SAKARYA UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY

IMSSAP: AFTER-SCHOOL INTERACTIVE MOBILE LEARNING STUDENT SUPPORT APPLICATION

Ph. D. THESIS

Ahmad KHACHAN

Department : **COMPUTER AND INFORMATION SYSTEMS ENGINEERING**
Supervisor : **Assoc. Prof. Ahmet ÖZMEN**

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This thesis has been accepted unanimously / with majority of votes by the examination committee on date 26/04/2019.

Prof. Dr. **Abdurrahman Ünsal** **Head of Jury**	**Assoc. Prof. Dr.** **Ahmet Özmen** **Jury Member**	**Prof. Dr.** **Yılmaz Aslan** **Jury Member**
Assoc. Prof. Dr. **Cenk Yavuz** **Jury Member**		**Assist. Prof. Dr.** **Muhammed Fatih Adak** **Jury Member**

DECLARATION

I declare that all the data in this thesis was obtained by myself in academic rules, all visual and written information and results were presented in accordance with academic and ethical rules, there is no distortion in the presented data, in case of utilizing other people's works they were refereed properly to scientific norms, the data presented in this thesis has not been used in any other thesis in this university or in any other university.

Ahmad KHACHAN
03.02.2019

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LIST OF ABBREVIATIONS AND ACRONYMS

API	:	Application Programming Interfaces
ADB	:	Android Debug Bridge
APK	:	Android Package file that's used to distribute applications on Google's Android Operating System
ACL	:	Access Control List
AS	:	Android Studio
Blackboard	:	A Virtual Learning Environment and Course Management System
Bluetooth	:	A Wireless Technology Standard for Exchanging Data Over Short Distances
BaaS	:	Backend-as-a-Service
Bite-sized learning	:	Short and Focused Learning Activity
CSS	:	Cascading Style Sheets
C	:	Computer Structured Programming Language
C++	:	Object Oriented Programming Language
2D and 3D bar codes	:	Barcodes Systematically Represent Data Using Two-Dimensional and Three-Dimensional Symbols and Shapes.
DVM	:	Dalvik Virtual Machine
DDMS	:	Android Device Monitor
Edmodo	:	Classroom Communication Hub
ELM	:	Extreme Learning Machine - Neural Network
e-mail	:	Electronic Mail

e-Learning	:	Electronic Learning
FCM	:	Firebase Cloud Messaging
GCC	:	Gulf Cooperation Council countries
GPS	:	Global Positioning System
GIS data	:	A Data Model in Geographic Information Systems
GPS chips	:	Tracking Chips
Gradle	:	An android custom build tool to build APK files and providing custom build logic.
GUI	:	Graphic User Interface
html	:	Hypertext Markup Language
HTML5	:	Evolution of the Standard that Defines html
IOS	:	iphone operating system
IDE	:	Integrated Development Environment
IMMAP	:	Interactive Mobile Messaging Application
JavaScript	:	An Object-oriented Computer Programming Language Commonly Used in Web Development.
JSON	:	JavaScript Object Notation is a lightweight data-interchange format
LMS	:	Learning Management Systems
Linux	:	Open Source Operating System
logcat	:	Android shell tool
M-learning	:	Mobile Learning
Moodle	:	Course Management System
MOOC	:	Massive Open Online Courses
mysql	:	Open Source Relational Database Management System
NFC	:	Near-field Communication
nosql	:	Not Only SQL
OS	:	Operating System
PC	:	Personal Computer

PDA	:	Personal Digital Assistant
PBL	:	Project-Based Learning
RAD	:	Rapid Application Development
RFID chips	:	Radio Frequency Identification Chips
RDBMS	:	Relational Database Management System
STEM	:	Science, Technology, Engineering and Mathematics
SMS	:	Simple Messaging System
SDK	:	Software Development Kit
SQL	:	Structured query Language
SPSS	:	Statistical Package of the Social Sciences
TAM	:	Technology Acceptance Model
TV	:	Television
VLE	:	Virtual Learning Environment
WIFI	:	Wireless Fidelity
XML	:	eXtensible Markup Language
"σ"	:	Standard deviation Sigma Greek letter
'μ'	:	represents the population mean
'ΣX_i'	:	represents the sum of all scores present in the population
'N'	:	represents the total number of students
'sqrt'	:	square root
'σ^{2}'	:	represents the population variance.
'$\Sigma (x_i - \bar{x})^2$'	:	represents the sum of the squared deviations of the scores from the sample mean
's^2'	:	represents the sample variance.
t	:	$t = (\bar{x} - \mu) / (S / \sqrt{n})$ testing null hypothesis
(H_0)	:	null hypothesis
(H_1)	:	(two-tailed) alternative hypothesis
μ	:	Proposed constant for the population mean
$\bar{x}$	:	Sample mean

n	:	S ample size (i.e., number of observations)
s	:	Sample standard deviation
($s/\sqrt{n}$)	:	Estimated standard error of the mean (s/sqrt(n))
$df = n - 1$	:	degrees of freedom
Sig P	:	Statistical significance is determined by looking at the p-value. ($p < .05$)

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SUMMARY

Keywords: Engineering, Education, Interactive Software, classroom Demonstration, Undergraduate Education.

In this research, we are engaging in the process of developing m-learning around the world. Social and pedagogical factors are being used while designing our m- learning tool. In a popularity-driven culture, interaction between users enriches discussions and promotes knowledge share.

The application was designed and created using android software development kit and java programming language. Google cloud storage a real-time database infrastructure was used to save data. The application was offered to students in different majors in engineering departments in Sakarya University, Turkey, for testing and feedback. Before conducting the questionnaire we introduced mobile learning concept to students and explained its importance in their own learning process. After using the application, students answered the questionnaire. The questionnaire reflected three major points: performance, gain and the social factors effecting mobile learning acceptance. Popularity is one of the top factors that motivated learners to adopt mobile learning.

OKULDAN SONRA ETKİLEŞİMLİ MOBİL ÖĞRENME ÖĞRENCİ DESTEK UYGULAMASI

ÖZET

Anahtar Kelimeler: mühendislik, eğitim, etkileşimli yazılım, sınıf gösterimi, lisans eğitimi.

Bu araştırmada, dünya çapında m-öğrenme geliştirme sürecine giriyoruz. M-öğrenme aracımızı tasarlarken sosyal ve pedagojik faktörler kullanılmaktadır. Popülerlik odaklı bir kültürde, kullanıcılar arasındaki etkileşim tartışmaları zenginleştirir ve bilgi paylaşımını teşvik eder.

Uygulama android yazılım geliştirme seti ve java programlama dili kullanılarak tasarlandı ve oluşturuldu. Google bulut depolama, verileri kaydetmek için gerçek zamanlı bir veritabanı altyapısı kullanıldı. Test ve geribildirim için Sakarya Üniversitesi, Türkiye. Anket tanıtılmadan önce, öğrenme sürecinin kavramı tartışılmıştır. Uygulamayı kullandıktan sonra, öğrenciler anketi cevapladılar. Anket üç ana noktayı yansıtıyordu: performans, kazanç ve mobil öğrenmenin kabulünü etkileyen sosyal faktörler. Popülerlik, öğrencileri mobil öğrenmeyi benimsemeye teşvik eden en önemli faktörlerden biridir.

CHAPTER 1. INTRODUCTION

1.1. Background

Mobile devices have become an essential part of our life as a communication, socializing, and entertaining tool. The use of mobile devices has increased dramatically over the past decade. Mobile phones, particularly, became available and accessible in almost all countries regardless of the economic and social differences [1]. In spite of this fact, mobile devices are still not fully acknowledged as an effective learning tool in the academic institutions.

After sales service is one of the most important attributes in product value creation. It is considered critical in the business process because it creates a relationship with customers and provides the company with valuable amount of feedback data that helps in decision making and product development. After sales service has variety of patterns like customer service, technical support and help desk, all are dedicated divisions to support, update and backup customers for the sake of improving product and service qualities.

In this research we will introduce a new concept almost identical to the customer support objectives but instead we will target university and college students, it's an "after-class interactive M-Learning student support system".

The academic institutions and the society are well aware that some students lack the comfort or courage to ask questions during class lectures. Parents expect academic institutions to pay attention to those students and find ways to help them overcome these obstacles which if not carefully taken care of might have an impact on their children's education quality and future achievement. We also have Self-study students

who prefer to study alone, put some effort and research after class, then list ideas and questions that need further clarification. Schools should create a space for students to talk about their experience, discuss ambiguous ideas, an environment that offers learners immediate answers, hints or clarifications, an environment to help overcome barriers that might hinder students learning progress and encourage them to search, question, ask, share and learn more about school subjects.

1.2. Motivation

Some academic institutions might be teaching students obsolete information, a knowledge that is neither productive nor used in the market or excess data [2]. The gap between some students and teachers is widening which in return affects the learning qualities. Furthermore, many studies have shown that graduate students are not ready for the industry [3]. Students are reading less, are showing minimal progress and development in analytical capabilities and critical thinking skills, are not questioning any information they are receiving and dropping STEM (Science, Technology, Engineering, and Mathematics) courses [4].

Academic institutions were very enthusiastic to embed technology into the educational system as a reliable and trustworthy facility, however unintentional problems were created. Technology was expected to help students improve their research skills, critical thinking and analyzing capabilities, also to provide teachers with teaching opportunities and creativity tools to generate ideas that could simplify complex ideas to learners. Somehow technology played a passive role in schools and affected the teaching and the learning process. Slide show presentations are a very compact version of the subject reference book. They are very similar to the teacher's preparation notes. It turns out that such notes are being used widely by students as a substitute to the suggested reading materials and sources. Recent studies showed that students are reading less, showing less interest in STEM courses, minimal progress in critical thinking skills and are not investigating or researching or questioning any information they are receiving. The slideshows and PDF files became a great relief to some

teachers, simply uploaded and extended to students without verifying if students understood the core ideas or not.

This might be a reason why the gap between students and teachers is widening which in return affects the learning qualities. Some schools require teachers to finish the whole book by the end of the academic term. The main issue is what if we are teaching our students unreliable or obsolete information, knowledge that is neither productive nor used in the market any more, excess data or outdated information .As we can't simply ask universities to change their teaching environment or ask teachers to bring back old school teaching skills like using the board or asking students to read aloud and discuss in class or start laboratory experiments to find proof for theoretical ideas, instead we considered finding a way to boost and strengthen the relation between teachers and students, inspire teachers to focus on topics that reflects the market needs and inspire universities to motivate students to practice what they have learned, apply it in real life and get hands on experience. This won't be possible without monitoring and guiding students, promoting and updating the teaching process.

Educational institutions should not graduate consumer mindset students but a generation empowered with analyzing skills and critical thinking capabilities. Unlike blackboard or learning management systems LMS where users need to pay for using and adding options or big web applications that fits on a desktop screen rather than a small smart phone one, we will introduce a bite-sized learning concept, a free mobile application designated and offered to mobile device users. The tool is featured with attributes and social motives to encourage students to practice researching and knowledge sharing. It is an application that will provide better learning opportunities for people with special needs and most importantly to provide education to girls in conservative families and communities around the world and link them with the educational institutions and introducing them as effective members in the society and as contributors to knowledge and the educational process.

Many universities around the world especially in the UK, Canada and Australia are paying much attention and putting great effort to find a solution for the gap created

between students, teachers, the educational institutions and the market. Most colleges are using their student's mobile devices and take advantage of mobile services like simple messaging system SMS and the results were very encouraging, motivating and inspiring for more future studies and researches. If the application is applied truthfully and used wisely, it will positively affect students, educators and the teaching\learning process all over the world.

This research will focus on 'mobile learning' and will try to draw attention to their importance for the educational institutions. The thesis will start with defining and identifying mobile learning concept and then study and clarify possible limitations.

1.3. Research Objectives

This study describes a novel framework to understand the factors that affect mobile acceptance in the learning process. The proposed tool is not a learning resource for materials or a testing tool. It is rather designed to create a learning environment which requires active contributions from learners and educators. An M-Learning tool was built with social networking motivations. Integrating learning pedagogies that will simplify topics and encourage students to contribute and be active learners. It is a simple, light-weight, straight forward, easy to use tool. The tool will remove the distinction between formal and informal learning and will delete the gap between native and immigrant technology users while taking in consideration M-Learning acceptance factors, app efficiency and performance and the learning benefits of using the app.

Our objective is to create a learning environment for students which enable them to discuss ambiguous topics. A tool to challenge student's learning capabilities and encourages them to initiate scientific experiments and researches. Help Improve learner's analytical capabilities and critical thinking skills. Learn knowledge exchange and knowledge share. Students should be prepared for the industry and be productive. Provide teachers with teaching opportunities and creativity tools like feedback tool

where teachers can monitor learners and evaluate their progress and assess their ability to understand and interpret complex topics.

Interactive mobile learning student support application IMSSAP is a bite-sized learning tool, teachers could benefit from the application to focus on main topics and ask students to pay more attention to these ideas and research more about. Students can share their experience by uploading an image or graph from a magazine or another reference book or show laboratory experiments outcomes. Teachers will be able to create discussion groups encouraging students to ask questions any time and update classmates about new data or results that will help them understand what they read better. Students will appreciate such learning activities, it will make them feel more close to their academic institution and help them build confidence as they contribute to the learning process by sharing their knowledge with their friends which will indirectly create a social activity. Teachers could use personal inquiry tasks, allowing students to include family members and friends in a research which could help in developing a socialized teaching process.

