach in the classroom, but supported through a variety of mobile-based technologies. All participating students found the system useful. 90% of the students prefer to use the system over the use of PowerPoint slides. 90% of participants found the system easy to learn and use. 60% of the students agreed that using the mobile devices during the lecture did not distract them, while 40 % found them distracting.

Keywords: Mobile learning, classroom management system, instructor, student, observational study.

Source code: https://github.com/abdrn1/

الملخص

الانتشار الكبير لتكنولوجيا أجهزة الموبايل قام بتغيير نمط حياتنا التقني. بإمكان تقنية الموبايل أن تقوم بتغيير مستقبل الأنشطة داخل الغرف الدراسية. العديد من الحلول قدمت لاستغلال أجهزة الموبايل لتطوير التعليم وإدارة النشاطات داخل الغرف الدراسية. بالرغم من ذلك لم تقم هذه الحلول بالوقوف على متطلبات كلا من المدرسين والطلبة داخل الغرف الدراسية.

قليل من الجهود تم إنجازها لتقييم استخدام تقنية الموبايل للتعلم والتعليم داخل الغرف الدراسية. غالبية الحلول المتوفرة حالياً تركز بشكل أساسي على تقديم ميزات تعتمد على تقنية الموبايل بينما تتجاهل تقييم هذه الميزات داخل بيئة عملية حقيقية.

من خلال عملنا نقدم نظام يعتمد على الموبايل لإدارة الغرف الدراسية. النظام المقترح يدعم العديد من الوظائف والأنشطة التي تسهل وتعزز مشاركة المعلومات ونقلها وإدارة الغرفة الدراسية والأنشطة التشاركية داخلها. النظام تم تقييمه بواسطة كلاً من المدرسين والطلبة على حد سواء، لقد قدمنا تقريراً عن الدراسة الوصفية التي قمنا بأجرائها على النظام المقترح داخل غرف دراسية حقيقة لتعليم لغة البرمجة جافا.

جميع وظائف النظام التي تم استخدامها داخل الغرفة الدراسية تم تسجيلها ومن ثم تحليل سجلات هذه النشاطات من أجل تقييم الوظائف التي يقدمها النظام بواسطة حساب عدد مرات استخدام الوظيفة التي يقدمها النظام وكذلك المدة الزمنية التي استغرقتها كل وظيفة. لقد قمنا أيضا بجمع ملاحظات المستخدمين الطلبة والمدرسين حول النظام عن طريق استبيانات موجهة لمستخدمي النظام.

أظهرت النتائج أن معظم الميزات والوظائف التي يقدمها النظام تم استخدامها من قبل المستخدمين خلال الدرس. أيضاً أظهرت النتائج أن النظام لم يقم بتغير أو استبدال نظام التعليم التقليدي داخل الغرف الدراسية ولكن قام بتعزيزه. جميع الطلبة المشاركين وجدوا النظام مفيداً، 90% من المشاركين فضلوا النظام المقترح عن عروض "بوربوينت"، 90% من المشاركين وجدوا النظام سهلاً في الاستخدام والتعلم. 60% من المشاركين اكدوا بان استخدام اجهز الموبايل لم يشتت انتباههم خلال الدروس، في حين 40% من الطلاب المشاركين وجدوا أن النظام ساهم في تشتيت انتباههم.

Dedication

To my lovely mother, for her affection, compassion, endless care and prays of day and night. For our permanent feeling of childhood in her presence.

To my great father, for being my first teacher, for all the memories stuck in my mind starting from his letters sent from the Israeli prison till the season of picking olives together and everything between them.

To my deer brother, for all the childhood's memories and our sense of masculinity together, for our silence mixed with smiles when being scolded by our parents.

To my wife, for her patience, resilience, and for everything we passed together, for our hopeful waiting for Allah's fate and believing in it.

To my sisters, for all their nice presence in my life, their true care and permanent encouragement.

To my true friends, for their wonderful friendship, their dedication in love and great support. For being in front of me wherever I look.

Acknowledgment

I would like much to thank my advisor Dr. Iyad M. AlAgha for his big effort which he did to accomplish this thesis. He advised and shared me the research of finding solutions.

He used all the possible means to communicate with me all the times without embarrassed me. I would never stand this place without his being at my side as advisor and professor. I have been lucky to cooperate with this great valuable man.

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Introduction

Smart mobile devices have become the leading computer terminal. Smart phones not only used for making calls and limited data services, but also for internet surfing, payment transactions, image capturing, navigation, watching movies gaming and e-learning. As far as computing life transfer towards smart mobile and there is smart mobile in most of students hands could replace computers inside labs and smart classrooms, smart mobile devices could replace the hard and expensive network infrastructure inside classrooms, and convert every classroom to a smart one.

Mobile devices provide new and natural forms of collaboration between students (Schweitzer & Teel, 2011). Students can use mobile devices directly without any peripherals (keyboard, mouse), small and light enough to hold and put it in the pocket or the bag. Students can use mobiles anywhere in classrooms and the labs which have huge equipment and there is no place for computers, such as physics and chemistry labs. The objective of using mobile technology in classrooms is to enhance the use of technology for classroom teaching and laboratory activities, and encourage collaborative work and active learning in the classroom (Rawat, Riddick, & Moore, 2008)

Unlike PCs, mobile devices have limited screen sizes, computing capability, and power, so there is a need to redesign the courses to include lecture slides, video demonstration, in- class group activities ,assignments and problem solving in order to maximize use of mobile devices (Rawat et al., 2008). Class management application systems used on PC offer most the features that the instructor or the student need. However, little effort has been done to build classroom management systems for mobile devices.

Mobile device could be connected to a server inside classroom using WIFI connection which enables the instructor to record students' absence. Furthermore, it enable instructor to communicate with any student in the classroom (Schweitzer & Teel, 2011), stick RFID tag on the students' android mobile devices enable students to record their attendance in the smart classroom then students could access the smart

classroom server to get the course workspace, which updated directly through the session, also this model enables instructors to give student access to smart board (Dekdouk, 2012).

Mobile collaborative systems enable users to work autonomous and loosely couples way, learning process involve instructor and students to work together collaboratively, but the development of collaborative mobile systems is complex because most of these applications implementations refer to the background process like communication and collaboration between devices (Herskovic, Ochoa, Pino, & Neyem, 2011)

Interaction with mobile devices in class should be natural (touches, voice command) and easy as possible in order not to distract student attention. Student should accept, view learning material, communicate with instructor and solve assignment on his mobile as simple as possible.

There is a lot of techniques has been applied in classroom to increase efficiency of learning process using technical collaborative techniques such as smart classrooms equipped with server, computers, high speed internet , projectors, large screens or large size multi-touch tabletop (Bargaoui & Bdiwi, 2014), (AlAgha, Hatch, Ma, & Burd, 2010) , which seems to be expensive and content based technologies that only available for specific courses.

Learning with mobile applications should enable students to expand discussion and investigation, it should enable students to collaborate and create knowledge and to interact with larger content (Rossing, Miller, Cecil, & Stamper, 2012). The mobile approaches that supplement traditional face to face learning should link students' devices with the instructor's device to facilitates sharing, viewing students' devices, so it provides a quick polling insight into student's level of understanding (Rawat et al., 2008). Other technologies use mobile in classroom to check student's absence, they also enable students to access content resource updated by the instructor and store these resources in storage server to be accessed later by the students also the students should have access to the classroom equipment such as smart screen (Dekdouk, 2012; Schweitzer & Teel, 2011).

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The majority of teaching and learning mobile + depended on remote learning which includes video streaming, lectures, and video courses. These solutions however, have focused on the delivery of the learning material, and are not adequate to be used inside classrooms. Remote learning applications are not applicable inside ordinary instructional classrooms as there is no support for collaborative activities, and there is no control on the learning material content.

The mobile-based solutions for classroom learning did not provide a complete solution that fulfills the needs of both the instructor and students. There is no monitoring system that enable instructor to monitor students without interrupting teaching activities. There is no general way or interface for linking classroom equipment (Printer, Projector, TV… etc.), and it is hard to extend it for new devices. Instructor should have control on the students' devices to deny or allow them to use mobile devices. These solutions did not provide a complete plethora of the features needed by students and instructors in one solution.

The mobile application for managing classroom should achieve the needs of both instructor and students inside the classroom. In the following we list these needs which we collected from existing studies (de Souza Fleith 2000, Motiwalla 2007, AlAgha, Hatch et al. 2010) :-

- Instructor should monitor student's activities without interrupting teaching activities.
- Support conversation between students and the instructor.
- Allow files and learning content to be transferred easily between students and instructor.
- Support of tests for student assessment and quick polling to measure students understanding or student's opinion survey.
- Support group creation and group discussions.
- Instructor could allow or deny student from using any feature in the application like conversation with instructor, or using his device.
- The system should enable instructor and students to use or link assets inside the classroom.

Other needs related for the solution performance and flexibility:-

- Application ease of use.
- Enhance student performance level.
- Keeping student privacy and security.
- Acceptable performance.

We present an enhanced classroom management system for android mobiles that help to manage the classroom activities and enhance the collaborative activities inside the classroom. This system could be used inside any normal classroom, so there is no need for special infrastructure or a computer lab. The mobile application could be simply installed on the students devices or preinstalled on a mobile devices belong to the institute. Our solution provides a plethora of services that should help instructor to manage his classroom, exploit mobile devices in learning for better classroom time management. The presented system offers an integrated solution to:

1) Control of classroom activities, by enabling the instructor to track the student's activity and control students' devices remotely.

2) Enhance instructor-student interaction by enabling the instructor to transfer learning material and feedback to students in an intuitive manner.

3) Enhance student-student interaction by enabling students to share content in the classroom.

4) Achieve a better utilization of classroom assets by enabling seamless transition of content from the mobile devices to the projector or the printer in the classroom.

The results of using our system inside real classrooms show that both of students and instructor find the system very useful inside the classroom, the system did not change the normal instructional nature of the classroom, the system help instructor to save time and effort, and there are no fears to distract students' attentions. Most of the students find it interesting to use mobile devices inside classroom for learning. The system could replace the normal presentations slide such as "PowerPoint" and could be used to make a smart classroom anywhere any time without any expensive infrastructure.

1.1. Statement of the problem

Several applications have been proposed to manage the classroom activity and support interactive learning. However, most of these applications relied on expensive equipment or special infrastructure that is not available in traditional classrooms. Some efforts tried to leverage mobile devices to enhance interaction and classroom management. These efforts, however, were often application-specific (e.g. designed for specific learning scenarios) and did not address the generic requirements of both the instructor and the learner in the classroom. In addition, little effort has been done to assess the use of mobile technology for learning and teaching in the classroom in practice. Existing solutions focused mainly on the presentation of mobile-based features while neglecting the assessment of these features in practice.

1.2. Objectives

Main objective

Integrate mobile devices inside classroom for better classroom management and more collaborative classroom to enhance learning and teaching process.

Specific objectives

The specific objectives of the research are:

- Investigate the needs of both the instructor and the students in the classroom.

- Explore mobile technologies to address the instructional and learning needs.

- Explore easy-to-use interaction metaphors that allow instructors and students to interact intuitively.

- Design solutions to support interaction between students and the instructor through the mobile devices.

- Design an approach that allows the instructor to manage the classroom tasks with least effort.

- Investigate how the proposed system will be evaluated in practice.

1.3. Scope and limitations of the research

1) We present a solution for mobile devices based on android system only.

2) We will not support any feature that needs special device configuration such as device rooting.

3) The system will be assessed in practice in short lectures. Longitudinal studies are out of scope of this work.

4) The supervisor of this thesis was involved in the evaluation process. However, the supervisor was neither involved in the development of the software nor in the collection and analysis of the data.

5) The evaluation of the system did not consider the learning outcomes of using the system. Only an observational study was conducted to give only indicators of the feasibility, reliability and ease of use of the provided services.

6) The system was tested in lecture rooms that use lab settings.

7) The system was tested with a single course (programming course), and over two learning sessions, each of which lasted for 1.5 hours.

1.4. Importance of the research

The research proposes a mobile-based system that is applicable inside the classroom, and addresses the specific requirements of both teachers and students. It enables the teacher to practice the various teaching activities including student assessment, monitoring, conversation, classroom management and information sharing. Similar solutions do not support all these features in a single system, and are often application-specific or are not adequate for classroom use.

The system help instructor to save session time, control his students' activities, get students attention towards him and to evaluate his students levels and progress. Students will interact with wide range of learning material content; they could work together in productive and monitored manner, the system decrease the social fears of the students during classroom sessions, so, they could make conversation or ask the instructor or each other while keeping their privacy.

Educational institutes could replace expensive or special infrastructure of the class management applications by this solution which need ordinary and cheap infrastructure to conduct.

This approach could be used in science labs where is no space for computers and there is large lab equipment and experiments conducted without disturb other lab activities.

The system features evaluated by mean of an observational which conducted in realistic classroom settings. We also provide subjective comments from both instructors and students who used the system. Similar solutions often do not provide this level of assessment.

1.5. Tools

- Android studio and JDK for system development.
- Apache commons to handle file transfer over network.
- The network library (Kryonet).
    - https://github.com/EsotericSoftware/kryonet
- JDom library, Parses, manipulates, and outputs XML.
- BASE64Decoder, Decode from Base64 or Encode to Base64.

1.6. Overview of the thesis

This thesis consists of five chapters as following:

Chapter One: Introduction

Introduction chapter introduce mobile technology, and how mobile technology used in the learning field, we present the benefits of using mobile devices inside classroom, and the problems facing mobile devices usage inside classroom. We present a quick overview of previous work related to using mobile inside classroom we list the problems and the suggested solutions.

Chapter Two: Related work and literature review.

In this chapter we presents the works related to our research, we classified the previous work into three main categories. These categories focus on the work done inside classroom, mobile collaborative technologies, and other technologies

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conducted inside classroom. In this chapter we present how we build upon the previous work and what is make our work different.

Chapter Three: Methodology.

In this chapter we present the steps we follow to build a class management system, that provide a solution for the problem. We also present the system features and functions and how these features fulfillment the needs, and solve the problems.

Chapter Four: Evaluation.

In this chapter we evaluate the system services and function, present how our solution answer the research questions, then we present the study we conduct to evaluate the system and discuss the results.

Chapter Five: Conclusion and Future Work

A final statement that summarize our work, discuss the future work we looking for.

Chapter 2

Literature review

Chapter 2
Literature review

2.1. Preface

Mobile learning enables students to work collaboratively anywhere while they are in movement. Students can use mobile devices inside the classroom while they are moving and talking with other students. Students can use mobile devices in learning while they communicate face to face with partners and instructor. Mobile applications supports three types of interaction between members 1) between student and instructor one to one or student to student 2) instructor to student one to many 3) group of students together many to many (Zurita, Baloian, & Baytelman, 2008). Devices inside classroom divided into two types: infrastructure devices and mobile devices. Infrastructure devices are stationary and provide media and information for mobile devices in order to communicate and work collaboratively. Mobile devices are always related to students and instructor, normally they use it for interaction share contents solve problems. For better integrating of mobile technology in everyday classroom practice, learning design has these characteristics (Boticki, I. Wong, L. & Looi, 2013) :

1- The technology should allow divers of content type or it should be content dependent.

2- Technology should support face to face activities inside classroom, and support dynamic forming of groups

3- Instructor should be able to utilize the support technology provide to enhance and support his students.

This chapter presents works and studies relevant to our research about mobile based class management system. We address previous work done inside classroom aiming to enhance classroom management making classroom more productive, more collaborative .Other research present lecturers and students technology needs inside classroom. We will present and discuss these studies in more detail to determine how we could build upon this contribution. Designing mobile based services inside

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classroom is an interdisciplinary work that needs education and computer science research.

We classified related work into three main topics:

A) Mobile solution inside classroom.

Discuss mobile based solutions done inside classroom in order to enhance classroom management, help student and instructors to be more collaborative. This solution should be mobile based and done inside real classroom; we will discuss solution's features, weakness and missed features.

B) Mobile technologies for collaboration and data communication.

Present and discuss these technologies and specifications of a mobile system to be collaborative, and have better data communication between mobile systems each other or with any different systems.

C) Other Technologies inside classroom.

In this section we explore other computer related technologies applied inside classroom in order to help lecturers and students to be more productive, collaborative and help them to overcome weakness.

D) The proliferation of mobile Devices.

In this section we explore the spread of mobile devices and mobile application among the Palestinian students.

2.2. Mobile Solutions inside classroom

Mobile solutions conducted inside classroom could be classified into content dependent which relay on the learning material and content independent.