The tool shall provide students with a great opportunity especially for those who doesn't like to ask questions in class, or for self-study students, and this could be an indirect substitution to student's office hours. In order to enrich the system we'll take advantage of mobile device facilities like texting services. This will make the system more interactive and interesting to use. The texting services like SMS or the social networking application services will add more value to the system and create a space for students and instructors to communicate, discuss and analyze different topics.

By playing the role of a tutor, teachers will have a better chance to monitor the learning process, evaluate student's progress, understand student's needs and create different methods to simplify ideas, improve student's critical thinking skills and data analyzing capabilities.

Managing mobile device facilities and embedding them correctly in the learning process will increase student's productivity and encourage them to put more effort in class discussions.

After each discussion, students will have a quick question to understand and assess their abilities in consuming ambiguous topics. Teachers might ask students to check some of the answers and comment on them. Social networking had a great impact on young students. A tweet is usually shorter than a comment and students are wasting most of their time reacting to such tweets and postings. We are living in a tweet and post era so we should develop and embed a system that can mirror social applications but will be used for educational purposes, students will use their own devices to socialize and learn. Students will have a thorough understanding of class topics, enjoy learning and build stronger bonds with their teachers, class mates and their academic institution.

Summarily, the objective of this study is to introduce an efficient and effective mobile learning tool and to discover the factors that might motivate learners to accept mobile learning as part of their formal learning process.

1.4. Thesis Organization

In chapter one, we have provided background about the issue of m-learning in education and generalities about the topic. This section also includes the motivation, the objectives behind this project and brief information about earlier studies and the gap we are trying to fill in this research.

Chapter two offers a literature review and earlier studies in details. This chapter introduces different researches related to importance and strategies to merge mobile in education from all over the world, researches about factors affecting mobile learning acceptance and two case studies reflecting the functionalities and importance of student's mobile devices. This chapter also includes different Learning Management

Systems used by academic institutions and the current learning tools in education in addition to the problem statement.

Chapter three is about learning with mobile devices and mobile development process, advantages and disadvantages of each platform. Mobile learning application development challenges and the learning methodologies we embedded in our learning tool.

Chapter four covered the technical definition and all the technologies and tools used to build our learning tool (Firebase, Android studio, Google cloud real time data storage).

Chapter five introduces our application in details, the learning principles used, the usage and benefits, application usage etiquette and the design and architecture of the application.

Chapter six is all about assessment methods, types of data, statistical data analysis (methods used, data source and functions used). In this chapter we also talk about test environment, we introduce the questionnaire used to collect feedback from application users (students), the results and a comparison between our app and another application for effectiveness and efficiency purposes.

Chapter seven represents the conclusion of the thesis. The major points and the contribution to the topic is highlighted and summarized. This chapter discusses future work and what we recommend to develop an efficient and successful mobile learning tool.

CHAPTER 2. LITERATURE REVIEW

Traditionally, technology was believed to have played a passive role in schools and it affected the quality of teaching and the learning process. For example, Ktorido, Gregoriou & Eteokleous [5] claimed that students are becoming less interested in reading, are showing minimal development in critical thinking skills and are not investigating or researching or questioning any information they are receiving. Additionally, despite transforming web-based learning content to fit mobile learning services, students still didn't show enthusiasm to accept such new learning methods [6]. Many academic institutions have the technological infrastructure and organizational capabilities to integrate social media with the learning process, yet they didn't adopt such learning strategy because people feel that social networking is for pleasure and not designed for academic purposes. Jones et al. debated that students prefer not to use social media tools for education [7]. Martin & Ertzberger emphasized that video games and interactive entertainment had affected student's learning style [8]. Nowadays schools are expected to provide students with engaging and interactive learning methods [9]. A study by The Institution of Engineering and Technology (United Kingdom, 2008) about the barriers of studying STEM and a review about the decisions students made, had shown that young students are losing interest in science and are considering them boring and not vivid or interactive. They believed this may be due to difficulties students encounter while trying to understand theories in science courses and the lack of a learning tool that provides them with immediate support.

Universities are currently facing the challenge of bridging the gap between digital natives (students) and digital immigrants (teachers). According to Nitsche the technology that offers interactive learning activities and environments are very important because digital natives are looking for interaction based learning environments [10]. Many studies shed light on the student-teacher interaction issue as

some studies show that a group of teachers are resisting the idea of merging technology with education [11].

Recently, in conjunction with the significant improvement mobile devices has achieved, and with the increased effect of the social media on students, several researchers worldwide have conducted studies to assess the possibility of engaging mobile devices as a learning tool to improve the learning process.

In 2005, Scanlon, Jones & Waycott studied the motivational role of mobile devices and how valuable it is in learning on field trips. According to Jones & Waycott, the learning activity in which students obtain and gain information adding to it their own opinion and perception through interaction with other learners and educators is what creates a true and effective learning process. The teachers, students, an interactive mobile learning tool and the user's mobile devices will create a perfect environment for learning. The findings of the study revealed that learners interact in two settings, physical with peers at school and indirectly from the society or culture. Mobile learning is a perfect learning tool that fits in both settings. Hence, there is a need to develop applications specifically designed for mobile learning [67].

Vimala, Liew, & Pourgholaminejad have conducted a research in Malaysia about the usage of learning tools empowered with social media factors and to understand whether university students are motivated to this learning method. They have designed a learning tool with social media acceptance keys like social influence, facility, performance, functionality and self-administered learning. The tool was introduced to students and two surveys were offered one before the tool usage and another one after using the learning tool. The data analysis has shown that there was a noteworthy development in student's performance after using the suggested learning tool. The study highlighted the fact that students are willing to change their perception about mobile learning tools that are designed with features like social media applications. This would suggest that educational tools supporting these features have the potential to enhance students learning experience and motivate them to adopt mobile learning to improve the learning process [12].

Shorfuzzaman & Alhussein [13] initiated a study investigating learners' motivational factors and readiness to adopt M-Learning in higher education institution in the Arab Gulf Cooperation Council (GCC) countries. Undergraduate students from one of many GCC universities took part in a study in which technology acceptance model TAM was used to spot light and focus on mobile learning acceptance variables like, usefulness, attitude, behavioral intention and ease of use [14]. The survey questionnaire data analysis has shown that both learners' mobility and creativity have positive impact on performance and effort expectancies, which are stronger factors of learners' readiness to use M-Learning. Even though the social atmosphere is vital for young learners, this research findings shows that it has less significance in determining learners' behavioral intention towards using mobile learning.

Popovic. O, Markovic, & Popovic. R, [15] have developed a testing tool for a school in Serbia then measured the influence of the mobile platform on learning. Popovic et al. argued that teaching and learning in an informal environment is made possible through the use of mobile learning [15]. This will create more relaxed learning environment. Complicated mobile learning user interface and design might drive away learners from accepting mobile learning concept in education. The amount of information offered to learners should be presented in an easy to digest and understand. Applying interactive learning and discussion between learners, allowing them to share their knowledge and offering them experimental and challenging tasks that requires researching and testing and the utilization of instant feedback tools need to be implemented and applied to mobile learning environment [16]. The researchers have tracked their student's grades for five years to discover the impact of mobile learning on student's performance. Their study have shown that mobile learning have a noteworthy and positive impact on the learning process because the students grades and performance were higher and better after using the mobile environment compared to previous years. It was clear that mobile learning supports and works harmoniously with formal learning. Many of the students who have participated in this study were very enthusiastic and motivated to discover, use and apply mobile learning in their studies, on the other hand there were many students who resisted and opposed the idea of mobile learning in education. The study claimed that those who opposed the idea of

mobile learning got lower pass rates in tests and experimental activities. Although mobile learning environment is of great importance and adds a lot to formal learning and opens new horizons to motivated learners, the academic institutions must leave the final decision up to students to adopt or reject the suggested learning concept.

Gana & Balakrishnana investigated the effectiveness of interactive mobile messaging in class to enhance classroom interaction [17]. The findings showed that students are willing to use interactive learning tools because of the potentials to support the learning process and to improve student-teacher interaction. Hence, there is a need to develop applications specifically designed for mobile learning.

Another research was conducted by Liu, Chen & Tai questioning if collaboration, participation, popularity and teaming activities have an impact on students [18]. This study was intended to students in Taiwan and China to help improve in English and computer use through collaboration. After a set of learning activities a questionnaire were offered to participants aimed to discover if organizing students in groups and offering them team work learning activities had any effect on their performance, what strategies did the students used to collaborate with other team members and whether social network acceptance and usage factors like popularity has motivated students to participate and contribute more to the learning activities. This type of learning activities where social networking tools that allow students to learn through collaboration were efficiently employed revealed that such methods had a positive effect on students' engagement and motivated them to prefer social networked learning approach as an informal method of learning. It was found that participating in the learning process has increased students' self-assessment, interaction, and collaboration and allowed better interpretation and understanding of the learning contents [19]. The social networking activity involves online information sharing, fun, satisfaction and increase motivation and confidence to accept and adopt online learning tool [20].

Wang (2017) showed how integrating mobile learning functionalities with an effective learning pedagogy like flipped classroom, encouraged students to engage more in class activities, and helped them improve their problem solving and critical thinking skills

[21]. The researchers have added some factors to the framework they implemented, Merrill's framework, like self assessment and reflection. The study claims that allowing learners to assess and evaluate their performance themselves has a positive impact on learners and encouraged them to participate in the learning process and learning activities. Self assessment leads to better self reflection and offers learners the opportunity to engage more and act as contributors which in return improves their learning performance on the long run. The study used Moodle to collect and analyze learning data from many courses offered in a school in Taiwan. The results revealed that engagement, self assessment and social interaction have improved students-students and student-teacher's relationship and helped students reach higher level of learning skills especially critical thinking and problem solving.

A study conducted in North Korea by Kim and Rha (2017) suggested that students working collaboratively achieved better than those working individually [22]. Furthermore, students' collaboration increased after being involved in mobile learning group activities. Individual-level inertia means that digital immigrants (teachers or students who are not good in using mobile devices) tend to resist and stick to current learning methods and do not care about other alternatives even though better alternatives exist. While developing an effective mobile learning tool, developers should pay more attention to users who prefer and willing to adopt mobile learning. Thus, we have to introduce mobile learning services in a simplified way to avoid resistance and customize the learning tool to match with student's personalities and attitudes.

This study has measured six elements, relative advantage, complexity, inertia, innovativeness, mobile learning resistance and intention to use mobile learning [22]. 58 students from a school in South Korea were surveyed. A self-administered online questionnaire was offered to participants. The research outcome suggested that for students to benefit from mobile learning, instead of transferring the academic institution web based learning resources or transform and modify them to fit as mobile learning tool content we should design a simple learning tool and offer students small chunks of knowledge to interpret and understand through collaboration and

experimental learning activities that are suitable for a mobile environment and fits the educational needs of the students who are motivated and showing willingness to adopt mobile learning [23].

Ktoridou et al. (2007) evaluated if it is feasible and practicable to merge mobile technology into the teaching and the learning processes in education. The objective of their study was also to assess if educators are willing to integrate mobile devices in their classroom learning pedagogies and to figure out what features and characteristics effect the integration of mobile learning in education and develop strategies and requirements for integrating mobile learning in the learning process.

The study suggests that criterions like the academic institution role, the learner's role, technology, organization and structural issues and content design should be based on explanatory and comprehensive learning and teaching methodologies and pedagogies. In this research no solution or tools were proposed, instead a qualitative survey was conducted to evaluate attitude, information literacy, knowledge and skills, software and hardware [5].

A mobile learning pedagogical framework that is helpful for developing mobile learning materials was suggested in this study [24]. Chee-Kit et al. suggested that in order to enhance learning experience in a mobile environment we need to change the current learning environment. We need to introduce new learning concepts to learners like self motivational learning. The researchers were interested in studying and discovering the problems that educators have when they merge mobile learning contents with formal classroom educational resources. The study outcomes revealed that focusing on the student or the learner in school or in a workplace and adopting the learner centered teaching methodology had a great and positive impact on the quality and performance of learning. Educators can benefit from mobile learning tools and online educational resources and students can organize and manage their learning process. This independence and collaboration between teachers and learners will enhance creativity and encourage learners to accept new learning concepts. [24].

Traxler and Wishart (2011) argued that the mobile learning community is capable of developing and improving the concept of m-learning. The changes in the learning environment and the learner's needs encouraged educators to create new learning pedagogies and merge it with mobile learning in a way that fits the syllabus goals. Mobile learning offers a space for teacher-learner interaction. Introducing the concept of game based learning and trying different technologies in education like SMS to motivate students to interact actively with the learning contents. The outcome shows that mobile learning is increasingly becoming more accepted and we can benefit from social app motives [25].