Schweitzer (2006) tried to replace traditional laboratory computers by implementing a mobile based tool named SHERPA for both student and instructor, SHERPA enables instructor to do some administrative classroom tasks such as viewing student informal information like nick name and picture such as Figure(2.1), recording student absence, gather students' evaluation, and communicate with specific student simply using email. SHERPA depended on server-based 3-tier architecture, the client connected to the server database and cache information form the server locally on the mobile. The application builds on android platform and use

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SQL Lite as local database and MYSQL as server remote database. The server and client use http and https to communicate, data transfer performed using java script object notation (JSON) which is a light weight data transfer protocol. SHERPA make it easy to deploy system services as web service like amazon web services because the server based on LAMP stack stander (Schweitzer & Teel, 2011).
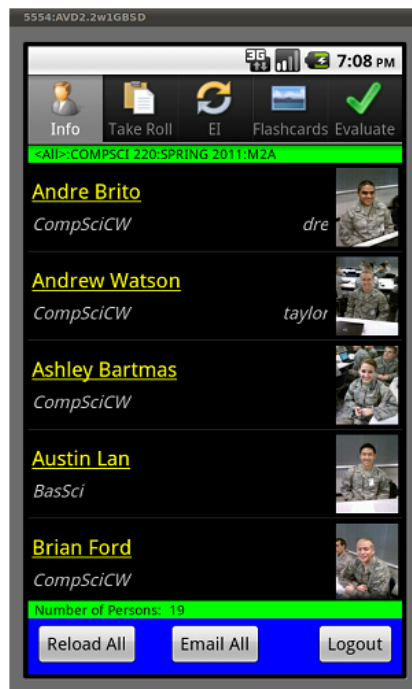
Figure (2.1): SHERPA, shows active students (pictures and names), (Schweitzer & Teel, 2011)

Schweitzer & Teel (2011) built instructor application with many features but there is no student application that enable collaboration between students and instructor inside class room, there is no way to monitor activities students can't get files, pictures or any digital resource form students and broadcast it on other student In the class there is no direct collaboration between students, we thought the 3- tier architecture of SHERPA make it is difficult to use the application off-campus where is no connection media with the server. To maximize use of mobile systems inside classroom the learning material should be redesigned to include lectures, oral presentation and audio video demonstration, classroom activities should be designed in order to enable instructor to modify learning content according to student's needs (Schweitzer & Teel, 2011).

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Rawat et al. (2006) tried to build classroom management system using tablet pc and CMS application "Net Support School CMS". This system enable instructor to share notes comments and assessment with students, Instructor tablet pc connected to multimedia projector so it can work as virtual white board. Instructor can monitor student activities deny student from using his tablet pc. The project enable students to participate efficiently in class collaborative activities as shown in Figure (2.2), but this solution valid for tablet pc, the solution depend on real time students screen monitoring, there is no log of students' actions and there is no interface to link classroom asset (Rawat et al., 2008).

Figure (2.2): Students using tablet-pcs for collaborative activities

Many researches have been conducted inside classroom used mobile devices and other equipment in order to build a powerful smart classroom , these classrooms have very high speed internet line, interactive smart boards, cameras, NFC tags and sensors.

Dekdouk (2012) built a smart classroom using tablets, WIFI connection and RFID tags and sensor as show in Figure (2.3). They put RFID tag on instructor and students' mobile devices, the RFID sensor detect the RFID tag when instructor or student go inside the smart classroom the tag id registered on the management server. The student automatically gets the course work space form the server after entering the smart class room. The Course content updated during the lesson, also the students' workspace stored in the server. Students and instructor can access finished course resources form course platforms such as WebCT and Moodle. In this solution Instructor can interact with some students e.g. Instructor write questions on smart

board and give some students privilege to write on smart board to answer the questions (Dekdouk, 2012).

Mobile devices could be very effective and powerful tool in the learning and teaching process inside or outside classroom, while mobile learning defined as using mobile devices to be more productive interacting or creating educational content (Menchaca & Romero, 2015).
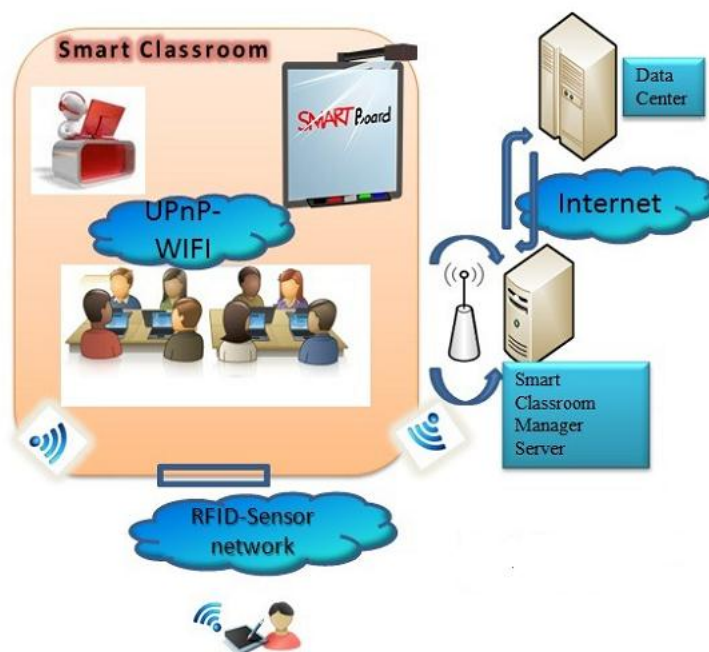
Figure (2.3): Components of Smart Classroom, (Dekdouk, 2012)

Menchaca & Romero (2015) presented a review of using mobile devices as teaching and learning tool inside or outside education facility, they claim that mobile devices promote a long learning experience and continuous learning because mobile give student continuous learning experience after leaving class room. They show how mobile devices integrate in learning activities inside engineering classrooms. Student use mobile device for common tasks such as check email access shred calendar consult Moodle download files check grades and results. other activities demonstrate communication and collaboration like instant messaging and data exchange. other activities done on the lab where practical work done (Electronics, Robots, computer architecture). Students can demonstrate their work by taking a picture using Mobile cam, student can use video to record experiment critical

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changes in time. A questionnaire applied on students to gather information about Mobile devices they hold, about the applications they use, and the value from using mobile in learning process. The results of this paper should be applied on our research, we should support all the mobile learning activities listed in the paper in one complete classroom solution (Menchaca & Romero, 2015).

Williams (2011) studied the applications that use smart phones in chemistry classroom, student can use much chemistry application on mobile to view chemical data tables, drawing chemical compounds, and 3D render of large molecules that student can download from RCSB Protein Data Bank. They discussed other chemistry mobile applications such as (chemspider) which use online large database contain millions of chemical compounds. They also discussed how to use mobile augmented reality application to change chemistry class room. These previous solution are content depended solution it's just applicable to specific content, other contents need more application or application customization, most of these application need training, purchase, and sometimes internet connection (Williams & Pence, 2011).

Zurita (2008) presented collaborative mobile learning application to be used inside classroom. The system called MCI-Supporter has two modules one for student and one for instructor. Instructor module enable instructor to view student, create groups and assign students to one of these groups then create a problem and send this problem to the group's device. There is one device for each group, students in the group working together in order to solve instructor's problem, some problem need all group members to agree the answer before it return back to the instructor. "MCi supporter" provide techniques to enhance pedagogical content and have no features for classroom management and take control over student mobile devices. MCI supporter have no central connection it's fully peer to peer connection which it can be used any time in any scenario but the problem arise that we couldn't return back to any previous learning session. There is no control from instructor over students' shared content or behavior. The ability of crating free hand problems with sketch makes it easy to build and create new problems during classroom session (Zurita et al., 2008).

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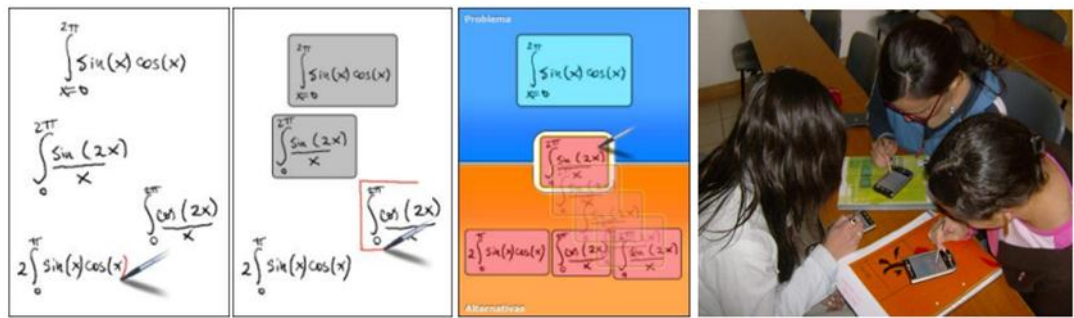
Figure (2.4): MCI-Supporter, sketch problems , group of students working together ,((Zurita et al., 2008)

According to our review of the previous mobile solutions conducted inside the classroom, especially the solutions that are similar to our solution, and have no dependency on learning content, we summarize the features supported by the previous solutions, to view which features this solutions supports. Table (2.1) shows these previous solutions along with their features.

Table (2.1): Class Management features supported by the previous studies

Feature Study	Monitoring	Data transfer	Assessment	Control and management	Link Class Assets	Pee to peer	Failover recovery
(Schweitzer & Teel, 2011)		✓					
Rawat, Riddick, and Moore 2008	✓	✓		✓			
Dekdouk 2012		✓	✓		✓		
(Zurita et al., 2008)	✓	✓	✓			✓	

It is obvious from the above comparison that there is no superior solution that supports all features that are commonly practiced or needed in the classroom. Each solution was often customized to a particular purpose such as classroom management or data transfer. In contrast, our purpose is to design one solution that provides all these features.

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The system proposed in this research fulfills the requirements of the students and the instructor in one solution. The proposed solution uses all the features (Table (2.1) that previous solutions support, and the features they did not support it.

2.3. Mobile technologies for collaboration and data communication.

The difficulty involved in designing collaborative mobile application come form that many groupware services not visible for designer. mobile collaborative application involve communication and coordination services that should be run on several devices services and have to integrate with large number of backend systems (Herskovic et al. (2011). As there is many technologies could be used in implementing a collaborative mobile application, the architecture of mobile collaborative application is the key of building well designed collaborative application (Neyem, Ochoa, Pino, & Franco, 2012) .

Neyem (2012) presented a reusable architecture design for mobile collaborative application. The architecture presented solutions for the problems of modeling communication and coordination services required to build collaborative mobile software. Mobile applications have the same requirements functional and nonfunctional requirements as any normal solution, the author build a list of these requirements should be satisfied when building mobile collaborative solution (Neyem et al., 2012).

- **User flexibility:** Automatic user detection online or offline, allow application to work offline or online on-demand.
- **User Interaction protection:** protect the user work and resource from unauthorized access.
- **Communication:** Is the base of collaboration and coordination, defined as the interaction between mobile users and exchange resource like message files alarms... etc.
- **Heterogeneity and interoperability :** Type or size of the device should not be limitation
- **Networking :** user should be aware of other users connection, disconnections

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● **Data consistency and availability:** Users offline work and the frequent disconnections of the user make inconsistency and unavailability of the data, therefore collaborative mobile application should address this problem using mechanisms like explicit data replication, caching and conflict resolutions (Herskovic et al., 2011)

Table (2.2) shows matrix of collaborative mobile applications requirement which one of them could affect the other requirement in positive or negative direction. Solutions that provide user flexibility for mobile collaborative applications will impacts negative on communication capabilities.

Table (2.2): Relation between mobile collaborative applications needs, Neyem et al. 2012)

	Protection	Communication	Heterogeneity	Networking	Awareness	Information Support
Flexibility		-		-	-	-
Protection		-			-	
Communication			-			
Heterogeneity						
Networking						
Awareness						+

$+ : x_i$ positively impacts x_i
$- : x_i$ negatively impacts x_i

Neyem (2012) proposed a layered and fully distributed architecture which collaborative mobile applications should follow. Figure (2.5) shows collaborative application architecture which structures the basic of collaborative mobile application:

- **Collaboration layer:** provide solutions related to the application front end and use functions provided by coordination layer.

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- **Coordination layer:** provide solutions for session management, peer detection, data synchronization, and notifications… etc.
- **Communication layer:** focus on message interchange between mobile users, this include broadcast message, unicast and multicast.

There was a hierarchical relation between these layer and every two adjacent layers interact directly using programming interface.
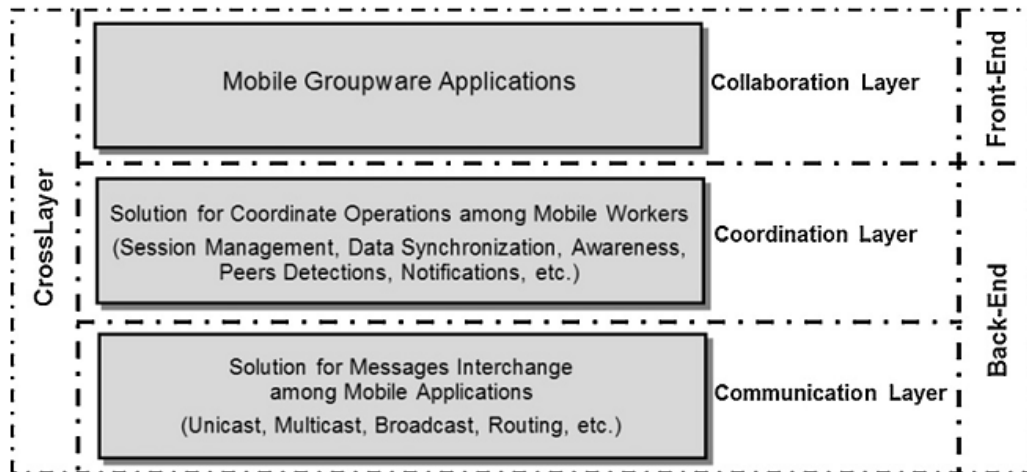
Figure (2.5): Layer architecture that support mobile collaborative applications, (Neyem et al., 2012)

Herskovic (2011) claimed that there is a gap between the collaborative application the user want and the final product because most of the collaborative application requirements including the most complex one are hidden requirements which makes the collaborative mobile application development process complex. In mobile collaboration, most of the activities are loosely coupled, the user work autonomously most of the time then do periodic collaboration process with the group (Herskovic et al., 2011). A list of simple nonfunctional requirements presented by the author should be satisfied in the collaborative mobile application, and then they organized collaborative system in space and time matrix Figure (2.6).
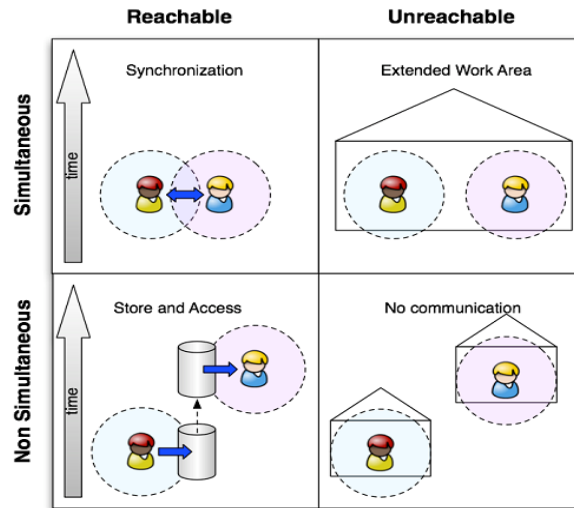
Figure (2.6): *Classification of collaboration scenarios*, (Herskovic et al., 2011)

Pino (2006) created a contextual element based framework that help to understand the collaborative application context through development process. As a result of this framework developers can identify a set of requirements and design restrictions to get contextualized application. The framework classified these context elements into eight categories. They claimed the framework support the process of analysis and design of collaborative application. The framework proposed based on authors' experience (Pino, 2006).

The framework had three phases "Conception, Analysis, and architectural design. We think this framework will be very helpful for us during analysis and design phase of our collaborative classroom system, because the majority of this framework elements should be applied in our implementation.

Communications and networks issues was the core of collaborative application development, so we should focus on the communication and network programing and protocols instead of focus on social groupware and other functionalities.

Rodriguez (2011) used mobile ad-hoc network (MANET) to support their collaborative implementation. MANET did not need any infrastructure to create a connection between devices, MANET create dynamic mesh between groups of mobiles to exchange messages (Rodríguez-Covili et al., 2011).

Rodriguez (2011) presented application programing interface which implement the HMLP (Rodriguez-Covili, Ochoa, & Pino, 2010) protocol which originally

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designed to support mobile collaborative work using Ad Hoc network. The API shows a good performance especially in high mobility situations HMLP API shows stability and robustness during file transfer operations (Rodríguez-Covili et al., 2011).

Many researches have been conducted on mobile cloud computing where most of the processing and storage done outside the mobile device (Dinh, Lee, Niyato, & Wang, 2013). Mobile equipped with large number of sensors such as high resolution camera, GPs, barometer, etc. which enhance the capability of mobile as collecting data devices. The data collected by mobile devices could be uploaded to the cloud and apply analytics and mining techniques on this large amount of data collected from millions of mobile devices (Wang, Chen, & Wang, 2015).

Wang (2015) discussed the Challenges in Building MCC Applications and provide survey of the existing solution and the important research about these challenges. Challenges like Code offloading code be solved by static code partitioning and local/cloud processing decision, other major challenges are task-oriented cloud services, elasticity and scalability, security, and cloud pricing. They claims that the future research direction is to apply and combine trusted techniques of cloud computing, ad hoc networks, sensor network into one solution that enhance quality assurance, services quality and security (Wang et al., 2015).

The architecture of mobile collaborative application is the key of building well designed collaborative application. The proposed system in this thesis follows the layered architecture for collaborative application discussed in the work of (Neyem et al., 2012). The proposed system architecture has three separated layers: communication layer, coordination layer, and the collaboration layer. There are general requirements that must be found in the collaborative system, most of these requirements are nonfunctional requirements such as user flexibility, communication, networking, data consistency and availability and user protection. In the proposed system we try to fulfill these requirements as possible because some of these requirements could affect other requirements in negative direction.

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2.4 Other technologies applied in classroom.

This section discusses technologies and techniques other than mobile that are used inside classroom. These solutions conducted inside classroom environment to enrich learning material, enhance collaborative learning or to provide better classroom management.