A study by Pimmer and Norbert (2012) suggested that developing and sharing multimedia learning resources like audio, video and illustrative images with different learning environments at school or at work would help discover and create new individual and social forms of learning. The research studied some attributes that can add value to mobile learning and make it possible to be part of any learning environment, formal and informal. The suggested strategies will motivate learners to collaborate and contribute to the learning process and be part of the learning process. [26].

Martin and Ertzberger (2013) investigated the effects of here and now mobile learning on student achievement and attitude. The research questioned if the concept of "Here and Now" mobile learning significantly improve student perception and performance. The study affirmed that mobile learning can deliver interactive learning and keep students engaged in any learning environment. In this study no mobile learning tool were introduced, just another learning materials resource service [27].

Nitsche (2013) evaluated some issues that relates to the teaching process. Nitsche argued that the gap between digital natives and digital immigrants lead to inefficient learning conditions. Some universities are forced to offer mass lectures in crowded lecture rooms due to rise in school enrollment. Teachers won't be able to apply interactive learning methods and students will be deprived from interactive learning opportunities. The study found that mobile learning tools represent a great opportunity

to increase interactivity. The study mentioned that some educators and academic institutions are not willing to accept this kind of learning process because mobile learning couldn't show the expected benefits quickly. The study suggested that lecturers should include mobile app in lectures and encourage students to be active users of mobile learning applications [6].

Yang et al. (2007) study aimed to understand and figure out the factors that motivate learners to take part in an online discussion. The researches proposed that if we can identify such influential factors and merge them with different learning methodologies it will have a great effect on the learning process. This will create an effective learning process and motivate students to share and exchange knowledge and expertise. Knowledge share and exchange will have a positive impact on the performance of the learners. The interaction between learners creates a social learning environment, a relaxing learning pedagogy that encourages and motivates learners to participate voluntarily and not due to formal learning rules [28].

In a recent study, Gana and Balakrishnana (2016) investigated the effectiveness of interactive mobile messaging in class to enhance classroom interaction. The findings showed that students are willing to use interactive learning tools because of the potentials to support the learning process and to improve student-teacher interaction [17].

As can be seen from the literature review, the concept of mobile learning is gaining global interest. The potential for M-Learning for becoming part of the learning tools that academic institution can use is now evident. The studies also showed that mobile devices have offered great opportunities to the M-Learning communities, and that arranging students in groups had a positive impact on classroom collaborative learning activities. Still, there is a need to explore the factors that attract young technology users around the world and to develop an effective learning tool that fits their learning needs.

2.1. Learning from Earlier Case Studies

Science and engineering subjects and related topics are important, critical and essential to any country's competitiveness, and governments have real concerns about the skills students need to develop to be creative and productive. 'Science in practice' is a challenge to show how today's technologies can motivate students to investigate, learn and discover the power, opportunities and promise of science through hands-on activities.

A proof is required to show academic institutions that mobile learning has a positive impact on learners and is of great importance to the learning process. Unfortunately mobile learning enthusiast couldn't develop appropriate evidence. The evaluation was compared to e-learning because of the common environment factors with mobile devices (learner\user centered, engaging and interactive content, personalization). Mobile learning researches and for the sake of research purposes only did not put any effort on experiments and designs and preferred to use school laboratory devices and not student's devices. The outcomes were good for their research, but when applied in user device learning environment is unsustainable and academic institutions can't rely on.

Several recent case studies represent an attempt to initiate modern and innovative projects with illustrative purpose (a concept) after mobile learning popularity has increased. We must not miss the opportunity to take advantage of previous attempts and studies as those projects are informative and revealed many ideas that would help us understand mobile learning mechanisms and potentials.

In these case studies, mobile learning researchers were asked to explain and clarify the technology used and how are they going to apply them and whether involving students' mobile devices was effective in supporting their learning or not. Researchers noted that SMS texting, for instance, are being used as an innovative academic pattern in learning and for supporting students, it is an effective and appropriate learning pedagogy that can be easily applied to different learning environments.

2.2. SMS for Real-Time Simulations

This is an illustrative example reflecting the impact of texting on the learning process. A rain flood simulation project is done by some students using SMS to share information for decision making. Teachers intended to help learners to transform theoretical ideas to a practical case and to teach them to take immediate decisions practicing agility in decision making.

First, teachers provide students with brief discussion about the case study. To motivate students to actively participate in the learning process, students were assigned a manager's role to learn decision making in critical situations. Students started sending information messages to alert the manager to predict heavy rain.

After a while a message arrived asking learners to make a decision. The students should use the messages received and edit their investigations before decision making. Messages must be sent on a timely basis otherwise the manager sets the default decision.

For the task, student could use any source that would them in decision making. The teacher (tutor) will provide students with variety of information depending on student's requests. All the messages, the information and the decisions made after each phase were open to all students to review, reply, comment or add on their own observations.

For this project teachers have selected SMS because of its availability anytime, anywhere and easily accessed by students enabling the activity to take place in real-time helping students applying theory to practice and breaking the rules of traditional teaching methods as well.

Moreover, teachers have used e-mail services so students can communicate and share data using both services. Students were allowed to use their personal mobile phones. For decision making, teachers can use the online weather forecast simulation system

which has branching decision tree or a more sophisticated method like rough sets and extreme learning machine ELM for Multilayer Feed forward Neural Networks and a powerful and highly accurate data classification function. Students will appreciate such assignments being active real time teaching methods and not just being another theoretical boring lecture or essay. They feel more involved, contributing, learning and having fun.

Sustainability means reuse but an ethical issue might appear. Spending too much time on mobile learning activities might have an impact on student's performance and progress. Mobile learning is not intended to prevent boredom, its data exchange between teachers and students, it's observing and analyzing, learning from trial and error, it's a teaching method that put theory into practice [25].

SMS text messaging simplified the process of integrating theoretical knowledge and rapid decision making through practicing, investigating and analyzing theoretical facts. The academic institutions are in need to create a 'virtual' physical and social system based on text messaging as an appropriate tool for learning and communicating.

2.3. Field Trip Settings and Case-Based Learning

Another research studied the role of mobile devices and how valuable it is in learning on field trips. Mobile devices usage on field trips has motivated learners to initiate a research, learn more about subject topics and helped improve critical thinking and decision making. However, the main goal of the research is to help students develop practical skills and apply them in course theoretical ideas.

Field trips are somehow considered formal learning environment. It is very close to group learning activities where students share knowledge and learn from each other based on their individual observation and analysis experience. It is a method that teaches students to contribute to subject topics, participate in real life experiments and support group work.

The concept aims to make students experience the process of managing a work-related activity via mobile technologies similar to researches held by real companies. The teachers, students, the school lessons and the mobile device will create a perfect environment for learning, combining formal teaching methods with hands on experience and the capabilities of mobile devices social tools. It is a smooth strategy to enrich learning through the use of technology. It is a technology enhanced learning concept.

Information technology capabilities have opened new opportunities for e-learners. If we compare devices that are used mostly in fieldwork like the handheld Global Positioning System GPS with smart phones, most probably we will find that the smart phones usage is higher in fieldwork than GPS and learners can keep using them for feedback after field work practice and experiments, a thing that encouraged educators to support personal mobile devices embedding in the learning process, especially that these devices enables data collection and analysis on site, instant feedback, update, data storage and sharing [25].

This type of activities will build learner's confidence to examine and assess scientifically produced data or data provided even by legislators and help students to link classroom activities to their non-school knowledge. Such vivid and interactive teaching methods may encourage students to share, discuss, present their data and prove them scientifically, enhance their report writing skills and improve critical thinking

2.4. LMS Systems, Types and Drawbacks

Without effectively examining various current M-Learning apps, we won't be able to develop an innovative, efficient and productive M-Learning tool. Several web based applications have adopted M-Learning. Blackboard Learn, Moodle and Edmodo are probably the most trusted, well known and widely used LMS systems by academic institutions that are interested in e-learning and enthusiast about developing and embedding M-Learning in education.

Blackboard is a web based commercial system that enables the management of courses and can be used for supporting the formal way of teaching through providing learners with an online environment for course interaction and is a tool that allows faculty members to add resources accessed online to enhance the learning and teaching process [29].

Moodle is a distance learning software and a course management system. Moodle is the most popular noncommercial e-learning platform. Edmodo is a platform that runs on a web browser offering a learning tool for students and allowing them to get connected with their teachers, collaborate, share knowledge and access class materials. Edmodo have initiated Snapshot a tool to measure student's progress [30].

There are many other LMS tools in the market some even have their own cloud platforms. Many cloud forms supports a new learning pedagogy that will have a good impact on the learning process called massive open online courses (MOOC) which utilizes multimedia as educational resource for learning [31].

LMS systems come with major drawback especially web based commercial systems, the cost and location. These LMS are accessed from a desktop or laptop to be used efficiently due to the details included in the systems that requires a wide screen which also means accessing the service from a fixed location.

M-Learning as a practical and efficient way of learning, reflected the mobility of students. M-Learning has provided learners with learning tools that can be accessed anytime anywhere on any mobile device no matter how small the screen size is, in school or off school merging formal and informal learning methods. Mobile learning has the capacity to deliver proper education and provide learning opportunities to different environments.

Besides the technical side of developing a learning and communication technology in education, we should analyze and implement pedagogy methods in order to have a productive and efficient learning system. We have to understand learner's needs

especially after school and we should provide educators with a communication tool that allow them to provide learners with easy to understand amount of information and a space to focus on and discuss critical data that will help improve students critical thinking and analytical capabilities, and prepare them for the industry through the learning of research techniques, knowledge share and knowledge exchange.

2.5. Current Learning Tools in the Mobile Environment

M-Learning is used to help the learning communities to interact and collaborate, learn knowledge share and research methods, initiate experiments, contribute and not passively consuming data. Since none of those systems reflected the characteristics of true education, we have created an "After class interactive M-Learning support app" a native mobile LMS platform for all areas of studies and programs, designed for academic and professional use all over the world. M-Learning system is supposed to provide the basic teaching and learning functionalities. Applications designed as learning tools must have a user friendly interface for users to accept it.

Several learning tools are available in mobile environment such as I-Tunes U, M-Learning Auto Assessment and others. I-Tunes U offers free education content from top universities. Teachers can build lessons on the app and interact with learners. I-Tunes U is built on the transactional logic of web design. It is not a good place for collaboration or creating a learning community. M-Learning applications are meant to build and strengthen the bonds between the educators and students inside and outside the classroom boundaries. Teachers can use m-learning auto assessment tools to initiate lessons and tests about pre-discussed topics to students. The system is not good for student's interaction or collaboration purposes it's a simple self-assessment application [20]. In addition, Khan Academy provides learning material in a form of drawings on electronic blackboard videos hosted on YouTube. The system generates progress reports and recommends new topics to learners [32]. A major flaw in Khan Academy is ignoring learning pedagogy methods. These methods are very important because it sheds light and reveals learners and educators needs that should be reflected in the M-Learning tool [33].

Khan academy provides learning material in a form of drawings on electronic blackboard videos hosted on YouTube aiming to make education easily accessible to everyone. They have a developed a mobile version covering different topics like math, science, literature and history. The system generates progress reports to help people track their progress and also to recommend learners new topics. The software offers practice exercises, instant feedback and continuous assessment. A major flaw in khan academy system is ignoring learning pedagogy methods. These methods are very important because it sheds light and reveals learners and educators needs that should be reflected in the system.

I-tunes u offers free education content from top universities especially for IOS. Teachers can build lessons on the app, give instant feedback, grade activities and initiate discussions, comment on student's replies and track student's progress. Students can join debate discussions, view assignments, answer questions and view grades and instructors feedback. I-tunes U is build on the transactional logic of web design. It is not a good place for collaboration or crating a learning community. Some universities have criticized I-tunes U defining it as a delivery mechanism and not a teaching and learning tool. The major strength in any M-Learning application is to strengthen the bonds between the faculty and students in and out of the classroom.

Blackboard Learn is a web platform commercial application that can be accessed from mobile devices, the mobile application is called Blackboard Mobile Learn. Students can use the application to participate in class discussions initiated by teachers, receive messages notifying class activities, reviewing the lessons, answer questions, reply and comment on topics.

Auto Assessment is a mobile application used by teachers to initiate discussions, make tests and explain new topics. The system offers learners a tool to test their knowledge and expertise in a specific topic using test designed by their teachers. The system is not good for student's interaction or collaboration purposes it's a simple self-assessment application.

Moodle is another learning platform that can be accessed from student's mobile devices. The mobile application name is Moodle Mobile 2. Moodle is famous for providing learners with customized learning environment of their preferences. Students can use Moodle Mobile to track progress, review lessons, receive messages and access a variety of learning materials. Built over Moodle web platform, instructors need to access the web version to design and control tests [30].

It is obvious that most mobile applications focus on offering videos, learning materials and lectures which is not the main purpose of M-Learning. M-Learning is derived from and inspired by electronic learning but designed with a different architecture and logic. M-Learning is used to help the learning communities to interact and collaborate, learn knowledge share and research methods, initiate experiments and not passively consuming data. The M-Learning tool should improve student's analytical capabilities and develop their critical thinking skills and most importantly build and strengthen bonds between learners and educators and to boost this relation in class and after class.

Since none of those systems shed light on any of these issues, we have created an after class support system as a mobile LMS platform for all areas and programs, designed for academic use free of charge.

2.6. Problem Statement

Initially we have to understand the major assets in any academic institution, the teachers and the lessons. Some teachers are labeled as digital immigrants. Digital immigrants are the generation that lived before the widespread use of technology it was not part of their formal or informal life style. On the other hand we have students or the natives who used technology at earlier stages of their life mainly for entertainment and have gained skills unknown to their educators. The gap between technology natives and immigrants is clear within academic institution because digital immigrants are teaching native users of technology. Such technologies are of great importance to teachers and offer them an opportunity to combine technologies with social factors that motivates students to participate and contribute to the learning

process [10]. Despite the low acceptance of such teaching and learning process nowadays, mobile learning is expected to increase the interactivity in classroom and create an opportunity for self motivating, encouraging and collaborative interactive learning activities.

Besides the technical side of developing a learning and communication technology in education, it is important to analyze and implement pedagogy methods like personal enquiry method, progressive enquiry and collaboration method in order to have a productive and efficient learning system. We have to understand learner's needs especially after school and we should provide educators with a communication tool that allow them to provide learners with easy to understand amount of information (Bite-sized) and a space to discuss and focus on critical data that will help improve students critical thinking and analytical capabilities, and prepare them for the industry through the learning of research techniques, knowledge share and knowledge exchange.

Another major challenge educators are facing is how to provide better learning opportunities for people with special needs and most importantly providing education to girls in conservative families and communities around the world. This challenge is experienced by individuals living in conservative societies like women who are deprived from formal learning and have no opportunities to join informal education. Mobile learning provided them with an opportunity to be active learners through private learning opportunities with mobile devices. Zurita et al. [34] have agreed with Ting [23] that mobile technologies coordinate and synchronize mobile learning. Mobile devices offer users obscurity. This feature will encourage learners to interact with online learning contents, contribute and share information and knowledge. Interactive learning helps students assess their progress based on replies from other learners. The interaction with other learners will have a positive impact on the performance of learners. Therefore, although mobile learning has faced different challenges but it has enabled teachers to reach different categories of students. It could be hard as well for some instructors to identify new methods to help students understand the course contents. While new instructors might be impressed and affected

by the academic institution teaching and learning tools and techniques, the current instructors on the other hand might prefer to use previous terms materials and stick to old school teaching tools and techniques and resist the use of new technologies or merging it in the educational process. Teachers and institutions alike are responsible for this issue and should figure out smart resolutions for the case.

Therefore, the major concern of this research is to work closely with university students in order to introduce a learning tool that incorporates the benefits of social media in a mobile learning system to improve the learning process. Accordingly, our objective is introduce an application that represents a great opportunity for academic institutions and staff as well. An application creating bridges between students and teachers and between students and the course contents as well. But how can we implement that method effectively? A user friendly and easy to use application, a cutting-edge teaching tool for all teachers and students, an application that teaches, guides and motivates students to read more, dig deeper to find answers, generate evidence from experiments and share knowledge. This will help students understand class topics more and gain confidence by seeing themselves as contributors to knowledge and not passive consumers of teacher's instructions.

In this research, we are engaging in the process of developing M-Learning around the world, we are offering a learning tool with social media functionalities that will attract students and make learning more enjoyable. Moreover, we have observed that there were no studies that assessed the perceptions of students globally or shed light on the required factors that should be added to mobile learning tools that will motivate students to adopt mobile learning in their education process. The tool includes a feedback system which will show students progress, teachers should monitor the learning process to recommend answers, review references used and to keep students challenged through the course by setting a timed test, a challenging topic or post group debate assignments which enhance collaboration and communication and boost knowledge share and exchange [63].

Summarily, higher education has recently recognized the huge potential brought by social media technologies to improve student engagement, college experiences, and pedagogical practices. Thus, we need to introduce effective learning methods that would enhance the learning process and help students develop true learning skills. We believe that mobile learning provides other opportunities for learning. It can also be used if sitting idle, while waiting or while in lounge. This is known as Bite-sized learning, it could appear of limited educational effect but we should experiment it and take advantage of smart phones mobility and capabilities in M-Learning and that users see these phones as a lifestyle, improving their quality of life and not just another device.

CHAPTER 3. LEARNING WITH MOBILE DEVICES: DEFINITIONS AND TYPES

We can simply define mobile learning as learning with mobile devices. Years before, educational institutions have underestimated 'learning with mobile devices'. Mobile learning appeared too simple to everyone. With time mobile learning proved that it is more important and should be redefined and rated better than being an opportunity to replace outdated e-learning methodologies or introduce old-school e-learning in a new structured model. Recently mobile-learning has shown that it has the capabilities to offer something unique. Mobile learning can introduce and offer improved ideas about learning almost similar to early perceptions and enhancement for e-learning, but mobile learning is going to be more specific and uniquely customized to learner's preferences overcoming geographical or physiological complications and difficulties.

'Mobile devices' like smart-phones, notebooks and handheld computers are popular devices and people are familiar with using them. They offer various functions that are of great importance to mobile-learning, especially mobility. Besides mobility there are many other key functions like connecting via wired or wireless networks, Bluetooth and NFC communication technologies, collecting and storing variety of data like image, video, text or number, finding location (GPS) and have a capability of running any application and generating different forms of output like documents, graphics, audio/video and reports. Nowadays almost everyone uses a mobile device. Users choose fast and powerful devices, adapt to using them quickly even knows how to deal with the device most sophisticated options and settings.

Mobile devices especially smart-phones and handheld computers have widely spread in a short period of time because of their capacity to be everywhere any time empowered by good battery life. It's an interesting kind of technology improvement, people count on them very much almost in every aspect of their daily lives.

Advancements in mobile learning is a proof that it is not going to be an updated form of e-learning applied to mobile devices for experimental purposes, it’s a new learning concept where learners' own devices are used to initiate a new learning environment and extend education into new communities and places all over the world as well.

It is easy to identify limitations surrounding desktop computers when compared to mobile devices. We have identified the main advantages of handheld devices such as mobility but the main drawback in these devices is still battery life. Some teachers who are used to PC devices might resist new technologies although mobile devices are now equipped with wide keyboards and wide screens, various operating systems, variety of applications, connect to various networks and devices, respond to voice, touch or gesture; record and play different media types. New mobile technologies have full internet access, nanotechnology, mobile social software, location-awareness and a great battery life.

In order to avoid this diversity and confusion we can simply use a school lab limited devices for testing, keeping the capability for the deployment of other mobile devices. There is no doubt that the student’s own device should be considered as the main delivery mechanism in the learning process because it is scalable and an easy to maintain device.

Handheld mobile devices are already in use to assist in the teaching and learning process. PDAs run office editing tools, includes a browser, a camera, communicating via voice, text messaging, email, Bluetooth and WIFI. PDAs helps teachers using the virtual learning environment like blackboard, organize a student centered approach where a tutor monitors and initiates discussion groups. PDA allow students to access course materials, immediate retrieval of information from online databases, organize projects and lessons timetables, record and analyze laboratory results, capture images of science experiments for revising and commenting, adding notes during lessons and sharing files with other groups of learners.

3.1. Origin of Mobile Learning

Mobile learning came from years of ambitious experimental studies applying different methods and technologies and testing them in different learning environments and e-learning communities in the interest of providing e-learners and the academic community with solid proof about the reliability and efficiency of learning using mobile devices. Early mobile learning projects (early 2000's) have studied the limitations of mobile devices like speed, power and screen size when compared to computers. They found out that transforming e-learning methods to fit mobile platforms was ineffective and inefficient.

Nowadays mobile learners and the mobile learning communities are having a chance to work in environments of powerful devices. The most important and noteworthy point is that people own the device, understand technical aspects and can control powerful devices, they also have ideas to improve m-learning unlike earlier days when technologies used for educational purposed were expensive and only corporate and academic institutions can afford such learning equipments. Nowadays mobile devices are affordable to individuals and societies and their performance and functionalities will support and offer researchers and educators new hopes and open new horizons for efficient and reliable mobile learning environment.

Figure 3.1. below shows percentage reflecting what type of mobile devices students use while on campus and use it for schoolwork. At least 92% of college students use smart phones and 40% of them say it is the most important device for their academic success and 72% of students have a laptop where out of 77% claims that it is important for their academic success (see Figure 3.1.). In the same way, a study conducted in the University of Central Florida Chen et al. [35] showed that 86% of undergraduate student own smart phones and about 47% owned a tablet. Accordingly, academic institutions can take advantage of the concept of M-Learning which is an active teaching method that make students feel more involved, contributing, learning and having fun [36].

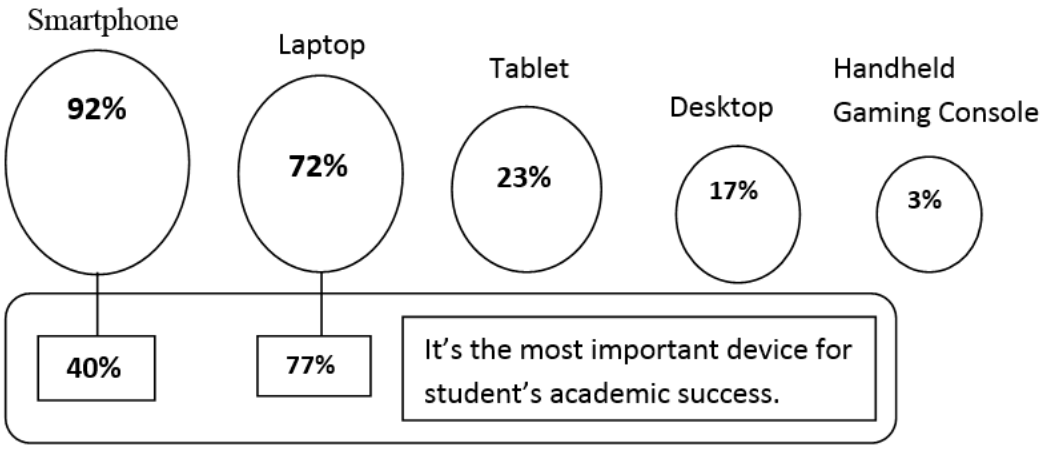

Figure 3.1. Many students consider smartphone and laptop are important for academic success

Therefore, such active teaching methods will make students feel more involved, contributing, learning and having fun. Mobile devices were also used to improve and enrich school field-trip activities and to transform field-trips into a discussing technology [25]. The great specs of mobile devices improve and enhance the ability of mobile learning to redefine learning methods especially for science, mathematics and technology subjects. We can structure and enhance learning through linking physical and social experience with abstract content. Social interaction between learners motivates them to explore the topics and share their thoughts and knowledge [23].

3.2. Mobile Applications Development

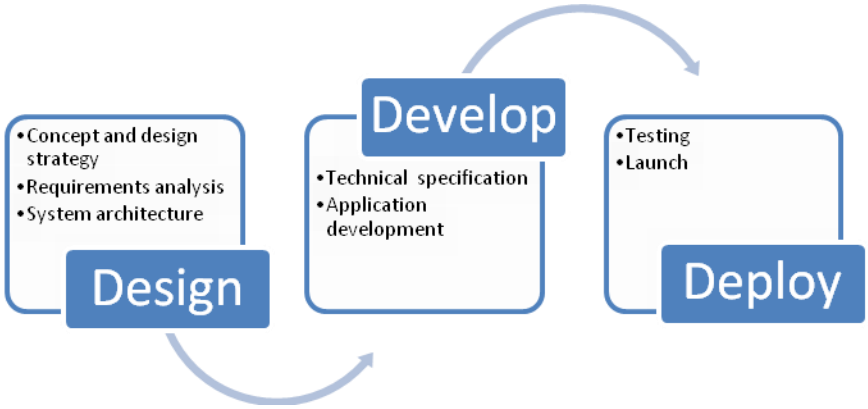

Figure 3.2. Mobile application phases from design to deployment and launching.

Software or mobile development starts with an idea. The idea will be refined into more precise basis and analysis that reflects the motivations, the behavior of the application and benefits to users. The end user, in our case is the student, must always be in mind while designing the application. The user's needs should be discovered and converted into an efficient and effective application which will gain users loyalty on the long run. After development, the application is being tested for errors, after rectifying the errors the application is offered to end users (see Figure 3.2.).

3.2.1. Web applications vs native application

3.2.1.1. Mobile web applications

A mobile web app is a web application where users access them through the device web browser and downloaded from a dedicated server each time users access them. They are designed especially for smart phones and tablets. Java Script, html and CSS are technologies used for building interactive applications and web pages, for text and image design, for style respectively. An advantage of mobile web applications is that they run on both devices the mobile and the desktop regardless of the operating system. This flexibility allows web apps to run on any smart device [37].

3.2.1.1.1. Advantages

- The main advantage is that mobile web apps are compatible with broad number of smart device platforms. Deployment flexibility allows web app to target and reach large number of users without putting much effort into app development. Because mobile web browsers are standardized, creating a universal mobile web app becomes easier. Cost wise, web apps are considered cheap, easy, and doesn't take much time to build unless a specific device customization is required.
- Web apps maintenance is cheaper and easier than native apps because of cross-platform compatibility which allow web app to count on browser

applets without the need to keep up with different devices continuous changes.