AlAgha (2010) explored the educational benefits of integrating multi-touch networked surface with the classic classroom environment. They presented interaction technique that facilitate instructor learner dialogue, enable instructor to manage, monitor, distribute learning material, and intervene in the group work. The multi-touch tabletop enables any group of student to access and share this surface simultaneously. This technique requires expensive infrastructure, large space classroom, and it is not suitable to evaluate students' progress individually as there is no way to keep student's privacy or separate his own work from others in the group (AlAgha et al., 2010).

Bargaoui (2014) proposed a model for smart class room that connect all devices like camera, computers, smart screen, projector and laptop through one network and one getaway to involve students in one technical environment that support collaboration and interaction. The system can take students presence automatically by RFID based identification. The system could project the instructor slides automatically after he start the slides. In addition, instructor and students have access to smart devices and the digital content (Bargaoui & Bdiwi, 2014).

Shen (2014) proposed a smart classroom that contains instructor side equipped with a multi-touch display and Microsoft SQL server database. The student side has a computer with multi-touch display, NFC cards and NFC readers and mobile devices support NFC. NFC play important role in this smart classroom; students will not make any configuration to connect via NFC. Student ID and other information stored on student's mobile device which enables connection to established quickly. Students can register attendance using his NFC tag or mobile. The system shows students' position in the hall and display student place in the class to the instructor. Furthermore, the system allows students to indicate his understanding level range from 1 to 5. This system aims to measure students attitude towards science, this

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system give instructor feedback form students about their understanding but have no concerns of class collaborative activities (Shen, Wu, & Lee, 2014).

Virtual reality have been used in classroom with 3D interaction and motion detection where student and instructor could navigate the virtual class room, the instructor could display the learning content to the student (Sharma, Agada, & Ruffin, 2013).

Shaema (2014) used Microsoft kinect to detect instructor motion to move instructor avatar in virtual environment. This technique needs expensive infrastructure to build, the application limited to number of virtual movements and interactions, any new learning material or interaction way needs the system to be customized (Sharma & Chen, 2014).

Billinghurst (2014) evaluated how augmented reality technology can enhance the traditional learning inside classrooms. AR required capturing and tracking devices, CPU, display system with graphic hardware and software. All the previous equipment could take many forms but this survey concentrate on two leading AR format, augmented books and AR application in handled device. They claim that AR systems specific to certain projects so it is hard to generalize AR evaluation results. AR places emphasis on the collaboration between user and technology but not between students and instructor or between students (Billinghurst & Dünser, 2012).

There is many techniques have been used inside classroom to enhance the learning and teaching activities. Integrating multi-touch tables inside classroom requires expensive infrastructure, large space classroom, and it is not suitable to evaluate students' progress individually as there is no way to keep student's privacy or separate student's work from others in the group. Virtual reality is suitable for virtual classrooms. Virtual reality applications are content based, so it is hard to have one general a system for any classroom. The same as virtual reality augmented reality techniques are content based and it is emphasis on the collaboration between students and technology but not between students and instructor or between students.

2.5 The proliferation of mobile devices.

Alzaza & Al-Kayyali (2015) investigated and evaluated the quality factors of mobile applications in a Palestinian university QOU (Alquds Open University). they found that the majority of the students have a smart mobile and Android operation system was the most popular platform. The Palestinian students have the knowledge and practice to use mobile device, and QOU university has the necessary infrastructure to deploy mobile services (Alzaza & Al-Kayyali, 2015).

Similarly (Alzaza, 2013) studied the opportunities of utilizing mobile learning services in five Palestinian universities. The study revealed that the students had awareness and knowledge to use mobile services. The majority of students owned a smart mobile device and their universities provided a wireless network in campus (Alzaza, 2013).

The popularity of mobile technologies between college students is increasing. Students found laptop as the most important device in the academic life (85 %), the importance of mobile devices such as tablets come next (45%), smart mobiles (37%) and e-book reader (31%). Nearly 67% of the students used mobile devise (Smart phones and tablets) for academic purpose a rate that nearly doubled in one year (Dahlstrom, Walker, & Dziuban, 2012).

Chen & Denoyelles (2013) explored students' mobile learning practice in higher education. The survey results showed that 91% of the respondents owned mobile device, 37 % owned tablet, and 27% owned e-book reader. 55% of the students who owned a mobile device use the mobile technologies for learning purpose while 82% of the studies who have tablet use it for academic purpose. The study indicated that students need support in how to use mobile technologies for learning. The study of (Jacob & Issac, 2008) found that students use mobile devices for learning because of many aspects such as the permanency of taking notes, multipurpose mobile devices hold work and entertainment, closer relationship between students and teacher, time saver, instant documentation by taking photos.

The previous researches show that the popularity of mobile devices and mobile technologies among students is increasing. Students use mobile devices for learning purpose in or outside the campus. The studies of Alzaza & Al-Kayyali (2015) and

Alzaza (2013) revealed that the Palestinian universities infrastructure supports using mobile devices for teaching and learning inside classroom. Most of the Palestinian students owned a smart mobile device and has the knowledge to deal with mobile application and mobile services. This research exploits the proliferation of mobile devices between students to support using mobile devices inside classroom for learning purpose.

2.6 Summary

In this chapter, we review researches related to our thesis. We classified the researches in this field into three main categories a) mobile solution conducted inside classroom b) Mobile technologies of collaborative applications c) Other technologies conducted inside classroom d) The proliferation of mobile Devices.

We present the works done to build a mobile-based class management system. We address the features provided by these solutions, and make comparison between these solution features. We outline how these solutions fulfill the needs of both instructors and students inside classroom.

We discuss the technologies and techniques used to build a collaborative mobile application; we address the specifications of an efficient collaborative application.

We review the technologies conducted inside classroom environment to enrich learning material, enhance collaborative learning or to provide better classroom management.

In the last section we review the spread of mobile devices and mobile services among the students specially Palestinian students and how the palestinian universities infrastructure supports mobile learning.

Chapter 3
Methodology

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Methodology

Class management system is an approach that realized by mobile software system that could achieve students' and instructor's needs inside classroom.Class management system is designed to enhance and support teaching process inside ordinary classroom regardless of students or subject. This system should provide a plethora of features that should fulfill the needs of instructors and students inside classroom, and meet the design principles.

The development process of the system follows the waterfall process model (Sommerville, 2010). Requirements analysis and definition is the first stage of the process model as shown in figure (3.1) then the system software and design by establishing the system architecture. The unit implementation and testing starts after the system design stage finished, every unit should be tested in order to verify that every unit meets its specification. The individual units integrated and tested as a complete system to verify that the whole system requirement have been met .After testing we can deploy the system for instructors and students.
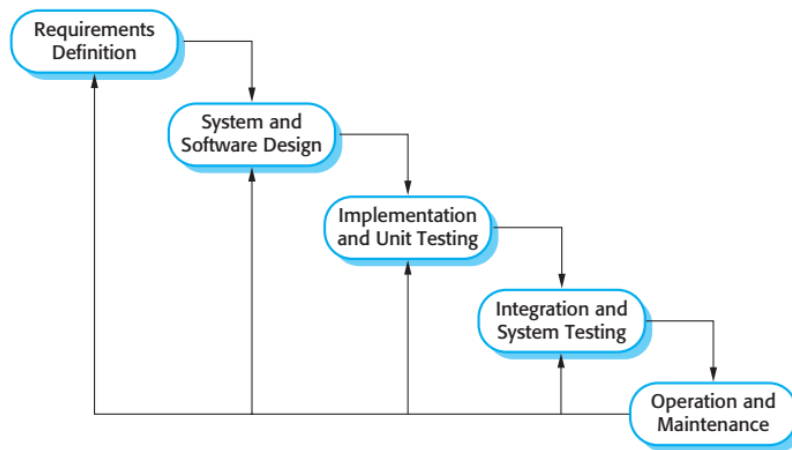
Figure (3.1): Waterfall model, (Sommerville, 2010)

Design principles:

Based on the analysis and the review of the previous studies, we set the following design principles for our system:

1- The system should allow the instructor and students to carry out ordinary learning activities. In other words, the system should not replace the conventional learning paradigm, but extent it by facilitating information sharing and classroom management.

2- The system should provide the instructor with the maximum amount of information including information about the student's activity and progress. Instructor could use this information to evaluate students or the whole learning process.

3- Information, such as learning material, should be reachable and accessible for both students and instructors. Information should be seamlessly shared and transferred without incurring significant effort or time.

4- The system should enhance communication and collaboration in the classroom.

5- The system should improve the classroom management and support the instructor in maintaining the discipline in the classroom.

6- The system should facilitate the communication and interaction between the various assets that exist in the classroom such as mobile devices, smart boards and printers.

7- The system should be easy to install and run by ordinary people.

The previous design principles will be revisited later in this chapter and in the evaluation chapter to ensure that they are reasonably met.

3.1. Requirements

The system should provide features (services) that achieve users requirements inside classroom, and meet the mentioned system design principles,

We group these requirements according to system users the instructor, student and supervisor.

3.1.1. Instructor Requirements.

- View a list of current online students inside class room: The system should inform the instructor of the identities of students in the classroom.

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- Send data (Files, Images) to all students or dedicated student; Learning material should be easily moved in the classroom without having the instructor and students to change their physical positions The proposed system should enable the instructor to send learning material and share it with students. In addition, several types of learning materials should be supported such as images, documents or videos. The transfer of learning material should be performed easily and instantly.

- Start conversation with any student inside classroom or broadcast message: Occasionally, the instructor may need to provide individual or group feedback to students. This can be achieved by enabling the instructor to start conversation with any particular student or a group of students. Students can also respond to the instructor's message using their mobile devices. This feature is essential to support individualized instruction and feedback that address the needs of different students.

- Build Tests, deploy it to the students and get results: Assessment is an essential activity in classroom learning the system should support assessment of student work. This can be achieved by using tests that are built by the instructor. The instructor should be able to deploy the tests on student devices and obtain results automatically. The system should mark student tests and present results on the instructor's device. In addition, several types of questions should be supported for classroom tests such as multiple choice, true-false, and short-answer questions.

- Allow or deny students from using their devices completely: If the mobile technology becomes allowed in the classroom, there will be a high risk to undermine the instructor's authority Mobile devices may cause students to loose attention in the lecture and to easily get distracted by texting to each other or using the Internet. Therefore, it is important to maintain the discipline in the classroom by enabling the instructor to control the activity in the classroom. Driven by this purpose, the instructor should be able to interrupt student's work at any time by locking their devices remotely from the instructor's device. This is necessary to maintain the progress of the

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learning activity and raise the students' attendance at any time during the learning activity.

- Linking students' devices with any assets inside classroom (Projector, printer, etc.). Today's smart classroom may contain different types of devices such as PCs, mobile devices, smart boards and printers. A learning technology in the smart classroom should be integrated easily in smart classroom in the way that enables the instructor to interact with the classroom equipment seamlessly and manage interactions between different devices. For example, the instructor should be able to link any student device to the smart board to show one particular work to the whole classroom.

- Monitor students' devices and keeping track of their activities: The system should raise the instructor's awareness of the activities being performed by students the instructor should be able to monitor the progress of tasks while being performed. However, the system should not breach the privacy of students by accessing their personal content or violate their activities that are not part of classroom learning.

3.1.2. Student Requirements

Besides the features that support the instructor's work and management of the classroom, the system should also support students through the following:

- Student can start a conversation with instructor, ask a question or provide feedback. This should be supported without interrupting other activities taking place in the classroom.

- Send data (files, images) to the instructor or other students inside the classroom. This feature is necessary to support group work when multiple students should work in groups to carry out particular tasks. However, data transfer between students within the classroom should be controlled by the instructor to avoid distraction and conversations that are beyond the learning topic.

- View instructor's tests and answer them. They should be able to receive feedback and/or test results after being marked. Student should be able to use

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assets in the classroom such as the smart board and the printer, but only after getting permission from the instructor to do so.

3.1.3. Supervisor Features

Supervisor should be able to keep track of all activities done inside classroom, use log information to monitor activities time and usage. This information should be stored inside central database which record any activity done by students or instructor inside classroom. Logging all activities carried out using the system will enable to get insights and analytics on the system affordances and limitations.

Figure (3.2) shows a use case diagram of class management system that display system users and use cases.
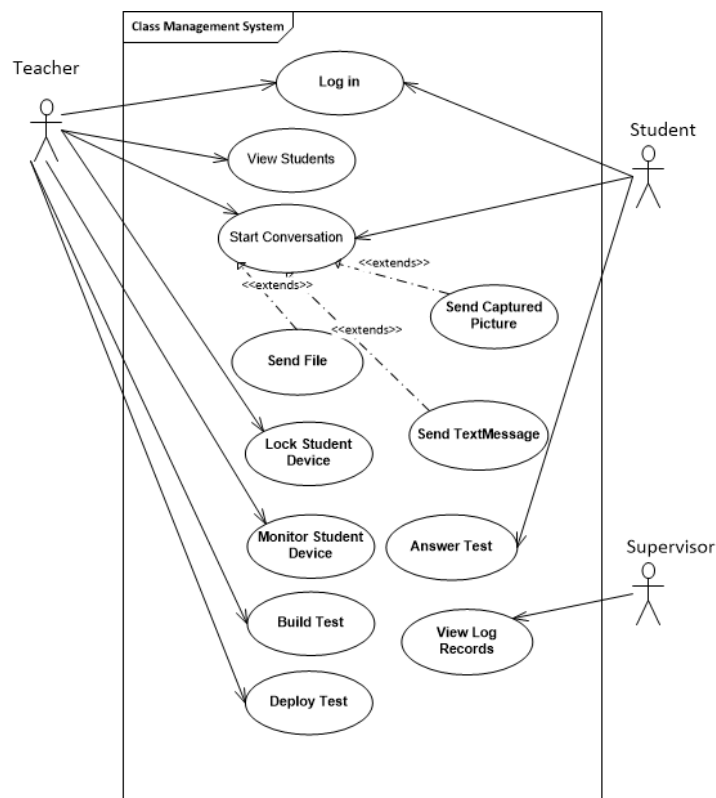
Figure (3.2): Class management system use case diagram

3.2. System Design

In order to build a class management software system that provides acceptable communication between students and instructor and improve the learning process, we should take care of some issues which include:

1. **Classroom:** Our system should be used inside classroom with the minimum number of equipment to run the system. The minimum equipment required for our system is a handheld device for each student, as well as a handheld device for the instructor. As we implemented our prototype system by using Android, the handheld devices should run Android. As there is wide spread of mobile devices that run Android and the considerable low cost of these device, this equipment can be easily made available in the classroom. The number of running devices depends on the network efficiency. In addition, the classroom may be equipped with other facilities such as a projector, a smart board or a printer. One of our objectives is to enable for rapid and easy transfer of learning material between devices of different types.

2. **Network:** All classroom hardware devices, including the handheld devices of the instructor and students, the projector and the printer, should be connecting to each other by using a robust wireless network. The network bandwidth should be high enough to handle the communications between devices. We adopted the client-server model where all devices are connected to a server machine, and all communications pass through that server.

We also decided to perform most heavy tasks such as the preparation of short tests and processing of learning material on the server side. The client software running of the handheld devices should be kept light-weight. This decision has two main benefits: First, making the client software compatible with a wide range of mobile devices including those with low computation power and memory. Second, make it easy to build client application for new platforms such as IOS.

The server receives requests from the clients (Instructor, Students), processes them and then redistributes results to other clients if it is required. All the

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clients will be connected using wireless local network. The server may be connected using wired link because mobility of server is not required. The number of clients (Students, because there is one instructor only) depend on the wireless network power. The number of clients could affect the network connectivity and server ability to serve the classroom. With acceptable wireless access point and a java server running on pc, the system could serve form 15-20 student (android client) per classroom.

We also design the system to be fault tolerant. This means that any client that accidently disconnects from the server can easily reconnect and restore it last status. The client status including its communications and any transferred data are recorded on the server. When a disconnected client reconnects it restores its status and recently received data and files from the server. The need to recover the client's status and data is also essential to address the limitations of many mobile devices that suffer from loose or unstable connectivity. Data recovery feature is also important from an educational perspective: by recording all clients' communications, sent and received files and taken actions on the server, it is possible to inspect the student's behavior by analyzing the recorded data. For example, the instructor can determine which students behave actively by messaging and discussing topics, which students remain passive during discussion sessions, what type of data is sent by each student, which students completed tasks or short test first, etc. In the evaluation of our system, we used the data recorded on the server to evaluate and track the system usage.

3. **Mobile Devices:** Mobile devices may have limited computation power, high disconnection rate, and limited battery power; all these limitations should be considered when designing our system. To achieve better flexibility and ease of use, it is also recommended that handheld devices have wide screens. With wide screens, it will be easy for users, an instructor r student, to interact with the application icons and components with bare figures. In the current prototype of the system, the user interface was designed to work on wide screens (7 inches or large).

3.3. System architecture

According to the previous issues we use client-server architecture to implement a mobile based class management system. Most of the processing will be done on the server. The server receives data requests from the clients (Instructor, Students) stores, processes it then redistributes it to other clients. The client server architecture was chosen for the following reasons:

First, the client server architecture helps in solving the problem of mobile device power and processing limitations because most the processing is done on the server. For example, the generation and correcting of tests will be carried out on the server

Second, the server stores the data after receiving it. Thus, a client that loses connection can retain this data from the server. This helps in recovering from errors resulting from network disconnections.

Third, the client server architecture enables system supervisor to keep track of all operations done on the system which make it easier to evaluate and develop both of the system and the learning process. For example, all communications between students, or between the instructor and students, and be tracked through the server.