- Available and accessible any where any time: without the need to download the desired application, users can access the app address through their mobile browser and instantly get an updated version of the application.

3.2.1.1.2. Disadvantages

- Apart from the well known operating systems, if a new platform need to be supported, the solution may be limited due to the minimal capabilities of web app on different devices browsers, providing users with an awkward app with technical glitches otherwise to solve this issue the process will take much effort and time to customize the apps to fit different browser versions.
- Web apps cannot access built in hardware and software on mobile devices. If the app requires camera or GPS control, or high graphics games, the phone platform will cast away web app immediately.
- Web apps need a good network connection to function properly otherwise users will face performance issues if the connection is slow or unavailable. Users are going to pay air time for Wi-Fi coverage to network operators if they want to access the app on the go.

3.2.1.2. Mobile native apps

Native mobile apps are written mainly in Java and designed specifically for a particular device and operating system. A native app is downloaded and installed from a web store and not through a web browser.

Native apps major advantage is the ability to access device's built in hardware and software and integrates with the mobile device operating system and available applications like calendar and camera [37].

3.2.1.2.1. Advantages

- Fascinating and addictive user experience: Native apps can use mobile device built in hardware like speakers and software like email, clock and file manger.
- Runs offline: No internet connection is required after the initial download and installation of the app. Users get the best performance all the times, with all graphics, images and data included. When the users get connected online, all updates and developments will be automatically transferred.
- Better visibility: Native apps install an on screen app shortcut providing visibility each time users check their phones. On the other hand app stores keep notifying users to upgrade apps. Apps that send update notifications frequently usually attract user's attention more than the other installed native apps with less update activities.
- Native apps are trending nowadays. Users spend good amount of time and money exploring and discovering applications on app stores looking for the latest app that can add something to their daily life routine.
- Native apps generate money. Just upload the app on an app store, set a price and once a user buys it, app owners make money immediately.

3.2.1.2.2. Disadvantages

The market offers variety of mobile devices each with different features. This requires a development of various app versions to fit different devices. However, preparing different app versions means that the developing and testing of apps to fit variety of mobile environments will cost money and time in addition to the high maintenance and update cost of different app versions for different mobile platforms. Cross-platform frameworks are of great help, but time and cost remain unavoidable when developing for different mobile platforms [37].

3.3. Mobile Development Challenges

Technology is rapidly changing and businesses need to keep up with this change if they want to compete in the market. Creating mobile development solutions in a rapidly changing field is a major challenge for companies. Mobile apps require a continuous customization to run on different platforms and be compatible with newly released hardware, OS versions and browsers. We should take in consideration the device platform overlay software which might have a great effect on the native app performance and look.

To avoid this matter, the mobile industry and for the sake of speeding up the development of the platform and simplifying the process has introduced source code analyzers, tools and libraries designed especially for multi-platform development. This is providing developers with new developing tools and capabilities. Developers will spend less time on code, taking advantage of the source code and libraries reusable components, achieve and accomplish more for a little effort and develop from scratch only if it is required for specific platforms and devices. These tools enabled developers to create solutions that should be able to work with the available and any future platforms or technology.

3.4. Web Applications

Nowadays we can find on the web many mobile app builders for free. These websites guarantee users that the app can be created in a short period of time and can be implemented and deployed successfully on any mobile device and any platform. Mobile web apps can’t be as rich and interactive as the original desktop websites. Despite web technologies common feature, developers need to spend more time and effort designing and testing the app, cast away, eliminate unnecessary elements, customize and tune the app until they get an effective and interactive app that fits the screen size, operating system and platform of each mobile device.

Most of the redesigning and testing effort spent by developers is used to solve one major issue, an interactive web app touch interface. Developers should find creative ideas to display web elements to users effectively and create a rich web app user interface experience taking in consideration the huge difference in performance, screen size and resolution between mobile devices and desktop computers.

3.5. Native Applications

The different mobile platforms offered by the market raise the bar of competition on both the developers and the mobile enterprises. The biggest issue to native apps developers is migrating and reusing app features, deploying and implementing it successfully on different operating environments with minimum cost and effort. On the other hand the market provided developers with cross-platform frameworks offering a neutral architecture for each of the environments in which the application will run, in addition to tools that are used to customize the app for specific devices and operating system feature.

Although neutral platforms saved developers time and effort, these platforms still have a major drawback, it sometimes prevents apps from accessing and benefiting from the device built on hardware and software features and capabilities. This could be a motive for developers to use the last resort and build the app from scratch, apps that are designed and customized separately for each mobile device platform using the original native app development tools. Inevitably this will cost developers more time and effort. Building an app from scratch could appear as a drawback but it will offer app design flexibility and help eliminate porting issues to different mobile device platforms.

3.6. Mobile Learning and Learning/Teaching Methodologies

Lately the mobile learning communities have shown that they can enhance and expand formal school learning through the dependence on the mobile teaching and learning concept. This in return will offer learners the opportunity to react and respond immediately to frequent educational environments changes. One of the methods

suggests that learners may gather and analyze data while in site and then investigate the findings at school and note down unique and important observations. Before, students had to be available in laboratories to note down measurements and perform calculations before starting outdoor experiments. The continuous change in the nature, context and settings of teaching and the learners motivated and inspired teachers to update and change their teaching methods to be compatible with the reformed and improved teaching environment and to satisfy the learner's needs. Teachers can use projectors, interactive mobile learning systems and instant feedback systems to evaluate learner's progress and ability to understand the lecture and to change the scope of experiments at hand [38].

Another method is situated learning. Learning in specific related surroundings makes learning relevant and significant, for example learning a foreign language by visiting the country where it is spoken, or visiting temples, mosques, churches to discover religions. Real life learning experience is called authentic learning, for example students can study and make presentation about the issue of pollution or overfishing. Situated learning and authentic learning are essential for any lesson with fieldwork activities such as science and engineering. Schools should include a professional course with a major element of work experience, especially for teachers and programmers. It is beneficial to spend long periods away from university to get practical experience with professionals. Mobile learning offers learners an opportunity to stay in contact with educators and trainees and to access open learning resources.

Situated learning can benefit from mobile functionalities like GIS data, GPS, RFID, Bluetooth, 2D and 3D bar codes, sensors, and near-field communication (NFC) and radio frequency technologies, mobile based visual search, image capture and social networking. Advanced technologies have enabled students to learn in an environment that integrates real world learning resources with digital world resources [39].

The fourth is context-aware learning or direct interaction with the task for example testing a chemical formula in laboratory or debugging a source code and rectifying errors. To improve student's learning experience it is highly recommended that

students visit the location that relates to the task at hand as this will provide them with learning resources and help them develop a deeper understanding of the topic. This is known as context-aware mobile learning.

A fifth major is customized or individualized learning in which the contents and the learning environment are designed to match the learner's needs, wants and requirements. Open source Mobile applications are enriching learner's experience. These applications enable students to find any information they need to complete their tasks.

Game-based learning nowadays is reflecting the underestimated capabilities of mobile technologies. It has a great impact on the students. Learners set a lesson plan using competitive exercises, motivating students to challenge each other to accomplish lesson goals. This is an effective way of learning and a method to immerse students in subject materials, search and learn more about complex topics [40].

Our research is based on proof-of-concept, small-scale approach while taking in consideration how to apply and balance mobile-devices and learners. E-learning devotees were motivated by the idea of adopting and merging some of the e-learning functionalities onto mobile learning and encouraged them to share their knowledge and expertise to prove that m-learning has the capabilities, competencies and resources and can provide learning opportunities to hard to reach people and communities especially territories with difficult economic and social conditions. Mobile learning infrastructural barriers in less developed countries was a great challenge to mobile learning. Nowadays geographical distances or reaching rural areas is not a barrier anymore. Rural areas are becoming educationally richer areas because of the greater internet bandwidth and network coverage. The main challenge of connecting learners together is to create effective communities of educators and plot guidelines that focus on information sharing and applying technologies to engage students as contributors in the learning process.

Finally, mobile learning has faced different challenges but it has enabled teachers to reach different categories of students like those lacking confidence in formal learning or low wage individuals, frequent travelers, students with special needs and students in illiterate rural communities.

CHAPTER 4. TECHNICAL DEFINITIONS, APPLICATION DESIGN TOOLS AND CLOUD-HOSTING

In this chapter we will introduce the tools used for designing and developing our mobile learning tool. We will introduce in details all the features about firebase, android studio and Google storage and hosting systems. In addition we will talk about java as the main programming language we have used to develop the mobile application. In this chapter we are going to talk about cloud-hosted database and explain pros and cons of various database systems like No-SQL and Relational database.

4.1. Firebase

To build user interface for a mobile application, Firebase provides us with a Backend-as-a-Service (BaaS) that doesn't need any language for server side programming. Firebase is a synchronized Real time Database accessed from mobile device or desktop. This means that whenever data changes all connected devices will immediately receive that update adding a smooth and interactive surfing experience. Firebase Real time Database executes data accuracy if the user requested to read or write data. Users can turn off the application without worrying about data loss. The Firebase database SDK stores data to disks and synchronize it with registered devices. Once the user initiates the application, all the stored data and suggested updates will be available immediately for use [41].

4.1.1. Firebase services

Firebase Services constitute of two groups, development and growth. Develop & test the app includes (Real time Database, Auth Test Lab, Cloud Functions, Firestore,

Cloud Storage, Performance Monitoring, Crash Reporting and Hosting). Grow & Engage includes (Firebase Analytics, Invites, Cloud Messaging) (see Figure 4.1.).

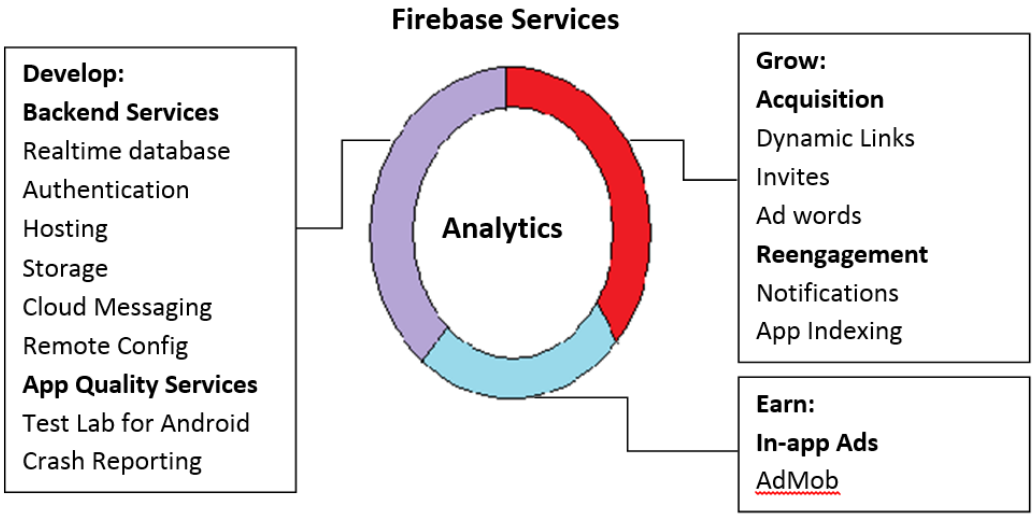

Figure 4.1. Firebase Services needed to develop an efficient and productive application

4.2. Real-Time Database

The Firebase Real-time Database is No-SQL, stored in the cloud and allows storing and syncing between different users in real-time. No- SQL is more scalable than RDBMS and can easily scale out to huge database nodes. Scalability gives more storage and higher performance (see Figure 4.2.). In cloud-hosted database JSON is used to store and transport data to authenticated users. When we built our application with Android and used JavaScript SDKs as a primary programming language, most of our requests depend on Real-time Database instance to get the latest data updates. Developers don't have to create and design a private database or API, because Firebase creates the backend components of Android applications. This can be done easily through the utilization of the Real-time Database instance feature. The current data and the updated data will be available for applications from the Firebase database API. The data is synchronized in real time for all users to access from their devices creating a collaborative environment between users [42].

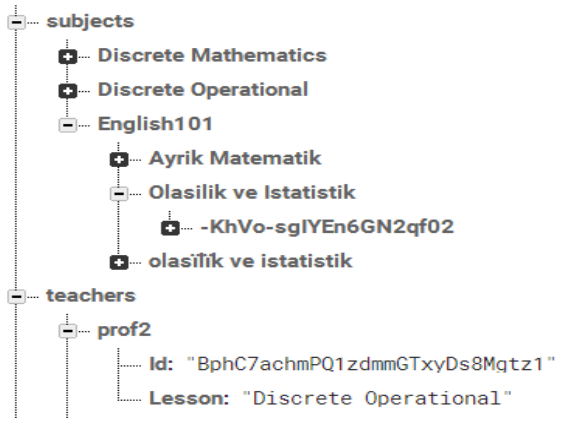

Figure 4.2. Firebase real-time database (admin) showing created sets (subjects and teachers) and subsets

4.3. Authentication

Firebase Authentication backend services, SDKs, and UI libraries are used to authenticate users to access application features. This is used by students and administrators. Sometimes it might take months to set up an authentication system, which means a dedicated team is needed to maintain that system. Firebase authentication supports the use of username, password, e-mail id, social-media login credentials to authenticate users and grant access to application features. Firebase authentication provides us with UI libraries, simple SDKs and backend services to verify registered users (see Figure 4.3.). In IMSSAP we asked learners to sign up using any e-mail (genuine e-mail address is not requested for privacy and security reasons), but signing in through social media is not enabled in our learning application. In our study we have mentioned that will not include a notification system in our app, the main idea is to motivate and encourage students to voluntarily access the app on one hand, on the other hand keeping them away from social media distracting notifications.