All the clients will be connected using a wireless local network. The number of clients, i.e. students depends on the wireless network power. The number of clients could affect the network connectivity and server ability to serve the classroom. With acceptable wireless access point, a java server running on pc, the system could serve form 15-20 student (android client) per classroom.

3.4. Server Architecture

The Server receives connections from clients (Instructor, Students) inside the classroom, processes requests and delivers the required service. The server consists of three main layers Figure (3.3). The functions in each layer are encapsulated and separated from the adjacent layers. All layers communicate together in order to complete server services. These layers are:

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Communication Layer

The communication layer is responsible for message exchange between the server and clients. This layer uses two protocols to achieve two different types of communication: TCP and UDP protocols.

The TCP protocol is used to achieve reliable communication, such as tasks that require high reliability (e.g. file transfer, user login, sending messages, and control messages) UDP protocol to achieve fast though less reliable communication. This is required when the client should get fast response of certain requests such as when tracking student work, or pulling screenshots of student's handheld devices. Data loss in former examples may not be a concern.

The communication layer offers additional services to enable for reliable communication such as:

1- Automatic server discovery: When a client device connects to the LAN networks, it automatically searches a server. This is done by broadcasting connection-request messages to all connected devices. When the server receives a request for connection, it responds to the requesting client with its identification details, i.e. IP address, port. The client then establishes connection with the server.

2- Connection recovery: if a client losses connection with the server, it automatically tries to reconnect to the server.

3- Reliable data transfer: the communication layer was design to ensure data integrity. For example, data sent from a client to another is automatically cached on the server. If the target client does not acknowledge the receipt of data, the data will be resent to the client when it reconnects to the server. From an educational perspective, this feature is essential to avoid any conflict or interruption of the classroom activity, especially when the instructor deals with a larger number of students.

Note that the communication layer is implemented as a separated layer that is not integrated into other layers. This separation between the communication layer and other top layers is essential to enable the portability and flexibility of the system. For example, the communication layer can be extended or overwritten, without

affecting other layers, to enable for communication over the Internet, Bluetooth or any other network infrastructure.
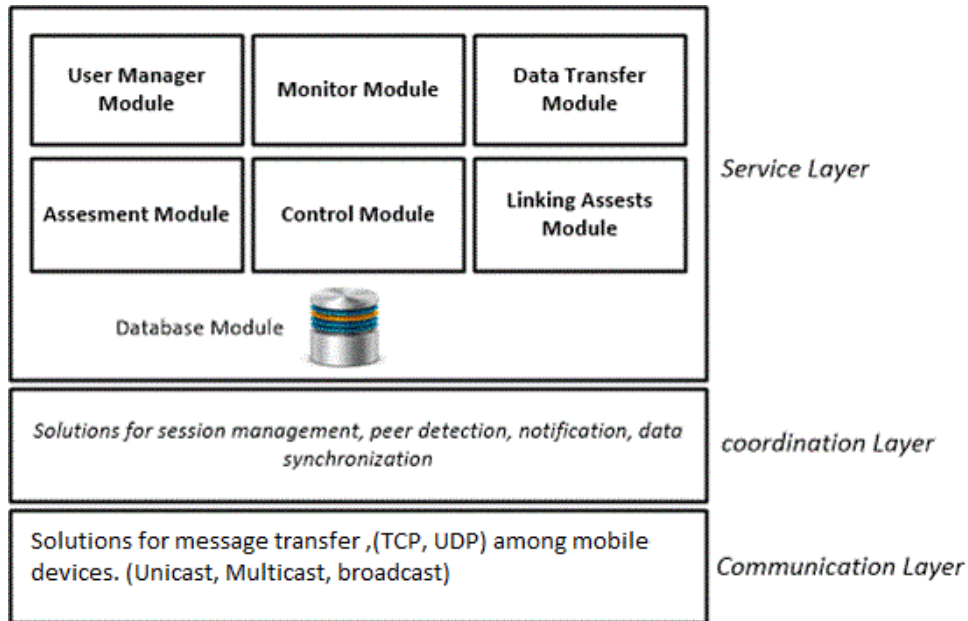
Figure (3.3): CMS, Server Architecture

Coordination layer

This layer is responsible for data synchronization between system parts. The major work of this layer resides on the server. Due to the high disconnection rate in wireless networks, this layer will manage sessions, peers detections, send notification to the clients.

Service layer

This is the core component that handles different activities and functions inside the classroom. This layer consists of several sub-modules as the following:

1) User Manager Module

The function of this module is to check login credentials and determine client type (i.e. Instructor or Student). According to user type, this module determines type of information to be sent and type of reports to be generated for the client. User manager is where clients' personal information is stored including the username,

password, and nick name and avatar image. It also keeps track of clients' status online or offline, as data should not be sent to an offline client.

2) Monitoring Module

One of the main objectives of the system is to enable instructor to track the student's activity during the classroom session. Meanwhile, it is essential to ensure that the student is not distracted or misuses his/her smart phone during the classroom session. This module should enable the instructor to monitor and keep track of the student's activity. This can be achieved by tracking touches on the student's devices, and other activities on mobile e.g. (browsing internet, open chat application).

All actions performed on the student's client application are sent to the Monitoring module on the server to be recorded. This happens in the background without disrupting the student work. The instructor notified only if there is important student actions.

In order not to disturb the instructor we should detect only important and suspicious student activity then notify the instructor. Therefore, the Monitoring module enable instructor to**:**

- View any student activities any time during the session. Student activities stored in log database. The log record includes the action name, time, and activity period if available. Stored records can be analyzed later to summarize the classroom activity, determine active and non-active students and clarify how students use their devices inside the classroom. In this thesis, the student's recorded actions were analyzed as part of the evaluation of the system.

3) Data Transfer module:

This module should enable Clients to send or receive files, images and start conversation with each other. This module may need to split large files into small chunks and then resemble these chunks on the receiving side. It also enables unicasting, multicasting and broadcasting of files and messages between the instructor and the students. Data module follows the following rules for any transferred information:

a) Files transferred and conversations inside the classroom session must be stored on the server to be retrieved later.

b) Server receives any files or images form clients then detects clients who should receive this data, then the server resends this data to the receivers if there is no restriction (e.g. instructor restriction) or a client become offline.

c) The server keeps records of transferred data for monitoring issues. These records include the sender's id, the receiver's id, the file name and time of sending.

4) Assessment Module

This module is responsible for the assessment of student's work through tests. It offers two main functionalities:

a) Creating and dispatching tests: This module accepts tests as XML files and converts then to an electronic format that can be solved on the student's devices. The instructor is responsible for building the XML file that represents the test questions. Any XML editing tool such as Notepad++ can be used for this purpose. The instructor should adhere to a specific format to represent different types of questions. Currently, the system can process three (multiple choice, fill gap and true or false) different types of questions. The instructor should set the questions as well as the answers to these questions so that the system can make correction results automatically. Figure (3.4) shows a sample short test file in XML file. Figure (3.12) shows the same file as rendered on the student's device. The instructor, through the instructor's app, can upload the test on the server then the servers distribute the test on the clients, or sonly elected clients inside classroom.

b) Correcting and reporting of results: After students answer the test on their devices, their results are sent back to the assessment module on the server where results will assessed based on the model answers. Results are then sent back to the instructor where it can be viewed.

Note that the assessment module resides on instructor, student's and server components. On the instructor's app, the assessment module handles the instructor's request to initiate the short test and send it to students. It also receives final results

and presents them to the instructor. The assessment module on the client side receives the XML file and converts it to a visual format that can be solved. It also collects answers, represent them in XML and send the generated XML to the server. The assessment module on the server receives results, marks them based on the model answers provided by the instructor, and caches the results in log databases to be reused in case of disconnect.

```xml
<exam>
    <question type="HEAD" weight="1">
        <q>رتب الاكواد التالي بالترتيب من 1-5</q>
    </question>
    <question type="MCQ" weight="1">
        <q>وحدة الكترونية تستخدم لتقويم التيار المتردد</q>
        <choices>
            <item stat="false">المكثف الكميائي</item>
            <item stat="true">القنطرة</item>
            <item stat="false">المحول</item>
        </choices>
        <answer>المكثف الكهربائي</answer>
    </question>
    <question type="TRUEORFALSE" weight="1">
        <q>تستخدم المرحلات لتوصيل دائرتين مختلفتين الفولتية</q>
        <choices/>
        <answer>true</answer>
    </question>
    <question type="FILL" weight="1">
        <q>يستخدم لخفض او رفع الجهد الكهربائي #gap#</q>
        <choices/>
        <answer>المحول</answer>
    </question>
</exam>
```

Figure (3.4): Short Test XML file.

5) Control Module

To give the instructor control over student's devices, this module resides on the server to receive lock or unlock request from Instructor device and then broadcast or unicast lock messages to students' devices. After student's device receive lock message it will be locked and there is no way to unlock device by students until instructor unlock student's device. The Server receives lock or unlocks messages from instructor then detects students who should receive this lock message then send it for them.

6) Linking classroom assets Module:

One of the main requirements of the effective classroom activity is to enable for seamless transition of learning material between the classroom assets. By classroom

assets we mean the hardware devices available in the classroom such as a smart board, a projector, and a printer as well as the instructor's and student's devices. For example, the instructor may need to examine one of the student's solutions on his/her own device and share it with the whole classroom. This module aims to facilitate the sharing of tasks by enabling seamless transition between the classroom assets. For example, the instructor can choose the activity on one student device and then show it to the classroom by projecting it on the screen. The instructor may also capture and send the screen of the student's device to the printer. The application on the instructor's device should allow him/her to perform these tasks easily.

In the current prototype of our system, we enable the instructor to link a projector to the classroom activity. We developed a special viewer application that runs on a PC connected to the LCD projector. Through the linking classroom module on the server, any learning material, either on the instructor's device or on any student's device can be transferred and displayed to the classroom via the viewer application. Figure (3.5) shows a snapshot of the viewer app as projected. The instructor can further manipulate the projected view by using some controls such as zooming in or out. . The linking assets module is responsible on managing the linking of students' devices to assess such as the LCD projector. It also communicates the instructor's requests to project or manipulate the learning material.
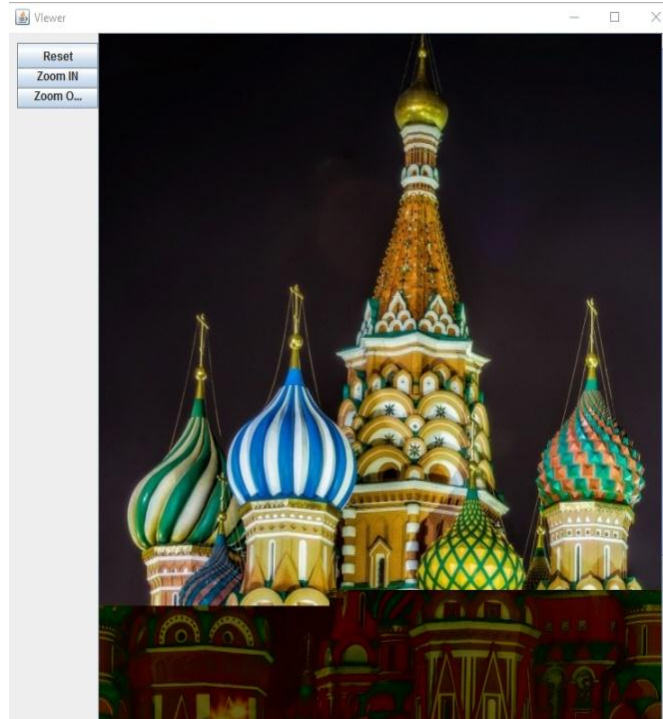
Figure (3.5): Display image form instructor device on the projector.

7) Database module

This module maintains data transferred over the server and all activities done by the clients in database records, so we can retain back these activities. Storing data in the database makes it safe to repeat sending any data in case of failure in client, server or network. Students, instructor or supervisor can retain back the classroom session activities or any data sent through the classroom session, which may help instructor in evaluating his/her students or helping supervisor to evaluate the whole system or the classroom, other modules inside service layer uses database module to store their activities or retain back a specific activity.

We use MySQL database as a database server. The server application stores all user information and clients log records and activities in the database. Log records hold information about message sender, receiver, content of the message, message transmit time, message type , and a flag indicate whether this message reach the receiver or not which help the system to recover any unreceived messages according to failover.

3.5. Clients

This section discusses the design of the client applications that were developed as part of our mobile-based classroom management system. The client's application is of three types: the instructor's app, the student's app and the asset's app (e.g. printer app). All client applications are mobile based and run on Android OS. We will provide an overview of both clients describing their design and implementation.

3.5.1. Instructor's Application

The instructor's application is a mobile application with features that enable the instructor to manage and control the different aspects of classroom activity. It was designed to enable the instructor to use services without disrupting the normal teaching activities in the classroom. For example, the instructor can send learning material to student devices, pull screenshots of student's works, show learning material on the projector, initiate tests and control student devices.

The instructor's application consists of three main layers as shown in Fig (3.6): Each layer has functions encapsulated separated from the adjacent layers, but the layers communicate and work together to provide the instructor serveries we discussed previously in this chapter. We will show how these services fulfill the needs of instructors inside classroom and how they meet the design principles that we discussed at the beginning of the chapter.
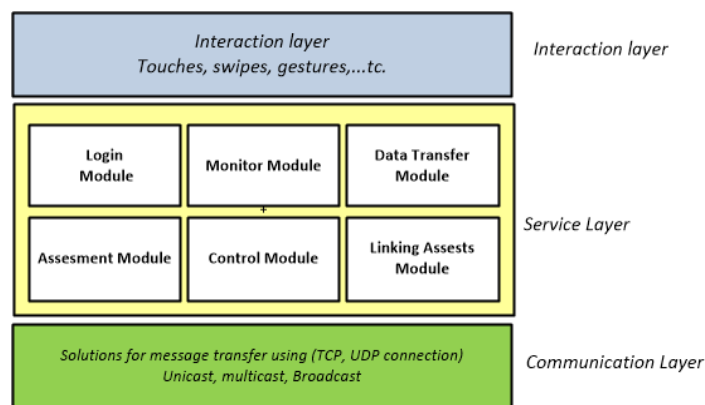

Figure (3.6): The Instructor's client application

1) Interaction layer: This is the top layer that accepts user interaction with the application according to the mobile interaction paradigm such as touches, swipes, long touches.

2) Services Layer: The core component that handles classroom activities, this layer consists of several modules that handle the functions of instructor client. These modules are as the following:

Login module: Instructor supplies his/her username and password then login module sends account details to the server Figure (3.7). Login module ensures that the user session remains action when the application is paused or sleeps. Because of high disconnection rate in wireless network, the login module automatically reconnects client with the server if connection is lost for any reason.

Monitor module: This module supplies the instructor with a list of current online students and student status if a student goes offline. This is essential to raise the instructor's awareness of student activity and status in the classroom.

The instructor also uses the monitor module to monitor student devices screen, to detect any suspicious behavior of students. When the instructor logs in for the first time, the server sends a list of current online students to the instructor client Figure (3.8). At any time, the instructor can choose some students to monitor their devices. The monitor module will capture the application's view on the students' devices and display them on the instructor's device. Figure (3.9) shows miniature views of two student devices as presented to the instructor. Several actions can be applied on each miniature view: Each miniature view can be enlarged and showed on the projector. The instructor can also request an updated screenshot of each device. In addition, by showing views of students' devices next to each other, the instructor will be able to compare students' works.

Data Transfer module: This module is responsible for:

1)   Starts conversation with a student or group of students inside classroom. Students can chat view each other during the classroom session. This feature, which can be activated or deactivated by the instructor, can be exploited to support group work in the classroom. In addition, students can communicate via mobile chat without having to be physically close to each other.

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2) Handles the process of sending files to the students or receiving files from the students. This module enables unicast, multicast, broadcast, messages, and files from instructor to the students. Students can also share files and images, a thing that may be useful for group work. Instructor could receive multiple files from students simultaneously, no matter what the file size large or small.