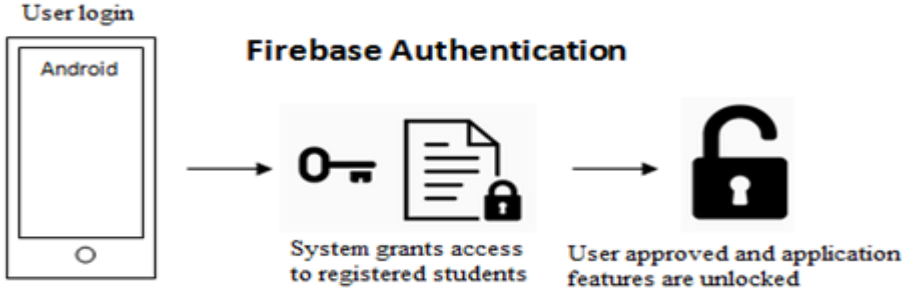

Figure 4.3. User credentials passed to Firebase authentication for verification and response

A secure authentication system can be easily modeled if we use Firebase Authentication services. These services will offer the application users a reliable surfing experience [43].

4.4. Firebase Cloud Messaging (FCM)

Firebase Cloud Messaging (FCM) is a reliable service that connects the server and the devices. This service has almost no effect on the connected devices battery life and consume very little from the memory. FCM allow users to exchange messages and notifications (Android devices) without adding any tariff (see Figure 4.4.).

FCM is part of Firebase Analytics and no coding is needed to set up the service. System administrators use it to send messages to registered users. The messages can be sent to groups or individuals. The limit for notification messages is 2KB and data messages limit is 4KB. This messaging solution is an effective, efficient and cost saving method to broadcast notifications to users as it can be used and run on different platforms and operating environments. In our application any updates will take place automatically once the user logs out from our application [44].

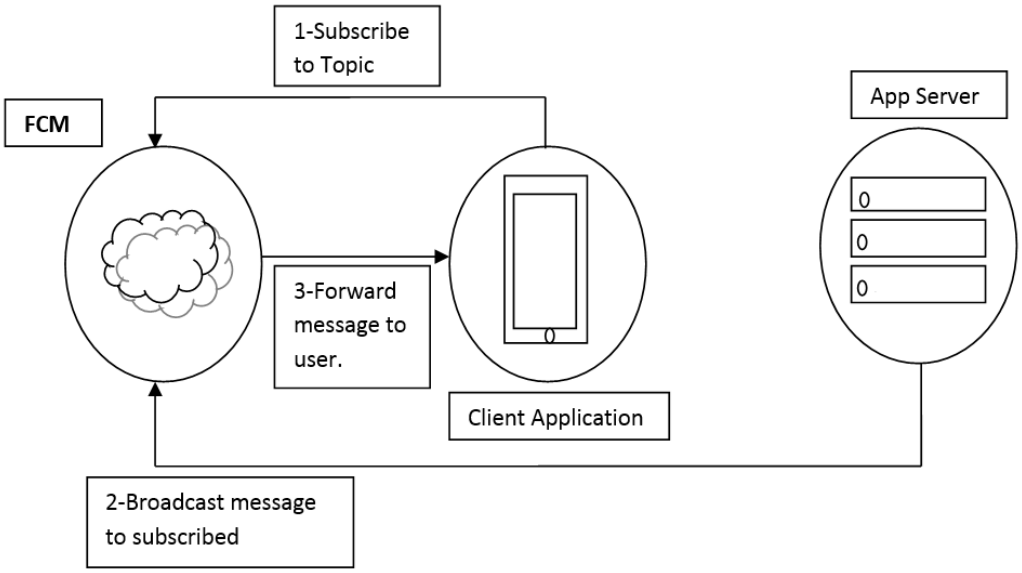

Figure 4.4. Cloud messaging stores and broadcast server messages to subscribed users (user / student and admin). It's a link between the server and the users.

4.5. Storage

Firebase Storage is controlled and maintained by Google Cloud Storage. Firebase is mainly assembled and designed for user generated contents like text, audio, image and video that needs to be saved and made available for all users. It provides users with a secure way to transfer data from servers to applications despite the connection speed. In our project we opt-in only for text and images in our application IMSSAP. We can consider Firebase Storage as a solution for uploading user-generated content like images and videos from Android device. Firebase Storage is designed specifically to provide security, and ensure network efficiency.

4.6. Remote Configuration

Remote configuration essentially allows admin to publish updates to our users immediately, whether we wish to change the color scheme for a screen, the layout for a particular section in our app using the server side parameters without the need to publish a new version (see Figure 4.5.). Remote Configuration enables us to: Easily update our applications without the need to publish a new build to the app/play store.

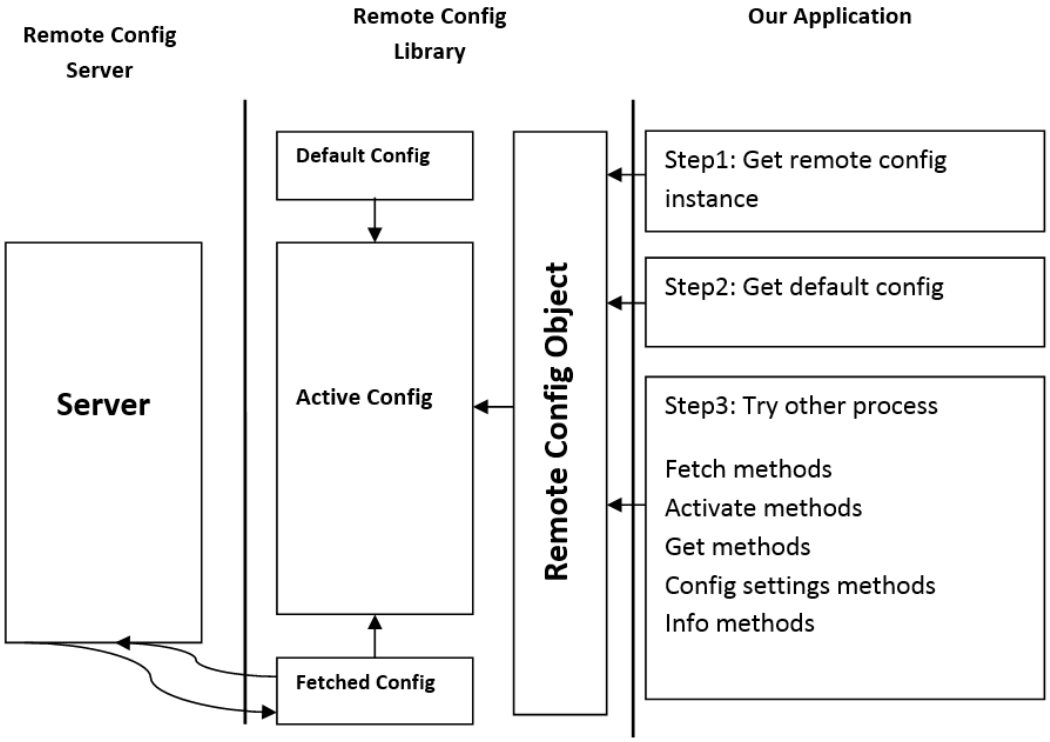

Figure 4.5. Remote configuration to publish updates to our users immediately (admin)

To simplify the process, say that our application (application instance) starts the communication with the server to retrieve the Remote Config instance. The application instance is the one currently running on the device. The application instance communicates directly with the Firebase library using an instance of the FirebaseRemoteConfig class (remote config object). Now as our application has fetched the Remote Config instance, if the fetched values haven't been yet set, then the Remote Config Library will return the set default values. If the parameter values are changed, our app feel and look stays the same until the retrieved values is stored within the fetched Config Instance in the library. Once activated, our application can use the Get methods to retrieve the updated values from the Remote Config Library.

4.7. Test Lab

We can test our application on the devices hosted in a Google data-center through the Test Lab. developers/admin can find device configuration issues that occur on a specific device. The Test Lab generates a report showing logins and screenshots, a data

that is saved in our project in the Firebase console. We don't need to run a test for our application code consequently because the Test Lab will look for crashes and errors automatically.

4.8. Crash Reporting

Crash reports create reports automatically in a detailed form showing the errors and allow us to save and analyze events and steps which lead to a crash. After initiating Firebase all the crash report features will be activated. There are some limitations for these features. We can't use firebase unless the applications are using the same database that is modified simultaneously by many users and the updates are broadcasted to all registered devices and users. My-SQL database is utilized on firebase to review functions. SQL features are not supported. JSON must be added to the programming language we are using (Java), build lists manually and save queries for future use in order to be able to broadcast messages or notifications to users.

4.9. Firestore

Firebase Firestore storing and querying of data is efficient and flexible. Users can retrieve any data without accessing sub data. Unlike SQL where data is stored as tables and row No-SQL stores and scales data as documents. Though this may sound like something similar to the Real-time Database, Firestore offers us the following:

4.9.1. Improved querying and data structure

Firestore keeps data in a form of documents clustered in collections (group of documents). Each document consists of key-value pairs and can contain any kind of data like objects, strings or binary data. Firestore database can consist of multiple collections that can contain documents pointing towards sub-collections (see Figure 4.6.). These sub-collections contain documents that point to other sub-collections. We can simply fetch any document that we want without having to fetch all of the data

that is contained in any of its linked sub-collections. We can fetch a single document without having to access any of its sub-collections [45].

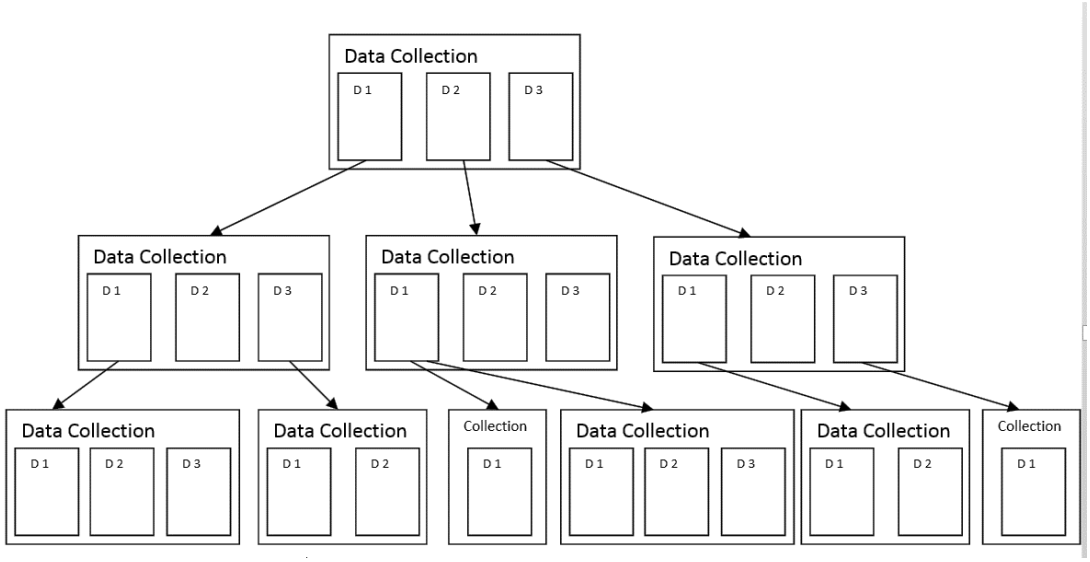

Figure 4.6. Data structure, fetching documents without having to fetch its sub-collections

4.9.2. Better scalability

Cloud Firestore is based on Google's Cloud infrastructure. This allows it to scale much more easily and to a greater capacity than the Real-time Database. This is critical once our database becomes huge.

4.9.3. Multi-Region database

In Firestore, our data is automatically copied to various regions. So if one data center goes offline, we can be sure that our app's data is still safe somewhere else. Firestore multi-region database also provides strong consistency. Any changes to our data will be mirrored across every copy of our database.

4.10. RDBMS and No-SQL

4.10.1. Relational database management system (RDBMS)

The most common relational database management systems language is RDBMS. In relational databases the data is usually saved as rows and columns. The rows in the database hold the unique instance of data for the categories defined by columns. The primary key identifies rows uniquely. SQL is a query language used to create tables and identify primary and foreign keys and build the relations between tables and used to modify, retrieve and update date.

4.10.2. Limitations for SQL database

Scalability and complexity are the two main limitations of SQL. Tuning of relational databases is very important and has a great impact on the performance of the server. This is critical especially if the server is sophisticated and expensive. If developers can’t handle such servers it is advices to split the database on more than one server for scaling purposes although managing and scaling tables will be difficult on multiple servers. Normalization is important as it helps fit data into tables and makes it easier to handle relational databases [46].