Figure (3.10) shows how the instructor could send a message to the students inside classroom; instructor can start conversation with any student inside classroom, send files and images to the students.
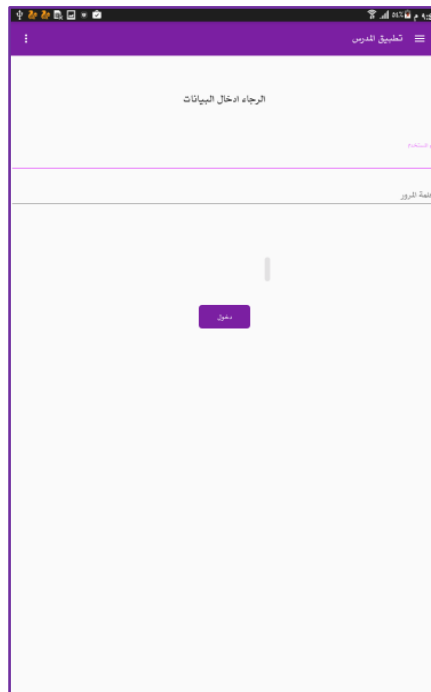
Figure (3.7): Login screen.
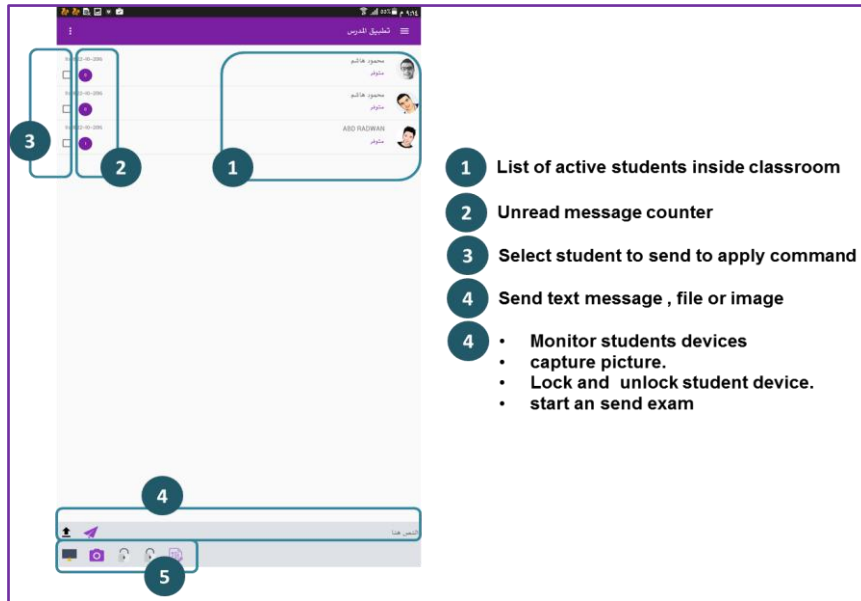
Figure (3.8): Active Students list.
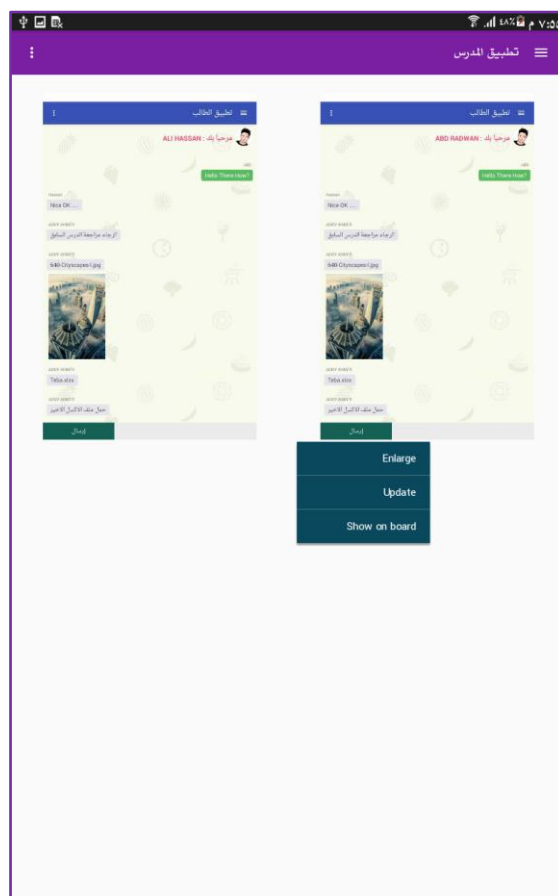
Figure (3.9): Instructor Monitors students' devices

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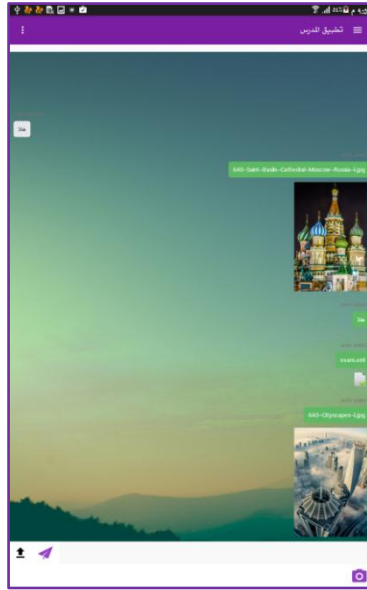
Figure (3.10): Conversation between Instructor and Student.

Control module.

This module enables the instructor to take control over students' devices. The instructor can lock students' devices in order to prevent students from using their devices. This enable instructor to draw the students' attention and promote discipline in the classroom. The instructor can send lock message to a specific student or all students inside classroom Figure (3.11). To unlock student's device the instructor should send unlock message from his devices, or gives the student the unlock key.

Assessment Module:

Instructor should be able to create tests to examine students, assessment module enables instructor to build and initiate tests to students' devices. The test easily could be built and written using XML and then imported by the assessment module. Several types of question are supported (MCQ, True or false, Fill the gap). Other types of questions could be also supported in the future. After the instructor sends a test to a student device, the student starts to answer questions. After finishing the test, it will be corrected on the student's device if the correct answers are provided with the questions in the XML file. The test score is returned back to the instructor's application. The assessment module receives

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scores from all students' devices and displays them on the instructor's device; Figures (3.12, 3.13) shows how the instructor sends and starts a test. The instructor can send the test to one student or more, and he can send different test for each student.

Figure (3.11): The instructor locks student's device

Figure (3.12): Test On Students device.

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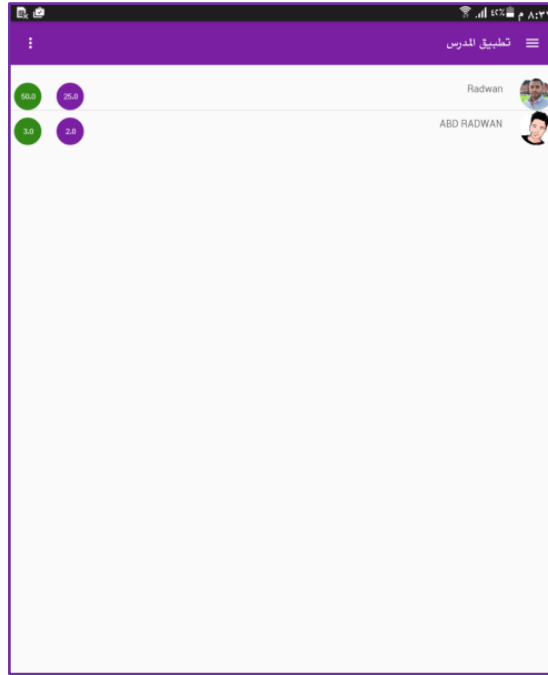
Figure (3.13): Test result return back to the instructor device.
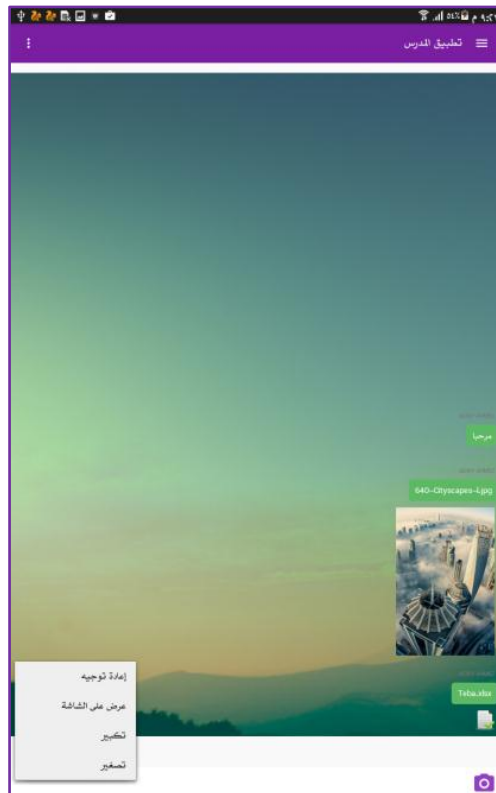
Figure (3.14): Instructor projects a file received form the student on the board.

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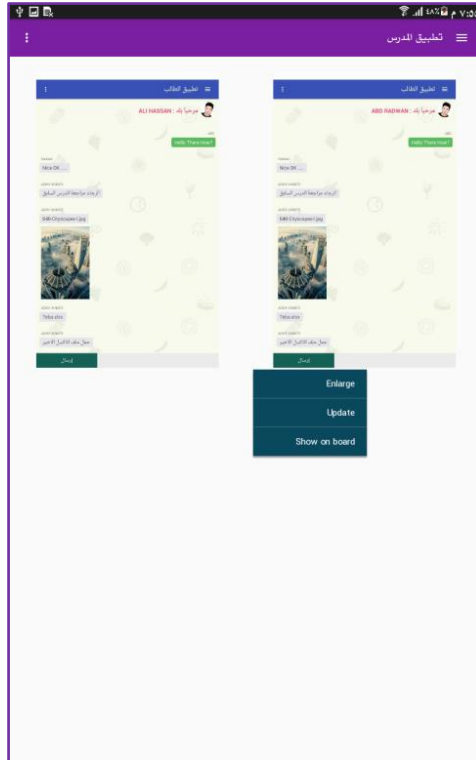
Figure (3.15): Display student's device screen on the projector.

Linking assets Module.

This module links mobile devices with assets such as printer or projector. Learning material such as images, files or screenshots of students' devices can be sent for printing or projecting. This module communicates with the assets linking module on the server which handles the communication between devices and assets. The linking module on the instructor's device is responsible for sending instructor's requests to the server side.

3) Communication layer: This layer is responsible for message interchange between server and clients. It uses both TCP and UDP sockets based on the type of communication.

3.5.2. Student's application

The student's application is a mobile based application that runs on students' android mobile devices. The student's application is used by students to access class management system services inside class room. It has three layers: interaction, services, and communication layers.

1) Interaction Layer.

This layer consists of application GUI that accepts user gestures and touches to access application functions.

2) *Services layer.*

This layer consists of modules responsible for student's core functions that include:

A. ***Login module:*** After a student supplies username and password, login module registers student on CMS server. Login module reconnects student with the server if the connection is lost for any reason, keeps classroom session as long as possible. It is also responsible for signing out client from the server.

B. ***Monitor module:*** This module receives monitor requests from the instructor's device then sends a status message about student's device to the server or sends a device's screenshot to server (student's application sends screenshots repeatedly after a pre-determined time).

C. ***Data Transfer* Module**: Manages conversation between student's application and instructor's application. It is used to receive or send messages and files to the instructor or other students inside the classroom.

D. ***Control module:*** receives lock messages form instructor. After lock message received the student will not be able to use his device until the instructor sends unlock message to the same device.

E. ***Assessment module:*** Receives test files form instructor. Test files are received in XML format. Thus, this module parses the received test file to extract the questions along with their answers. It then built the visual interface of the test and presents it to the student. After the student answers the test, the assessment module marks answers by comparing student's answers with correct answers extracted from the XML file. It then sends the test score backs to the instructor.

F. ***Linking Assets module:*** This module enables the student to display his/her device on the projector or print it out

4) **Communication layer:** Responsible for message interchange between the server and student's application. It used TCP or UDP sockets.

3.6. Summary

In this section we create a mobile system for learning inside classrooms, we follow the design principles we define it during the implementation process, these design principles collected and grouped from our experience and related work review. The system should provide a group of services and functions for both of student and instructor to obey their needs.

The system follows the server-client architecture, the server side does the most of the services processing. The server composed of several layers. The service layer contain the main functionality of the system, it has a module for control students login, a module for data transfer, module for monitoring mobile devices, control devices module, assessment module, and linking mobile with classroom assets module.

The system has two types of clients, teacher and student clients. These clients software will be deployed on the mobile devices while the server deployed on pc or mac device. The clients of student and teacher have the same layered structure and the same services modules, but the functionality of some modules such as control module and assessment module haves different functionality in the student's and instructor's side but they integrate together to make a complete service.

Chapter 4
Evaluation

Chapter 4
Evaluation

This chapter investigates how mobile-based classroom management system could be used inside classrooms, and to what extent the presence of mobile devices inside ordinary classrooms can support or hinder learning and teaching. As a case study, we report on the experiments we conducted to explore how our mobile based management system operates inside a classroom for teaching java programming language for university students.

The mobile-based management system was assessed with respect to:

1- Student: Student based assessment was performed by conducting an observational study in which the system was used in practice to teach undergraduate students. The system was then assessed by analyzing the use of the system and reporting on main observations. We also collected subjective comments by means of questionnaire.

2- Instructor: The system was also demonstrated to a group of 14 instructors. Instructors were then asked to fill in a questionnaire which aimed to explore the instructors" perceptions of the different features offered by the system.

The decision to conduct an observational study rather than a comparative study was motivated by the following:

First, comparing our mobile-based learning with the traditional learning in classroom will be biased and trivial because the two settings are not comparable. The main purpose of the mobile-based system is to exploit technology to facilitate management and communication in the classroom. In addition, comparing learning outcomes with and without the technology will not present significant results because learning outcomes are more related to the teaching skills than to the technology used in the classroom. However, we think that the mobile technology will indirectly enhance the teaching skills by facilitating the management and control of the learning activity in the classroom.

Second, we are unaware of mobile–based learning systems that we can compare our system with. Although there are various commercial solutions that have different

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features, and they are not specifically designed for learning and teaching inside classrooms (e.g. remote learning).

Driven by the above reasons, we decided to conduct an observational study in which the system was used in a realistic classroom configuration. All actions that emerge from the instructor and students were recorded and analyzed. The aim was to explore how each of the system's features was used, and to what extent it was helpful to the instructor and the students.

We used technologies like computers, smart boards, projectors and other technologies inside class to enrich learning material or to enhance the whole teaching process; we exploited the existence of mobile device to reinforce teaching process and class management system inside classroom with less equipment and without change the ordinary way inside classroom.

In our investigation, we aim to answer the following research questions:

Question A: Does the system support the instructor-student interaction in the class?

Question B: Does the system facilitate the sharing of learning material in the classroom?

Question C: How does the instructor manage students' questions and notices during the classroom session?

Question D: To what extent instructor could use the system assess the levels of students?

Note that to answer these questions; we recorded observations of the system usage in the classroom. We also recorded all actions performed on the system by both the instructor and the students. Student's perceptions of the system were also investigated through a questionnaire. We then inspected the collected data and observations, and mapped the results to the research questioned mentioned above.

4.1. Method

Through early stage of the research, we build a prototype of the system. We presented the system prototype to a selected group of instructors (14 instructors) from universities and schools, we showed them how the system works and what

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features are provided. A questionnaire was distributed on the instructors to discover if they find the system useful in the classroom, and why (see Appendix A). The questionnaire asked the instructors to evaluate the importance of every feature of the system and what further features should be supported. The questionnaire results discussed later in Section (4.4)

4.1.1 Usability Test

The international stander ISO 9241-11, defines usability as: "Extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.". The usability of the CMS evaluated using questionnaires and observations methods. The questioners designed based on USE questionnaire (Lund, 2001). The questionnaire suggested that users were evaluating the products using three dimensions, Usefulness, Satisfaction, and Ease of Use (Lund, 2001).

The questionnaire consisted of fifteen questions: seven questions to measure student's satisfaction and ease of use, the other five questions to evaluate the quality and usefulness of the services that the system provides. The former questions should be answered using a 4- Likert-scale. The remaining three questions are open questions to get subjective feedback from students. The student's questionnaire can be found in Appendix B.

In order to understand and explore how mobile based system works inside classroom we should monitor system usage inside real classroom. The system will record every activity done by students and instructor inside classroom. We used log records in order to determine type of interactions, the interaction frequency and duration.

The evaluation process of CMS was done in a real classroom for teaching java programing language for University beginner students. We designed a case study of how students and instructor could use mobile CMS inside real classroom. The case study includes instructions that direct the instructor inside the classroom to use the system efficiently. Two types of data will be collected from students and the instructor during the classroom session: quantitative data and qualitative data. Quantitative data are determined from the log records on the server. The log record

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stores information about who has initiated a class management system activity, others who collaborate or share this activity, the activity duration and type. The data collected form server log records provides us with quantitative information about CMS usage inside classroom which include:

- Total Time of interactions.
- Duration of each interaction
- Number of clients involved in the activity.
- Frequency of using a service by students.
- Frequency of using a service by the instructor.
- Frequency of service failure.
- Students' levels based on the given tests.

Qualitative data was collected by means of questionnaires. Questionnaires were distributed over students at the end of the classroom session. The questionnaire focuses on the usability of the system, and the user's satisfaction of the services (functions) offered by the system (see Appendix B). Students were also asked to comment on the features they liked most and least in the system, and about their suggestions to improve the system in the future.

4.2. Study setting

This section describes the experiment setting we applied in order to collect data and evaluate the system. We used our mobile based system to teach for an introductory programming course in Java.

The Course is Java programing language for beginners.

Computer science students could be   more open to use new technology in learning a computer course like java programming.

Number of students: From 8 -15 student

Student's device: A mobile device with 7 inches screen at least (student will use same devices model)

Instructor's device: Instructor application installed on one mobile device only (Instructor's Device) inside classroom.

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Server: Computer with normal accepted speed.

Other equipment: projector and Printer.

- At the beginning of the classroom session instructor should ensure that all students login to the system. Instructor will follow the instruction he found in the "Learning procedure "(Appendix C). Students use class management system according to instructor's instruction he found in "Learning procedure".

- Students and instructor fills the questioner after classroom session finished.

We use observation to detect how instructor and students interact with the system during the session. Any noticeable events or activities recorded during the session.

4.3. Learning procedure

To be sure that instructors and students will use the system as expected, we customized the learning material of a selected Java course lesson. We gave the instructor instruction about how he will use the application during the lesson. Appendix C shows the full content of the lesson and the steps that the instructor should follow during the lesson including the learning material to be presented and the quizzes to be sent to students. The design of the lesson was done in cooperation with the instructor who provided the PowerPoint slides, questions for quizzes and decided the order of the teaching steps. The learning procedure can be found in Appendix C.

4.4. Results

4.4.1. Results of Instructor's Questionnaire

Through the early stages of this research we built a prototype of the system. We presented the system to a selected group of instructors. The system was presented to the instructors. Afterwards, a questionnaire showed in Appendix (A) distributed on the instructors to measure their satisfaction, and how they evaluate the system services.

Table *(4.1)* summarizes the questionnaire results obtained from 14 Instructors involved in the study. Note that the 5-likert scale was converted to numerical values (1> lowest importance to 5> greatest importance).

Table (4.1): *Instructors' Questioner Results*

Total number of participants	**14 Instructor**										
QA. Do you think that the system will be useful in the classroom?	9 (Yes)	2 (Kind of)	3 (NO)								
Question / Evaluation	Very Large	large	Moderately	Little	Very little	Very Large %	large %	Moderately %	Little %	Very little %	Mean
1. Students login and display list of current online users	8	5	0	2	0	57%	36%	0%	14%	0%	4.43
2. Instructor ability to control students devices	11	1	0	2	0	79%	7%	0%	14%	0%	4.5
3. Students' ability to view learning material on his device	6	5	2	1	0	43%	36%	14%	7%	0%	4.14
4. Transfer and share files between Instructor's and students' devices.	8	5	1	0	0	57%	36%	7%	0%	0%	4.5
5. Transfer and share files between students' devices.	4	8	1	1	0	29%	57%	7%	7%	0%	4.07
6. Build and deploy short tests	7	4	2	1	0	50%	29%	14%	7%	0%	4.21
7. Automatic tests correction and viewing results	6	4	2	2	0	43%	29%	14%	14%	0%	4.00
8. Linking Instructors and students devices with display projector or printer	7	4	3	0	0	50%	29%	21%	0%	0%	4.29
9. Instructor's ability to monitor students' devices	9	3	2	0	0	64%	21%	14%	0%	0%	4.5
10. Conversation between students and instructor or students each other	5	5	4	0	0	36%	36%	29%	0%	0%	4.07

Results from table 4.1 show that:

(QA) ask the instructors if they found the system useful and why, the result was as follow:

- Most instructors thought that the system can be useful inside their classrooms **(9/14 instructor).**

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The instructors believe that the students like to use technology in learning, and they find it more interesting. They think the system will save the classroom session time and the instructor time and effort. The system will encourage students to be more collaborative and less shy to ask questions or giving opinion.

- **Three Instructors** found the system **unuseful** inside classroom.

  The instructors explained this result by indicating that mobile devices could distract students' attention or the system could be expensive to deploy inside the classrooms.

From table (4.1) we found that all the services we presented to the instructors is significantly important, these services are:

- System login.
- Instructor's control of students' devices (i.e.: lock, unlock) students devices.
- Students' ability to view learning material.
- Sharing files between students and instructor or between students.
- Make short tests.
- Automatic tests correction and display results.
- Linking classroom assets.
- Monitor student devices.
- Conversation between students and instructor or students each other.

When asked about any extra features they want to be added, instructors suggested the following:

- The ability to send classroom learning material and tests to the students' emails after the end of the classroom session.
- The system should support mathematical equation signs and using pen to edit images or writing on learning materials.
- The parents should have ability to view and track the classroom activities especially for the students in primary and secondary schools.

4.4.2. Results of the Observational Study

Main Observations

We collected usage data from two groups (male, females) of university students undertaking java course for beginners see Figure (4.2). As we mention before the system kept track of all interactions done by the students or the instructor.

We monitored how the system was used during the classroom sessions. We monitored how the students and the instructor interacted with the system and how they used the system services during the classroom sessions.

The instructor's and students' behavior in the classroom is reported through the following observations. Photos are shown to illustrate these behaviors:

1. Initiating the learning session:

The instructor asked his students to login to the system using their ids. When each student logged in, the list of online students was instantly updated on the instructor's device as shown in   Figure (4.1).
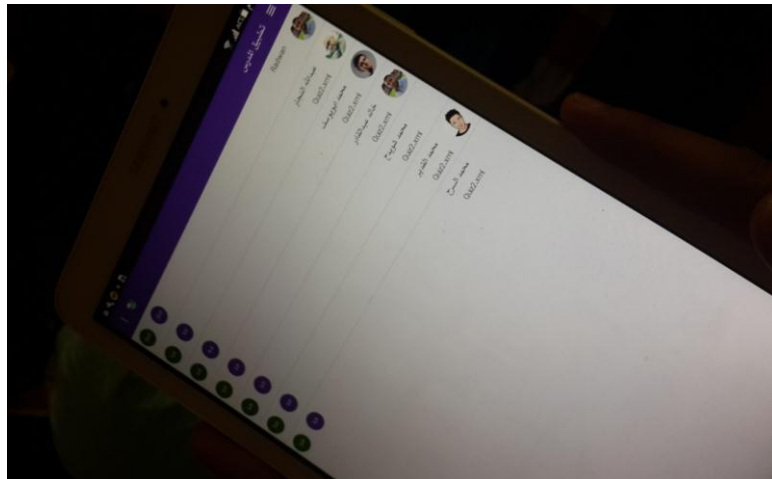
Figure (4.1): *Students appear on the instructor' application*

Figure (4.2): The students inside the classroom

2. Sharing learning material:

The instructor started the lecture by sending the learning material to students' devices. For example, Figure (4.3) shows a learning material, i.e. an image, as it was viewed by a student though his device. This learning material was sent by the instructor, who also shared it on the projector to explain to the whole classroom.

Sharing learning content by sending to students' devices and viewing it on the projector is an activity that was frequently performed by the instructor. We noticed that although the learning material used to be projected on the board, most students preferred to look at the material through their own devices rather than watching the projected view on the board. This observation can be explained by the fact that using personal devices for reading was more comfortable since they do not need to frequently bend their heads or change their sitting direction to look at the board.

Sharing learning material by either sending to student's device or by projecting the material on the project see Figure (4.4) was the most common activity performed by the instructor during the sessions.

3. Locking student's devices:

In some occasions, the instructor wanted to draw the students' attention to the projected view, or wanted to write some examples on the board. In such cases, the instructor opted to lock students' devices so that they could focus on the projected view only Figure (4.5). The locking features were used several times by the instructor to force students to look at the projected view instead of their personal devices.
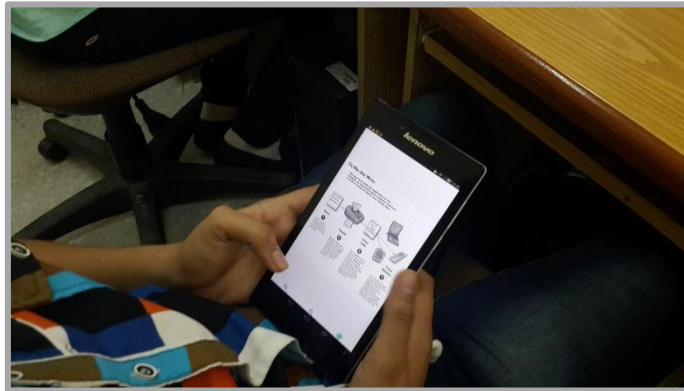
Figure (4.3): Student view a learning material sent by instructor

Figure (4.4): Instructor Projected learning material on the Board

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Figure (4.5): Instructor lock students' devices to deny them form using it.

4. Evaluating students:

After discussing and displaying the learning material, the instructor sought to evaluate his students by sending a short test on their devices. Figure *(4.6)* shows a test as displayed on the student's device. The test consisted of several types of questions including multiple choice and short answer questions. While answering the test, the instructor used to monitor students devices to assess their progress. *Figure (4.7)* shows the instructor's device whereas multiple snapshots of students' devices are displayed.
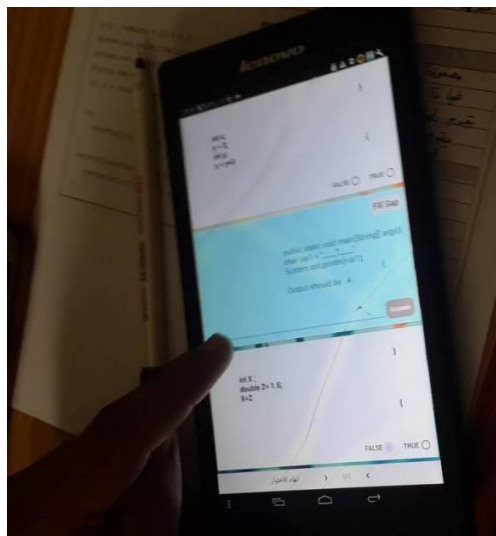
Figure (4.6): Student answers a test sent by the instructor

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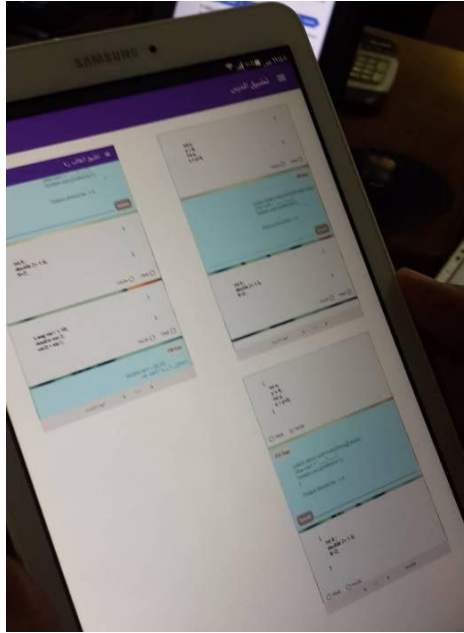
Figure (4.7): Instructor monitors student devices while they answering a test.

\- Once any student completed the test and submitted the answers, a notification sent to the Instructor. The Instructor could watch, on his device, the results of each student's test.

\- Another type of tests that was used is written tests. Students were given paper sheets showing code snippets. They were asked to guess the meaning of each line of code. Students wrote answers on the paper, and were then asked to take a photo or their answers by using the camera of their devices (see Figure *(4.8)*). Each student should then send his captured image to the instructor.

Figure (4.8): Student capture image of a training paper.

After receiving answers of captured images of the written test, the instructor reviewed the answers one by one. To share discussion with students and to comment on individual solutions, the instructor sought to select one answer and show it on the projector as shown in Figure *(4.9)*. The instructor performed this activity multiple times to discuss answers of multiple students and discuss correct answers or mistakes with the whole classroom. A problem encountered by the instructor in this activity was the low resolutions of captured images which made the handwritten text barely readable. However, this problem can be resolved by using devices with higher resolution camera.
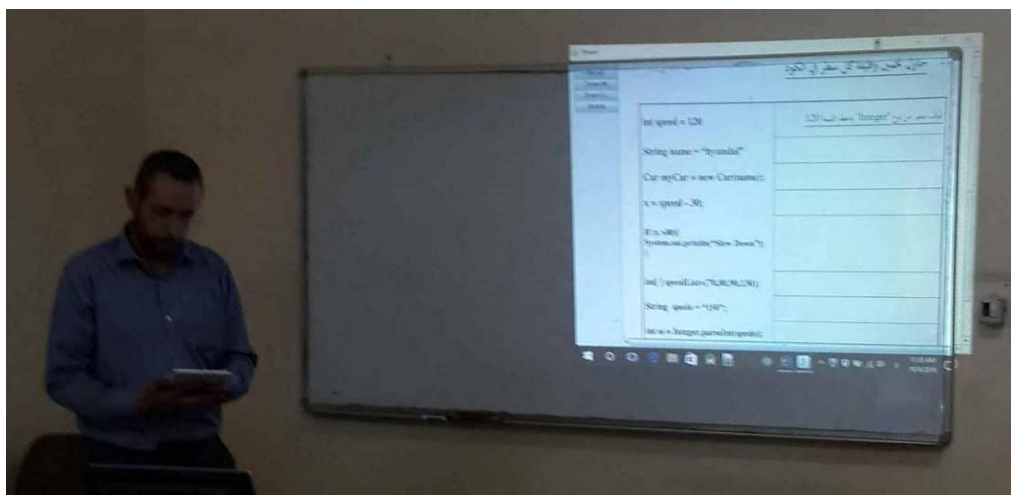
Figure (4.9): Instructor displays image captured by student's device.

After we reported on the main actions undertaken in the classroom, we also report on system features that were not frequently used. Of these features, the ability to send text messages between students or between a student and the instructor. Students and instructors preferred to communicate face to face instead of texting each other. In contrast, we found that this feature may distract students by inducing them to chat with each other. The instructor sometimes noticed this distraction and sought to raise the students' attention by locking their devices and asking them to pay attention.

4.4.3. Data Usage.

We analyzed the data form the log records on the server in order to identify what services were used, and how often and long each service was used. Tables (4.2, 4.3) and Figures (4.10, 4.11) show the service types and frequency of using each service in the two conducted classroom sessions. Note that a single broadcast event is counted with respect to the number of recipients. For example, the action of broadcasting a file to all students will be equal to the number of students receiving the file. *Table (4.4)* and Figure (4.12) shows the average time consumed by each service during both classroom session of group (A) and (B), we did not make a separate table for each group because there is no significant different between both groups.

Group A (Male), Number of the students: 11.

Classroom session duration: 1.5 hour.

Table (4.2): services usage frequency

	Service	Frequency
1	Login service and reconnect	80
2	Text Message Between Students	30
3	Text Message Between Students and Instructor	2
4	Send picture or file	113
5	Show image on board	14
6	Show Student Device on Board	8
7	Number of monitor students	48

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	device request	
8	Lock student device	11
9	Unlock Student device	10
10	Start Short Test	40
11	Exam Result	34
Table 4.1 :		
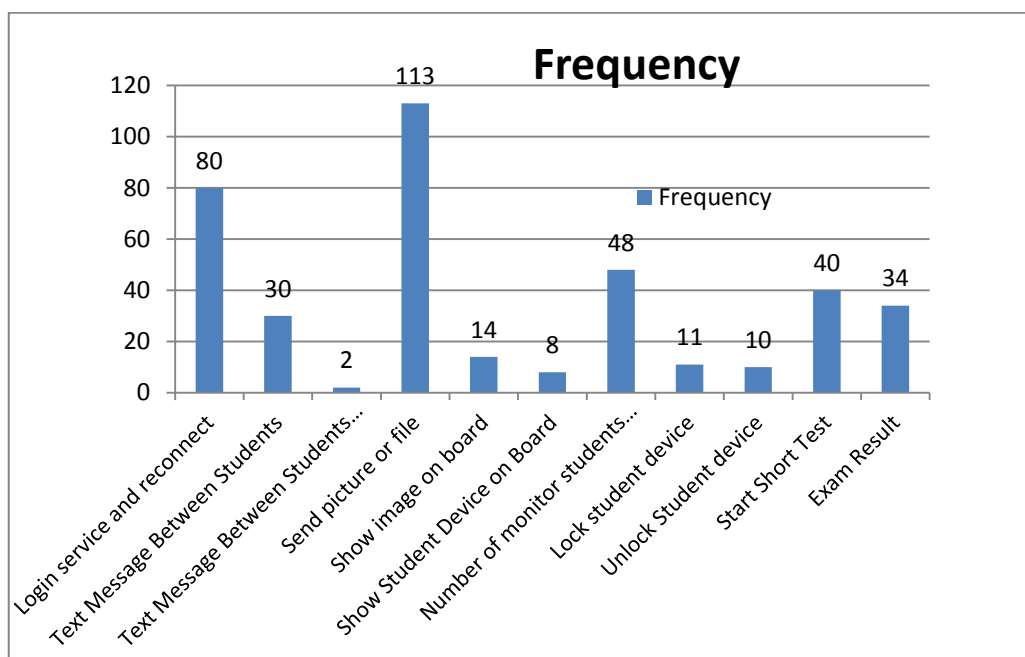
Figure (4.10): Service Usage frequency during classroom session, Group (A).

Group B (Female) Results,   Number of students: 9

Session duration: 1.5 hour.

Table (4.3): Services usage frequency

	Service	Frequency
1	Login service and reconnect	20
2	Text Message Between Students	8
3	Text Message Between Students and Instructor	9
4	Send picture or file	80
5	Show image on board	11
6	Show Student Device on Board	9
7	monitor students device request	20
8	Lock student device	30

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9	Unlock Student device	28
10	Start Short Test	26
11	Exam Result	23
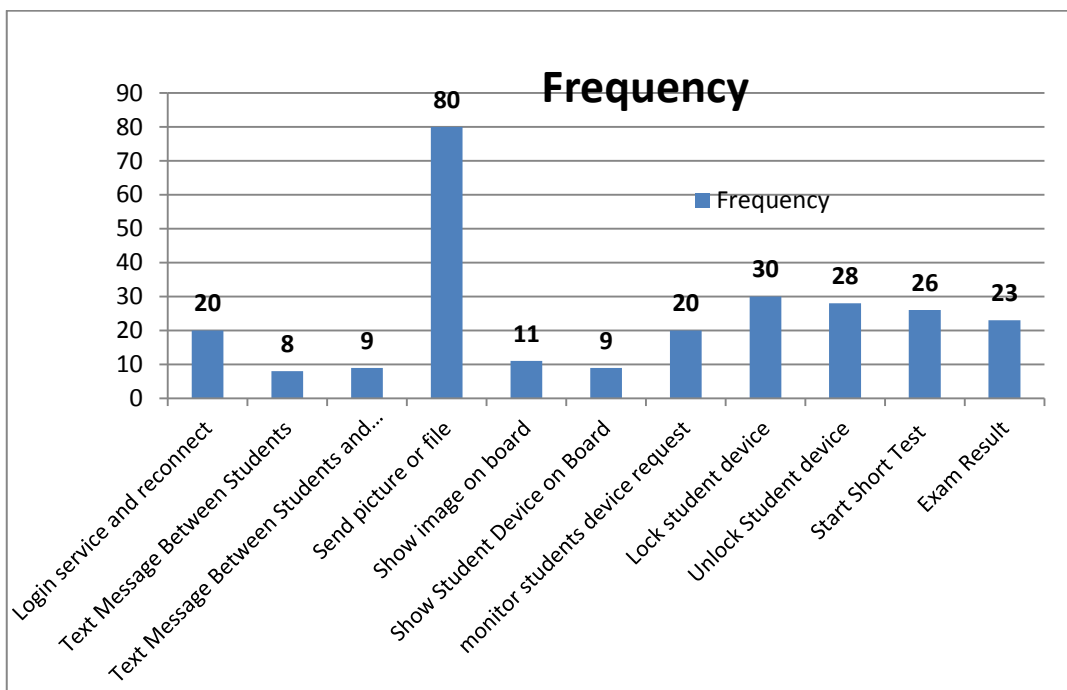
Figure (4.11): *Service Usage frequency during classroom session, Group (B).*

Table (4.4): classroom services and time consumed by each service.