4.10.3. No-SQL

There isn’t fixed table schemas in No-SQL (Not Only SQL) like RDBMS. No-SQL scales horizontally and support limitation of join query on specific tables. No-SQL databases are unstructured and schema less. The data can be stored on multiple servers. Firebase uses No-SQL for data storage and management.

4.10.3.1. Benefits of No-SQL

1- Highly and Easily Scalable

We scale relational databases vertically. But in case we have huge RDBMS database we need more powerful and bigger servers to handle the load for data to be scaled efficiently. On the other hand and contrary to RDBMS, No-SQL databases expand and scale vertically. Vertical scaling requires adding more servers to the available resources. Many developers prefer No-SQL because it includes auto management repair tools and simple data models and needs less tuning [46].

2- Lesser Server Cost

No-SQL is an open source database. No-SQL uses less expensive servers to manage data than relational databases and can implement data easily. Processing data costs very little compared to relational databases although RDBMS use expensive servers and expensive storage systems.

3- No predefined Schema or Fixed Data Model

No-SQL key-value cache database in system memory empowers and escalates its performance. Data models can easily change without the interference of the application because the database is schematic.

4.10.3.2. Limitations of No-SQL

No-SQL database is Open Source. No-SQL database doesn’t have plenty predefined stored procedures or a standard query language or API or GUI mode tool like RDBMS.

4.11. Android Studio

4.11.1. Android architecture

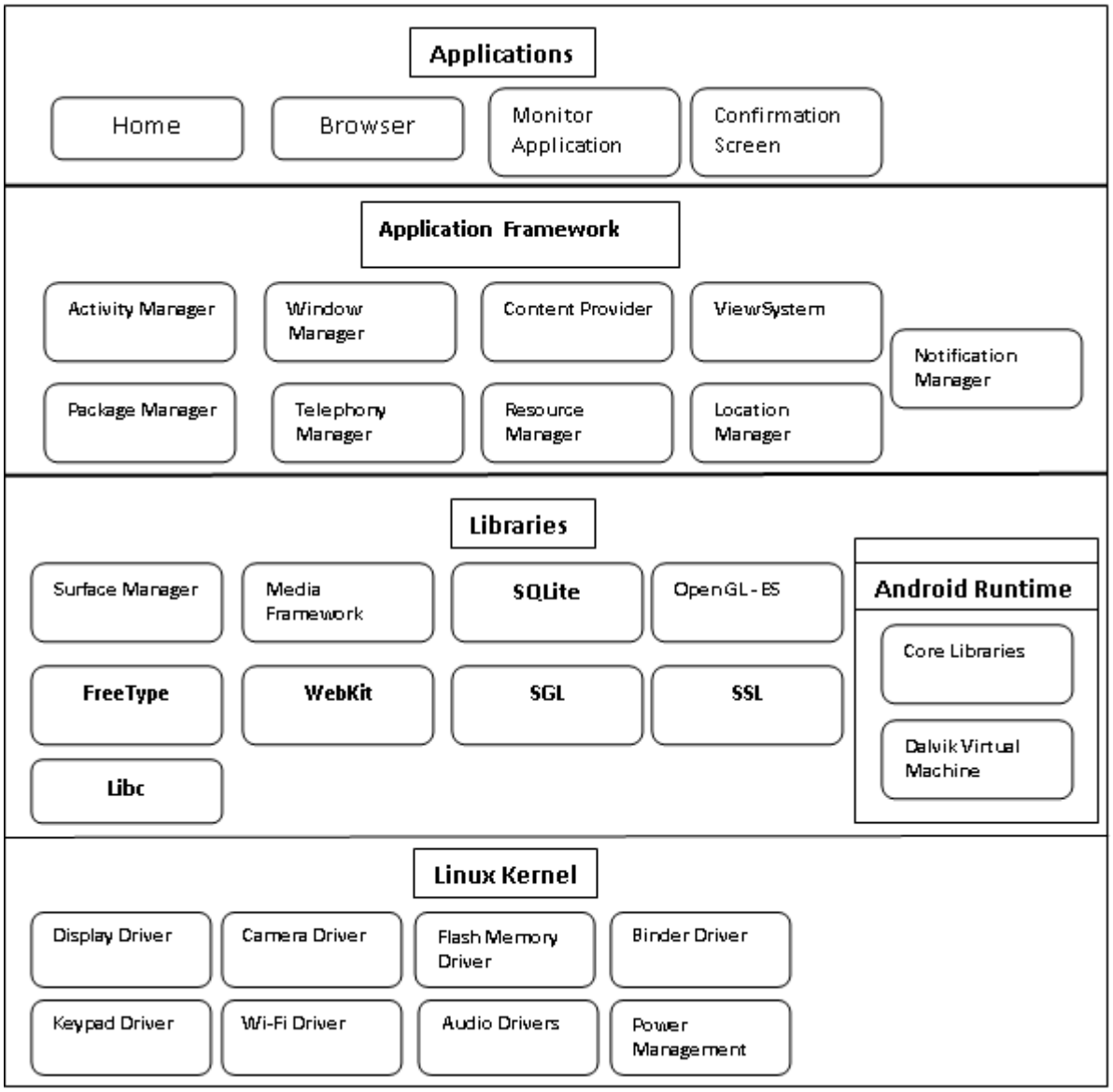

Figure 4.7. Android 4 level architecture for application development

Java applications running on a virtual machine are the main component of the software stack. The components are written in Java (application and application framework), C, C++ (libraries).

The four architectural levels of Android SDK architecture are the operating System (OS), a middle ware with core libraries and a run-time environment. The application development framework is created on a Linux kernel as shown in figure (see Figure 4.7.).

Android libraries offer most of the functionalities available in Java programming language libraries. These libraries support Dalvik Virtual Machine (DVM), an Android Runtime Engine. DVM counts on Linux kernel for functionalities like threading and management of low-level memory. The Application Framework layer is written in Java which we have used to develop our application IMSSAP [47].

The main components of the application framework layer are:

1- Package Manager: tracks installed applications on any device. This helps us track errors and generate crash reports.
2- Telephony Manager: offers application programming interfaces (APIs) for mobile device applications.
3- Notification Manager: shows custom alerts in the status bar. (eliminated from our application to minimize student’s distraction)
4- Content providers: enables application to share data and to access data from other applications and users.
5- View System: a set of views (text boxes, buttons and grids) used to develop an application's User interface. This relates to the application UI design and look.
6- Activity Manager: runs applications on a separate process and provides them with a smooth navigation and controls the lifecycle of the development process. This was helpful while designing the application where we were capable of testing some processes while developing the remaining parts of the app.

4.11.2. Android activity life cycle states

The application framework layer is composed of user developed application and platform supplied services. Android studio runs above this layer. The SDK application development environment is composed of emulator, debugging and performance assessment tools and plug in for Eclipse users. We didn't use Eclipse while developing our application instead we have used the android studio tool. An activity goes through the following states and the series of callbacks to handle transitions between states (see Figure 4.8.).

onCreate()
using this callback android system creates our activity and initial essential components like views and load data.

onStart()
using this callback our created activity is now visible to users. The activity is brought o the foreground of the screen and becomes interactive.

onPause()
A paused activity (on pause) has lost focus but is still visible. In case of low memory, the activity will be killed automatically by the system.

onResume()
using this callback the activity starts interacting with the user and takes input and do its job. In android system most of the core functionalities are executed in this state.

onStop()
using this callback our activity is no viewable by the user, either new activity gets started or existing activity gets resumed state or system memory is needed.

onRestart()

using this callback the stopped activity gets restarted. onRestart() restores the state of the activity from the time that it was stopped, no data loss [48].

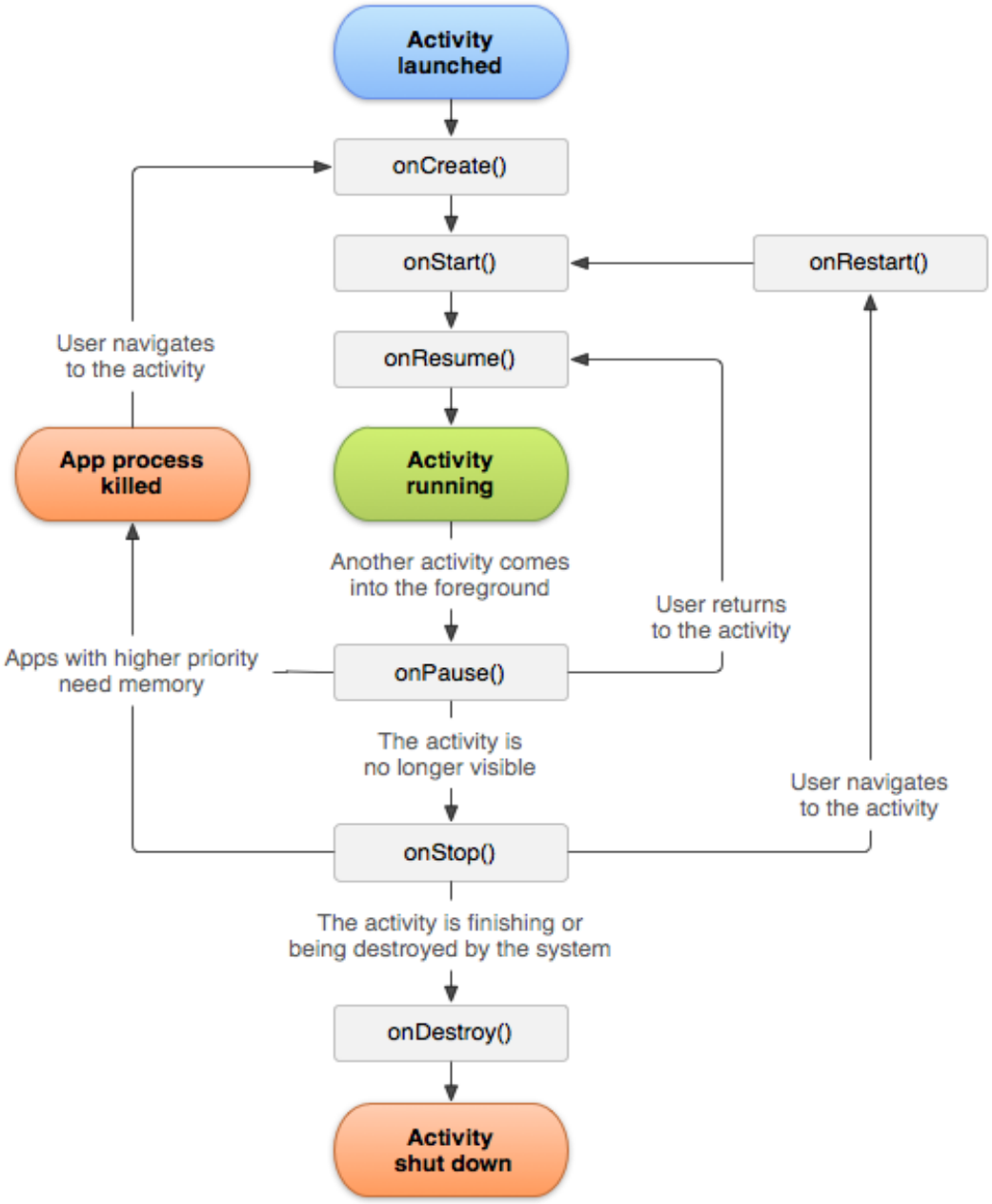

Figure 4.8. Aplication life cycle: starting, idling, stopping or closing (user / student)

4.11.3. Android SDK Structure

The Android SDK includes:

- Platform-tools
- Build-tools
- SDK-tools
- The Android Debug Bridge (ADB)
- Android Emulator

SDK tools are the most important part of android studio. It doesn't matter what version of android we choose we are in need to use these SDK tools. The SDK is responsible for creating the APK that turns a Java program to an Android application feasible to run on any Android mobile device. The build, debugging and image tools are some of the SDK tools. DDMS (see Figure 4.9.), an SDK tool, Android Device Monitor allows us to check the status of any Android device [49].

Figure 4.9. DDMS (used by admin) showing network statistics (courtesy of android.com)

DDMS, recently replaced by “Android profiler”, network statistics pane (image above) used to analyze the network usage. This tool is useful for providing information about when our application performs network data transfers. The Android class TrafficStats is used to add network statistics analysis code to our application. To distinguish among different types of data transfers in our application, we simply applied a TrafficStats tag in our code before executing the transfer. Knowing network statistics should help us make better decisions about how to optimize our network data transfer code.

We need to use the Build tools in order to build our Android applications. Some of the Build tools are, “zipalign” tool, mainly this tool enhances the application and force it to use less memory until the final generating of the APK, the “apksigner” this tool adds a signature to each APK and differentiates between different version of Android and helps select the best versions that matches and supports the signed APK. To communicate with any Android device we can use the Android Debug Bridge (ADB) tool. ADB is part of the Platform-tools because it can identify the Android version used on a device. “logcat” is an ADB shell tool needed to install developed applications.