	Service	Duration
1	Login service and reconnect	2 minute
2	Text Message Between Students	1 minute
3	Text Message Between Student and Instructor	1 minute
4	Send picture or file	7 minutes
5	Show image on board	35 minute
6	Show Student Device on Board	7 minute
7	Lock student device duration	8 minutes
8	Start test and receive results(2 Tests)	4 minute
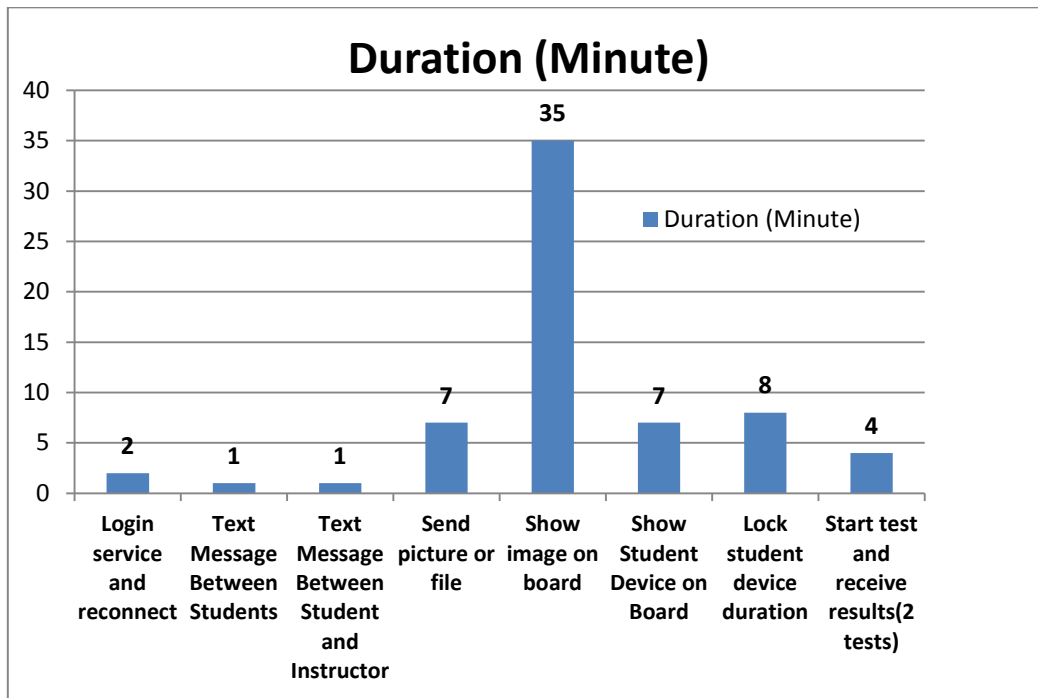
Figure (4.12): Time duration consumed by each service.

Discussion of results:

In the following, results of each service are explained in detail:

- ***Login service and reconnect:*** For male group, the number of service requests was high (i.e. 80) and compared to the number of requests obtained from the female group (20). This is because we had to disconnect students after first login attempt, and then create students' accounts for all students on the server so that the system can recognize their identities. For group B, we learned the lesson and created students' accounts before they logged in.

During the classroom sessions, we also encountered a very few number of connection failures. Even when a device accidently disconnected, it reconnected again without interrupting the student's work.

- ***Text messages between students:*** We noticed that the two groups varied when using this service. Male students sent 30 text messages and female

students sent text messages only. Male students were generally more distracted than female students and tried to text each other while the lesson is being taught. Overall, this service was not heavily used in both groups.

- *Text messages between student and instructor:* this feature has not been used, and the few recorded events were performed for testing purposes only.

- *Sending pictures or files:* This is the most commonly used services in both groups. This service was primarily used to share learning material on students' devices. Most file were sent from the instructor to the students. Students also had to send captured images to the instructor's device during the written test. Although it was possible to send files between students, this action was not performed because the learning task did not require this action.

- *Show image on board:* This is also of the mostly used services. This was actually the main service that enables the instructor to share learning content with the whole classroom. This activity was used for the longest time in both two sessions. Although student materials were sent to all student devices, the instructor and students preferred to watch the projected view of the learning material. Using the projected view, the instructor could point to or highlight specific parts of the learning material, or to explain extra examples on the side of the board. However, showing learning material on the students' devices can be useful for them to add annotations or comments on the material. This observation suggests that both the instructor and the students prefer to traditional way of teaching in the classroom, in which the instructor and students communicate face to face, and the instructor shares content with all students.

- *Monitor students' devices:* This is one of the features that was often used by the instructor. We noticed that the instructor sought to monitor students' device in order to share a student's work or device view with other students. The instructor did not use this feature to watch what students were doing on their devices.

- Locking and unlocking student's devices: This service was using in both groups. It was observed that it was used by the instructor to raise attention

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when students become distracted. This service was used more for the female students because they were more talkative.

- ***Initiating tests and viewing results:*** This feature was also frequently used by the instructor to access the students' progress.
- All the activities except display file or image on the board took bout (25%) of the classroom session time.

According to *table (4.4)* which shows each service and the average time consumed during the classroom session, we noticed the following:

- All services, except sharing the learning material or showing student devices on board, consumed short time. Some service is executed instantly, such as logging in or sending files. Other services such as tests should be completed within specific times. In contrast, sharing learning material was the service used for teaching by the instructors.
- Locking student devices during classroom sessions took small time intervals, which mean that there was limited misuse of students' devices during the sessions. This also gives an indication that students did not get distracted quite often. This might be due to the new experience of using mobile devices in learning. The instructor sought to lock students' devices in few times just to get their attention to important points.
- Login and Reconnect took time longer than expected because of high disconnection rate of wireless networks and the nature of mobile devices which pause applications when the device unused.
- Instructor normally shows student's devices on the board after or during tests in order to display and discuss questions and answers.

4.4.4 System validation

Table (4.5) shows how the user requirements, explain earlier in Section 3.1 map to the software units/ services that validate and fulfill each requirement.

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Table (4.5): CMS requirements validation

	Requirement	User	Validation	Responsible Unit
1	View current online students.	*Instructor*	✓	Login module
2	Send and share learning material.	*Instructor*	✓	Data Transfer module
3	Conversation between students and instructor.	*Instructor*	✓	Data Transfer module
4	Build tests, deploy it on the students, get and display results on the instructor device.	*Instructor*	✓	Assessment Module
5	Control (Allow or deny)students' devices	*Instructor*	✓	Control Module
6	Monitor Students' devices.	*Instructor*	✓	Monitor Module
7	Linking Instructor's and student's device with the classroom assets.	*Instructor*	✓	Linking assets module
8	Conversation between the student and instructor and between students each other.	*Student*	✓	Data Transfer module
9	Send and share files and learning material with the instructor and other students	*Student*	✓	Data Transfer module
10	View the instructors tests ,answering questions, display test result	*Student*	✓	Assessment Module
11	Linking devices with classroom assets (Projector, Printer…etc.)	*Student*	✓	Linking assets module

5.4.4. Students' Questionnaire Results

Table (4.6) summarizes the questionnaire results obtained from the twenty students involved in the study. Note that the 4-likert scale was converted to numerical values as the following**: (Strongly disagree -> 1, Disagree->2, Agree-> 3, strongly agree-> 4).** The table shows the answers frequency, percentage, and the answers mean.

Table (4.6): Students' Questioner results.

	Total number of Participants	20 student								
		Frequency				Strongly Agree %	Agree %	Not agree %	Strongly not Agree %	Mean
	Question	Strongly Agree	Agree	Not agree	Strongly not Agree					
Q1.1	I think the system is useful for learning in the classroom.	9	11	0	0	45%	55%	0%	0%	3.45
Q1.2	I enjoyed using the system during the lecture.	11	9	0	0	55%	45%	0%	0%	3.55
Q1.3	Learning using mobile devices is better than learning using power point slides	11	7	1	1	55%	35%	5%	5%	3.5
Q1.4	The system was easy to use and learn.	10	8	1	1	50%	40%	5%	5%	3.45
Q1.5	Using mobile devices causing me distracted and distracts my attention from the subject of the lecture.	2	12	6	0	10%	60%	30%	0%	2.85
Q1.6	Transfer of learning material (images and files) done easily between teacher and students.	8	7	4	0	40%	35%	20%	0%	3.2
Q1.7	Many errors appears while using the system	5	13	2	0	25%	65%	10%	0%	3.15
Q2.1	Ability of submitting quizzes and corrects it automatically.	13	5	2	0	65%	25%	10%	0%	3.55
Q2.2	Ability of capture activities and share the captured images through the classroom projector	14	6	0	0	70%	30%	0%	0%	3.7

Q2.3	Teacher's ability to control students' devices and deny them from using it during lecture.	11	8	1	1	55%	40%	5%	5%	3.5
Q2.4	The ability to send and share photos and files between teacher and students.	12	7	0	0	60%	35%	0%	0%	3.6
Q2.5	The ability to send messages between the students and the teacher.	12	6	0	1	60%	30%	0%	5%	3.5
Note : **Mean = (3.5 – 4 = Strongly agree | 3 ~ 3.5 = Agree | 1.5 – 2 = Not Agree | 1 ~ 1.5 = Strongly Not Agree)**										

The data in Table (4.6) collected form 20 students of two groups (Female, males). The table shows that:

A) **General Satisfaction evaluation (Q1 – Q7)**

-   All the students agreed that the system was useful inside the classroom (3.45/4).

-   The students strongly agreed that they enjoyed using the system during the session (3.55/4). This result explains why students remained undistracted during the sessions.

-   They strongly agreed that mobile system is better than PowerPoint presentations (3.5/4).

-   They agreed that the system is easy to learn and use (3.45/4).

-   They agreed that using mobile system did not distract them during classroom session (2.85/4)

-   They agreed that transferring learning material was done easily between students and instructor or students each other (3.2/4).

-   They also agreed that a very small number of errors appeared while using the system (3.3/4)

B) **Quality of the system services evaluation (Q21 – Q25).**

-   Students Strongly agreed that short tests service and automatically correction service is very effective and useful (3.55/4)

-   They found the ability of capture pictures of their activities and share it with the classroom is very useful and effective (3.7/4)

-   They found the ability of the instructor to monitor student devices and lock it, was very effective and useful (3.5/4).

-   The ability to share learning material or share files and pictures was strongly useful and effective (3.6/4)

-   They agreed that the ability to make conversations between student and instructor or students each other was very useful (3.5/4).

-   It is obvious from the above results that students gave very positive feedback to the system services.

When students were asked about things they most liked or disliked in the system, they responded as the following:

-      Most students liked the short tests and automatic correction service (11/20).

-      Many students indicated that they liked the way the instructor showed their device's screen on the board (9/20).

-      Some students liked the fact that the system managed the session's time in an effective manner (13/20).

-      Some students enjoyed learning whiles their mobile device between their hands (5/20).

-      Some students believe that, the chance of the system to distract the students' attention is very low (5/20).

-      Some found that the system could help them to ask questions and make conversation with instructor without any social fears or shy from other students (9/20).

What are things students disliked?

-      Some students reported that the system did not show them answers of questions that they did not solve correctly so that they can learn from their mistakes (5/20).

-      Some students disliked the messaging between students each other, because it may distract them or misused (4/20).

When asked about their suggestions to improve the system, they responded as the following:

-      8 students asked to have the ability to save short tests and return back to it any time.

-      5 students asked for the ability to use virtual pen in order to record comments or notes on the learning material.

-      4 students asked to make the tests correction system to be more forgiving and case insensitive.

Finally, we map the evaluation results to the research questions presented in the beginning of Chapter (4) as the following:

Question A: Does the system support the instructor-student interaction in the class?

Instructor-student interaction has been achieved in a variety of ways:

The instructor could easily transfer learning material to student devices. This service was frequently used in the classroom as indicated in Table (4.2, 4.3)

The instructor could track and monitor student's work by requisitioning snapshots of their devices. This feature allowed the instructor to use one student's solution, show it on the projector and use it as a focal point of discussion with the rest of students as shown in Figure (4.7).

The instructor could control the classroom activity and draw their attention by locking the students' devices so that they pay attention to the instructor.

The system allows students to communicate with the teacher through text messages. However, this service has not been frequently used maybe because it was not useful for this particular case study.

Question B: Does the system facilitate the sharing of learning material in the classroom?

Sharing learning material between teacher and students was the most commonly used service of the system as indicated in Table (4.2, 4.3). The instructor used material with students either by sending files and images to students' devices or by show learning material on the projector to explain publically. Both ways were intensively used by the instructor.

Question C: How does the instructor manage students' questions and notices during the classroom session?

In fact, students and the instructor preferred to communicate face-to-face rather than by exchanging private text messages. This result indicates that our system does not replace the traditional instructional methodology. Instead, it aims to support it

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through the provision of services that facilitates teaching and assessment activities in the classroom.

Question D: To what extent instructor could use the system assess the levels of students?

The instructor used the system multiple times to initiate quizzes and send them to students to answer. With the easy launching of quizzes and the instant marking of answers, the assessment process has become more interactive, less terrifying to students and less cumbersome to the instructor.

4.5. Summary

We conducted an observational study to evaluate our mobile-based learning system; we use the system in practice to teach undergraduate students. In this investigation we try to answer s research question about how the system support user's interaction, learning material, and students' assessment. We measure users' satisfaction using a questioner distributed at the end of the classroom practice. As the system keep track and store the activities used by both instructor and students, we evaluate the services of the system according to the service frequency and time duration.

The final results show that both of instructors and students find our system useful and effective in learning. The system enforces interaction between the system users, facilitate knowledge sharing, enhance the classroom session time management as there is no wasted time between mobile learning activities, and help instructors to assess students understanding levels during classroom session.

Chapter 5
Conclusion and Future Work

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Conclusion and Future Work

Mobile devices can be used to create a smart classroom. Students and instructor could use mobile devices during classroom session to be more collaborative. They could send and receive learning material; start conversation between students and instructor or students each other; however, instructor should have the ability to prevent students from using mobile devices, misuse them or to get students attention. Instructor can use mobile devices to evaluate his students' level and progress using computed mobile tests.

Mobile devices appear as great computer terminal that it has its own battery, equipped with a plethora of build-in equipment such as screen, speaker, mike, camera, network interface… etc. All these components grouped together in a small size and light weight device. Thus, we think that mobile devices could replace normal computer terminal (e.g. PC) to build a smart classroom without expensive or large equipment that need extra space and infrastructure such as networks and power source.

The problem raised is how to use this small device in innovative manner that could exploit the power of mobile devices, to achieve the needs of instructors and students during the classroom in order to make the classroom session more collaborative and more productive. However, instructor should deny misuse of devices and keep monitoring students while they use mobile devices.

The research and the presented system address the needs of instructors and students inside classroom. The system is content independent and not designed for a specific class or a specific topic. The system provides a number of services that support classroom to be more collaborative, and give instructor better management on his classroom. The system does not change the ordinary classroom instructional nature. The system support classroom with number services:

- Files and images transfer.
- Conversation between students and instructor or students each other.
- Short tests and automatic correction.

- Monitor students' devices.

- Instructor can deny students from using mobile devices programmatically.

- Instructor can link his device or students devices with classroom assets such as projector, printer, etc.

Mobile-based class management system is deployed easily in any classroom with the minimal equipment. It needs mobile devices (android-based) a pc or mac book to run java server and access point for wireless network linking.

The evaluation process of the system has two stages. At the early stage, we build prototype from the system and present this prototype to a selected group of instructors as they are the main operator and users of the system. We collect instructors' opinion about the benefits of using the system inside classroom, and the importance of the system services and the additional service they need. The vast majority of instructors find the system helpful inside classroom and the service provided is useful and effective. Then, we evaluate the system inside real classroom and we observe the system during the classroom session. The server records every activity done during the classroom session and keep track of who is initiated the service, how long it stills running, and who is the collaborators of this service.

The system could be effective and useful inside science labs such as chemistry and physics labs. In science courses in particular, there could be many interactive learning materials that need to be sent and discussed frequently with students. In addition, the need for public discussions and share of student's individual works are very common in lab settings. Also system could be very effective and useful inside large classrooms where it may be difficult for the teacher to follow and track each student.. In general the system could be effective and useful inside specific types of classrooms, specific students' levels, specific courses and could not be for others. The learning and teaching process depend on many issues such as teacher, student and the nature of learning material. The evaluation in this thesis has tested the use of the system only for programming courses. Further experiments will be conducted in the future to test the feasibility of the system for different courses and classroom settings.

We noticed that the system did not change the instructional nature of the classroom. Both of students and instructor use the system easily after two minutes of training on the system. Students enjoy while using mobile devices especially when they capture image of an activity or receive a learning material and notes from the instructor. All the activities the system provide used by students and instructors. Some services have the longest time of use and the largest frequency such display learning material on projector and share learning material. The system makes the best use of classroom session time so there is no significant wasted time during activities or after finishing the activity.

A questionnaire was distributed among students (20 student) after the classroom session ended. The questionnaire results show that all the participants' students find the system useful. 90% of the students prefer this system on the slides (e.g. power point slides) as they share knowledge and interact with instructor and each other. 90% of the participants found the system easy to learn and use. 60% of the students agree that using mobile during lecture does not distract them while 40 % of the participants state that using mobile distract them. The students evaluate all the system services as significantly useful and effective.

6.1. Future work

As a future work we recommend:

- Provide other services such as black board service to write notes (e.g. using light pen) or edit images and share them with the classroom.
- Use the system for longitude studies that measure the learning outcome of using the presented system.
- Support IOS devices.
- Evaluate using mobile for virtual classrooms.

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Appendices

Appendix A: Instructor's Questioner.

Appendices

Appendix A: Instructor Questioner.

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استبانة الهواتف الذكية

في ما يتعلق بنظام استخدام الهواتف الذكية للتعليم في الفصول الدراسية نرجو الإجابة عن الأسئلة التالية:

أولاً: هل تعتقد أن النظام سيكون مفيداً للتعليم التفاعلي داخل الفصل الدراسي ؟

☑ نعم ☐ لا ☐ إلى حد ما

ثانياً: إذا كانت إجابتك بـ"لا" على السؤال السابق, نرجو توضيح السبب في عدم فائدة النظام من وجهة نظرك.

إذا كانت إجابتك عن السؤال السابق بـ"نعم" أو "إلى حد ما", نرجو من حضرتك توضيح ما هي المميزات التي تتوقع تحققها من النظام حسب وجهة نظرك:

ثالثاً: هل هناك مهارة/مهارات تدريسية محددة متعلقة بتخصصك التدريسي تعتقد أن نظام الهواتف الذكية سيقوم بتعزيزها؟ نرجو توضيح هذه المهارات.

رابعاً: هل تعتقد أن النظام سيسهل عملية إدارة الفصل الدراسي أم سيصعبها؟ نرجو التوضيح.

خامساً: بناء على العرض الذي قام به المشرفون على النظام, نرجو من حضرتك تقييم أهمية كل وظيفة من الوظائف التي تم عرضها من وجهة نظرك:

1

</div>

Appendix A: Instructor's Questioner.

					السؤال	
					تسجيل دخول الطلبة من خلال الأجهزة الذكية وعرض قائمة بالطلبة المسجلين على جهاز المدرس	1
					إمكانية تحكم المدرس بأجهزة الطلبة من خلال جهازه الذكي (مثلاً إغلاق أجهزة الطلبة أثناء شرح المدرس)	2
					إمكانية استخدام الطلبة لأجهزتهم الذكية لعرض المادة التعليمية أثناء الحصة	3
					إمكانية نقل ومشاركة الملفات بين جهاز المدرس وأجهزة الطلبة	4
					إمكانية نقل ومشاركة الملفات بين أجهزة الطلبة	5
					إمكانية عقد امتحانات قصيرة من خلال الأجهزة الذكية	6
					إمكانية تجميع إجابات الطلبة وتصحيحها آليا ومن ثم ظهورها على شاشة جهاز المدرس	7
					إمكانية ربط الأجهزة الذكية للطلبة أو للمدرس بشاشة العرض أو الطابعة	8
					إمكانية مراقبة المدرس من خلال جهازه لأجهزة الطلبة أثناء الحصة بحيث يعرف المدرس كيف يستخدم الطلبة لأجهزتهم.	9
					تفعيل إمكانية المحادثة والتواصل بين الطلبة من خلال الأجهزة الذكية	10

سادساً: هل هناك أي وظائف أخرى غير الوظائف التي تم عرضها تعتقد أنها ضرورية وترغب في تطبيقها في النظام؟ نرجو توضيح هذه الوظائف.

Appendix B: Students' Questioner

هذا الاستبيان خاص بنظام الأجهزة الذكية المستخدم في التعليم.

غير موافق بشدة	غير موافق	موافق	موافق بشدة	البند	
				أولاً: أرجو اختيار التقييم المناسب لكل مما يأتي:	
				أعتقد أن النظام مفيد للتعلم داخل الفصل الدراسي.	1
				لقد استمتعت باستخدام النظام أثناء المحاضرة.	2
				النظام المستخدم للتعليم باستخدام الأجهزة المحمولة أفضل من التعلم باستخدام العروض PowerPoint.	3
				النظام كان سهل الاستخدام والتعلم.	4
				استخدام الأجهزة المحمولة تسبب بإلهائي وتشتيت تركيزي عن موضوع المحاضرة.	5
				نقل المادة العلمية من صور وملفات تم بسهولة بين أجهزة المدرس والطلبة.	6
				ظهرت أخطاء كثيرة أثناء استخدام النظام.	7
				ثانياً: قيم كل خاصية من خصائص النظام التالية حسب فائدتها من وجهة نظرك:	
				إمكانية تقديم الاختبارات القصيرة وتصحيحها أوتوماتيكياً.	1
				إمكانية تصوير النشاط ومشاركته من خلال شاشة العرض في الفصل.	2
				إمكانية تحكم المدرس بأجهزة الطلبة بإغلاقها ومنع استخدامها أثناء المحاضرة.	3
				إمكانية إرسال ومشاركة الصور والملفات بين المدرس والطلبة.	4
				إمكانية إرسال رسائل بين الطلبة والمدرس.	5

ثالثاً: أرجو الإجابة عن الأسئلة التالية:

1– ما أكثر الأمور التي أعجبتك بالنظام؟

Appendix B: Students' Questioner

_____

_____

_____

_____

2–   أكثر الأمور التي لم تعجبك بالنظام؟

_____

_____

_____

_____

3–   ما هي اقتراحاتك لأي تعديلات أو إضافات تعتقد أنها ضرورية لتطوير النظام مستقبلاً؟

_____

_____

_____

_____

تمــت

Appendix C: learning procedure

The instructor should use the learning material and follow the instruction he found in this learning procdure.

Teaching java course for beginners

What icons mean?

This instructor's activity

This student's activity.

CMS application's features used in current activity.

Other notes or remarks.

Instructor start Test

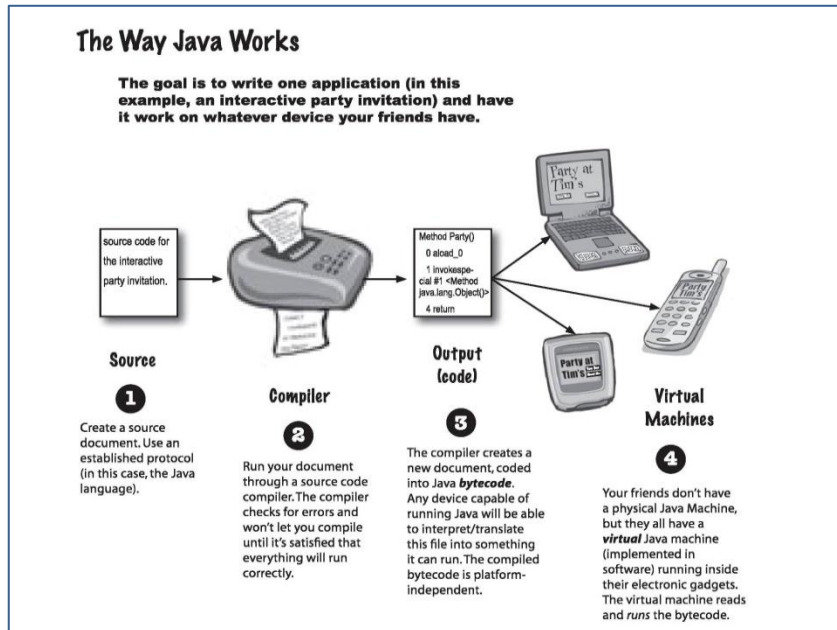**Appendix C: learning procedure**

The way java work.

Figure (C.1) The way java work, (Sierra & Bates, 2005)

Instructor: Send image in Figure (C.1) to the student's then display this image on the board.

Appendix C: learning procedure

Java data types.

Java is a strongly typed language, compiler check every data type in any operation for computability,

Java have two data types (primitive and object oriented data types) , the core of java is eight (8) primitive (none objects) data types.

☺Instructor: send image file in Figure (C.2) to All students from his mobile then display it on the Board, then discuss this types with student, ask every student received the picture to send ok message.

☺Student should send ok Message after receiving primitive data types image file.

> 🧑 Note: Instructor ask for (OK) Message to get students attention.

🖼️*Used Features: Send file, start conversation.*

Type	Meaning
boolean	Represents true/false values
byte	8-bit integer
char	Character
double	Double-precision floating point
float	Single-precision floating point
int	Integer
long	Long integer
short	Short integer

Java have only (8) primitive data types

Figure (C.2) java core data types, (Schildt, 2006)

- **Java define four types of integer,**

Type	Width in Bits	Range
byte	8	−128 to 127
short	16	−32,768 to 32,767
int	32	−2,147,483,648 to 2,147,483,647
long	64	−9,223,372,036,854,775,808 to 9,223,372,036,854,775,807

Figure (C.3) java integer data types, (Schildt,

Appendix C: learning procedure

Instructor: Send this image in Figure (C.3) to the student.

Instructor: monitor view student devices, to ensure that students use classroom application, and they receive the last image.

 App features used: send image, monitor student devices.

Anatomy of class

When java virtual machine starts, it looks for a class you give at command line or ask your IDE to run. Then java VM search for special method look like this

```
public static void main (String[] args) {
// your code goes here
}
```

Next, the JVM runs everything between the curly braces { } of your main method. Every Java application has to have at least one **class**, and at least one **main** method (not one main per *class*; just one main per *application*)

Instructor send image file in Figure (C.4) to all students inside class room, ask every student received the file to send (OK) message. Then instructor discusses class anatomy with students.

Instructor check if any students send him message or ask question.

 Features: send file, conversation.

Appendix C: learning procedure
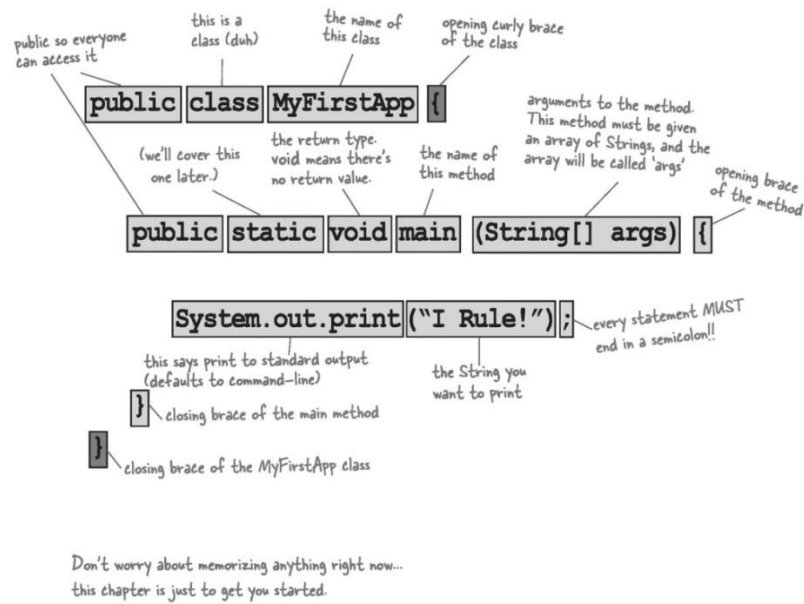
Figure (C.4) Java Anatomy, (Sierra & Bates, 2005)

Write first application

```
public class MyFirstApp {

    public static void main (String[] args) {

        System.out.println("I Rule!");

        System.out.println("The World");

    }

}
```

Figure (C.5) Java Code, MyFirstApp.java

Instructor: lock students devices during discuss first application.

Instructor: Send a java file contain code in Figure (C.5).

Features: Send file, lock devices.

Appendix C: learning procedure

How Easy to write java code

Instructor asks students to guess what each line of the code in Figure (C.6) is doing.

Instructor asks students to capture their answer.

Student write down answer on a paper then capture image of the paper then send this picture to the instructor.

The instructor chooses some students answers and display it on the board, and discuss answers with students.

Features: Capture picture, Send file, Show on Board.

Look how easy it is to write Java.

Try to guess what each line of code is doing...
(answers are on the next page).

```java
int size = 27;
String name = "Fido";
Dog myDog = new Dog(name, size);
x = size - 5;
if (x < 15) myDog.bark(8);

while (x > 3) {
    myDog.play();
}

int[] numList = {2,4,6,8};
System.out.print("Hello");
System.out.print("Dog: " + name);
String num = "8";
int z = Integer.parseInt(num);

try {
    readTheFile("myFile.txt");
}
catch(FileNotFoundException ex) {
    System.out.print("File not found.");
}
```

declare an integer variable named 'size' and give it the value 27

Figure (C.6) What java code do?

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Appendix C: learning procedure

Second Simple class

```
class Example2 {
  public static void main(String args[]) {
    int var1; // this declares a variable ◄────────── Declare variables.
    int var2; // this declares another variable

    var1 = 1024; // this assigns 1024 to var1 ◄────── Assign a variable a value.

    System.out.println("var1 contains " + var1);

    var2 = var1 / 2;

    System.out.print("var2 contains var1 / 2: ");
    System.out.println(var2);
  }
}
```

Figure (C.7) simple java program code, (Schildt, 2006)

Instructor send a java file contain the code after he discussed the code.

Double Data type example

To understand different between integer and float, try the following program.

```
class Example3 {
  public static void main(String args[]) {
    int var; // this declares an int variable
    double x; // this declares a floating-point variable

    var = 10; // assign var the value 10

    x = 10.0; // assign x the value 10.0

    System.out.println("Original value of var: " + var);
    System.out.println("Original value of x: " + x);
    System.out.println(); // print a blank line ◄────── Output a blank line.

    // now, divide both by 4
    var = var / 4;
    x = x / 4;

    System.out.println("var after division: " + var);
    System.out.println("x after division: " + x);
  }
}
```

Figure (C.8) Test, simple java program code, (Schildt, 2006)

Appendix C: learning procedure

Program output

var after division : ?   // Test students to guess the answer.

X after division : ?

Test (1)

: Instructor send short test in figure (C.8) to students ask them about expected program output.

Note: The test contains two fill gap questions.

Instructor checks how many student give true answer.

Features: Tests.

Test (2) Rearrange the code to get the next result.

```
10.0 gallons is 37.854 liters.
```

Instructor send short test in figure (C.9) to the students, ask them to arrange code parts to get the previous result.

Test contain three fill gap question each question contain part of the program code. Student arranges parts by giving each part number from 1 to 3.

```
public static void main(String args[]) {

        System.out.println(gallons + " gallons is " + liters + " liters.");

gallons = 10; // start with 10 gallons
liters = gallons * 3.7854; // convert to liters

                double gallons; // holds the number of gallons
                double liters; // holds conversion to liters

}
```

Fig (C.9) , Test, Rearrange the code to get the result , (Schildt, 2006)

1. **Just before use this variable.**
2. **At the beginning of code block that enclosed in { }.**

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Appendix C: learning procedure

Assignment Statements

> **Var =100;**
>
> **Name = "Ahmad";**

Simply the equal sign mean that we put or store value on the right of equal sign in the variable on the left hand.

Examples on Assignment

> **amount = 3.99;**
> **firstInitial = 'W';**
> **score = numberOfCards + handicap;**
> **eggsPerBasket = eggsPerBasket - 2;**

Initializing Variables

- A variable that has been declared, but no yet given a value is said to be *uninitialized.*

- Uninitialized class variables have the value null.

- Uninitialized primitive variables may have a default value.

- It's good practice not to rely on a default value.

To protect against an uninitialized variable (and to keep the compiler happy), assign a value at the time the variable is declared.

> - int count = 0;
>
> - char grade = 'A';

Assignment Compatibilities

Java is said to be *strongly typed.*

> o You can't, for example, assign a floating point value to a variable declared to store an integer.

Sometimes conversions between numbers are possible.

doubleVariable = 7; Is possible even if **double Variable** is of type **double**, for example.

Appendix C: learning procedure

- **A value of one type can be assigned to a variable of any type further to the right.**
  - **byte → short → int → long → float → double**
  - **Char →int**

A *type cast* temporarily changes the value of a variable from the declared type to some other type.

```
double dist;
int feets;
feets = dist  // illegal no direct conversion we need casting
feets = (int) dist;
```

Test on variables (3)

True or false;
| ```
{
    int x;
    y = 5;
    int y;
    x = y+3
}
``` |
| *Fill the gap* |
| ```
public static void main(String[] args){
    char var1 = '_____';
    System.out.println(var1);

  }
```
*Output should be : A* |
| *True or false* |
| ```
int X ;
double Z= 1.5;
X=Z
``` |
| *True or false* |
| ```
{
Long var1 = 10;
double var 2;
var2 = var1
}
``` |
| *Fill The gap* |
| ```
double var1 = 25.22
short var2 = (_____)var1
``` |
| *Figure. (C10), Test (4)* |

Instructor sends this short test to the student.

The Student answers the test, the result returns back to the instructor.

Instructor detect students student understanding levels.

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