In order to test and monitor applications on a PC, a real PC device is not required because an Android system image is available and can run on any PC, we can use Android Emulator (virtually, Simulation testing). Choosing the device hardware specifications including performance (CPU, memory, GPU, screen size) and the version of the Android system we need to emulate, along with the device specifications we need to use the Android Virtual Device manager.

4.11.4. Android SDK utilization

Almost all of the SDK tools include testing, debugging and packaging apps for Android. These tools link the emulator, the physical device and the Android system. This way we can develop our applications, test them while developing the apps (see Figure 4.10.). In software engineering this is called the V-model of testing, develop

and test. APK (RAD rapid application development) Run or Build features of Android studio, provides developers with the required updates and components.

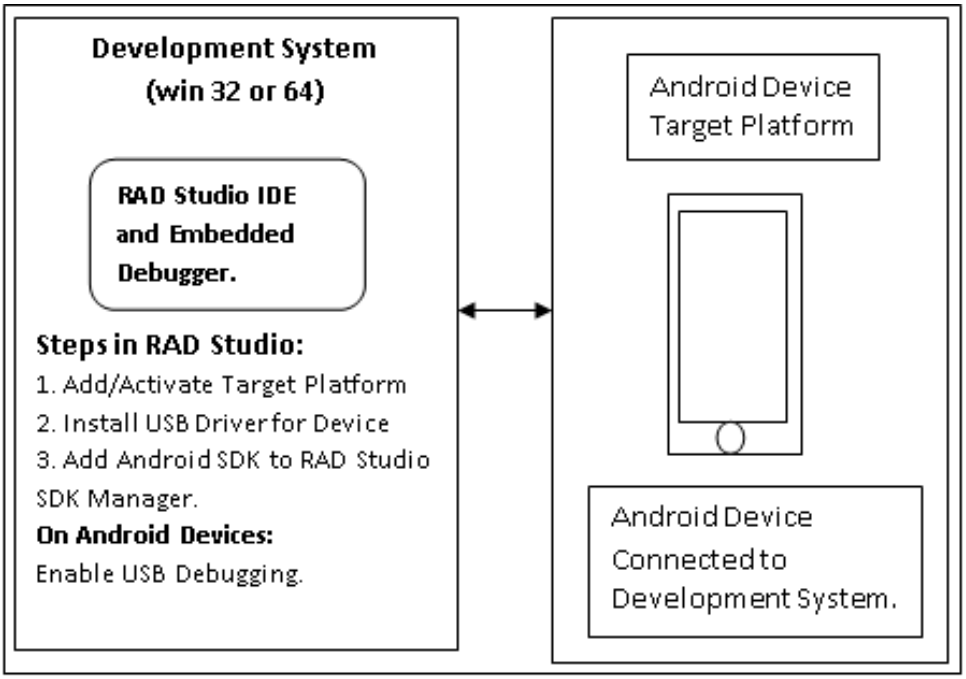

Figure 4.10. Android SDK, bridge between Android Studio and device (admin)

4.11.5. SDK Manager utilization

The SDK Platforms, SDK Tools, and the SDK Update Sites tabs of the SDK manager can be used in order to manually update some features or components although this feature is done automatically by Android Studio. (see Figure 4.11.).

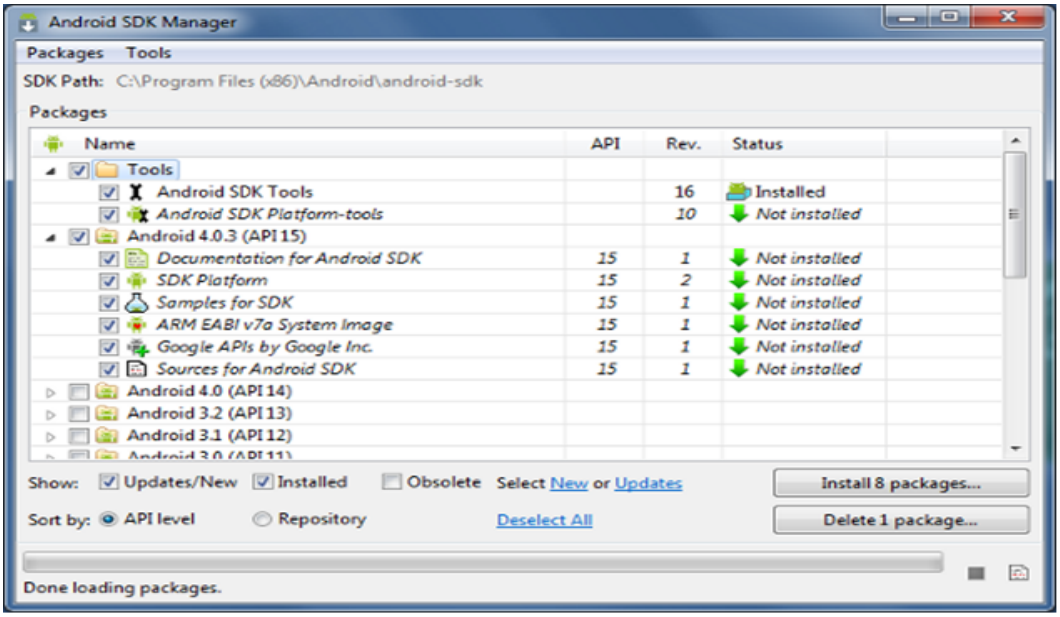

Figure 4.11. Android Studio SDK manager (admin). (courtsey of android.com)

4.11.6. ADB utilization

The figure shown below explains how to use ADB. Initially we need to locate the Android SDK installation folder then access the platform-tools directory (see Figure 4.12.). “adb devices,” will get a list of the connected Android devices and the device ID. “adb install package-name” is used to install an APK on any user mobile device powered by android [50].

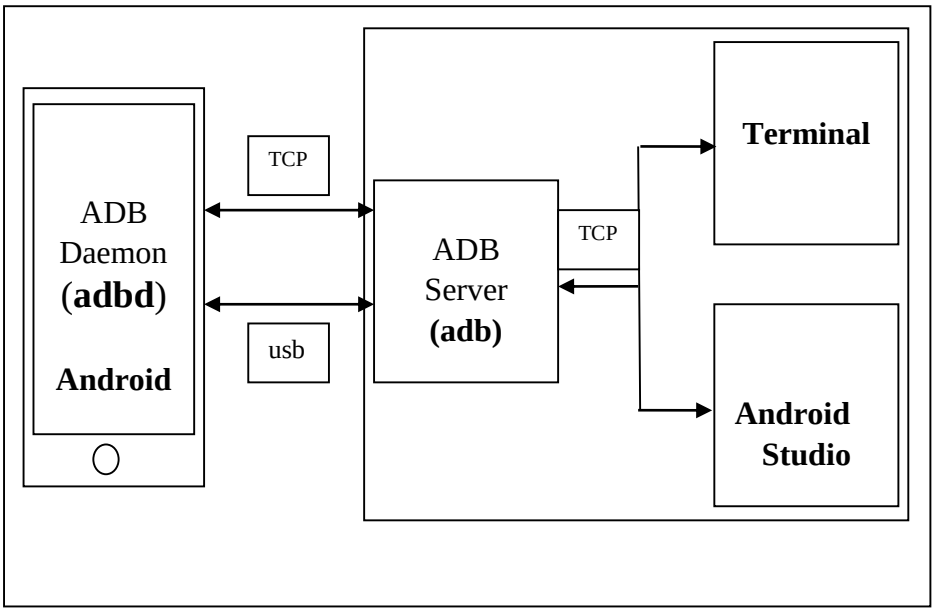

Figure 4.12. Android debug bridge, remotely install an APK on any user device (admin)

4.12. Android Studio Benefits

Gradle Integration: Android Studio uses the highly enhanced and integrated Gradle build system. Gradle helps developers build, test, compile, deploy and create better and faster android software.

Advanced Code Completion: Java code auto completion is one of Android Studio attributes.

User Interface (UI): Android studio is built for Android. Unlike Eclipse, Android Studio offers straight forward functionalities and easy tools for application development.

Organization of Project: Modules are used to manage code in Android Studio. Module is a source file that allows us to divide our project into separate units that can be built and tested easily.

System stability: Android Studio provides secure and fast performance and demands low system requirements for downloading and executing. Android security updates

guarantees that bugs will be tracked and fixed quickly although the bugs are very little compared to other platforms. Android is flexible and tools are easy to use, developers can create applications in a short period of time [51].

4.13. Google Cloud Storage

Our learning tool is offered to university students and teachers for educational purposes. We were looking for a reliable, effective, efficient, secure and low cost method to fulfill our needs. Building our own server to save, backup and manage data will cost much and need a dedicated team to follow up with the system especially when we need to deal with huge amount of data. The user's private information need to be secured. Students and teachers will exchange information in the form of text and images. With time the data will get bigger and bigger. A perfect choice was Google Cloud Storage as it can handle huge amounts of data, provide secure access to our system and offer many other services we will cover in details in the next sections.

Individuals or groups can effortlessly and comfortably use Google Cloud Storage services to store small of huge loads of data. The data is well protected, managed and stored for future access. We have selected Google's cloud storage system because it is reliable, scalable, functional, equipped with highly developed security features and data-analysis tools [52].

The data storage process like maintaining data servers, storage disks, firewalls and backup copies is costly and time consuming. Developers doesn't need to worry about scaling and maintenance anymore as Google Cloud Storage allows us to store, retrieve, share, and analyze our data on a daily basis. Google cloud resolves scaling, upgrade and maintenance issues.

4.13.1. Why we should use google cloud storage

1- Data back up: easy to maintain highly reliable and available data-backup solution.

2- Data storage: fast access to application data designed to share data with authorized users.
3- Data share: if we have interactive app and dynamic user we can create and manage access control lists to user's data
4- Data analysis: Google analytic tools allow us to analyze user's data.
5- Easy-to-use interface: no specialized hardware or software, just enable Google Cloud Storage and begin uploading data [52].

In summary, Cloud Storage is data storage that is made available as a service via the internet. We can easily and efficiently store and back up our data. It provides remote and fast access to our application data. The system is up and running all the time, the data is always available and students can access the application and modify and exchange data any time. Cloud storage is highly available, efficient, effective secure and easy to maintain and has a sophisticated data-analysis tools.

CHAPTER 5. IMSSAP: AFTER-SCHOOL INTERACTIVE MOBILE LEARNING STUDENT SUPPORT APPLICATION

We need to view schools as a cultural environment for teaching and learning and to fully understand the importance of mobile devices usage and its associated applications in everyday life of today's students. As was previously discussed, mobile devices usage has begun to take place largely in schools. Many students trust their own devices and prefer to use them for learning purposes. This reflects how students become aware of the importance of technology, viewing their own mobile devices as trustworthy facility to create an appropriate environment for learning from formal, informal and from other's experiences.

There are some issues we need to consider regarding the usage of schools reserved devices or student's devices. Giving students a device may be suitable for most students, because it will be totally controlled and managed by the teachers where all data, backup and the software are installed already. Teaching devices usage protects data from being altered by students, learners are not allowed to add personal data or entertainment applications, high-safety level devices as they are connected to school network only.

But students could use their own devices as well, save time getting to learn how project dedicated devices work and most importantly the schools will benefit from the capabilities student's smart mobile devices will afford. However, personal devices have some drawbacks, teachers need to be aware that they'll have less control on them and mobile safety might prevent researchers from accessing project data on other learner's devices.

Mobile devices software, hardware, power, safety and back up facilities if well prepared and organized, and if the application is loosely structured, these arrangements

and flexibility will enhance student's creativity and will encourage them to develop and contribute more. Flexibility is a key word in mobile learning, setting proper arrangements and using a variety of teaching and personal devices are very beneficial in the process of e-Learning.

5.1. IMSSAP Application

As we are living in a post-era we should develop and embed in education a learning tool with social media motives and social interaction attributes. Most studies [23] [53] stated that if we associate social interactions flexibility, cooperation and competence with instructional interactions like instant feedback and collaborative experimental activities, it may enhance interactions during learning. According to a study about social media in education, students are open to new learning technologies and to the idea of utilizing social media as a learning tool with education as it can enrich the learning process [12].

While developing this learning tool, user experience and user interface (UI) look-and-feel were carefully designed. It was intended to make students feel comfortable and motivated while using the application. Users will immediately notice that the proposed mobile learning tool IMSSAP is built with social networking functionalities. The bite-sized challenging topics posted by the teachers will walk students through the application. In a post-era, students are expecting lectures to be more interactive, entertaining and they prefer quick and shortcut information. Some students are wasting many hours online for entertainment and especially for communicating with other students. IMSSAP represents a great opportunity for both the students and the teachers. The teachers can spend more time discussing the topic key concepts and can encourage students to challenge each other, experiment data, and share outcomes with their classmates. This will indirectly create a learning community and a collaboration and communication environment. Although our learning tool is built with social network motives, it should not be viewed like other LMS services providing variety of learning materials or for entertaining purposes or like a messaging service. Our application is rather designed to create a learning environment which requires active contributions

from students. Popularity is one of the top reasons why students use social media. It will motivate students to voluntarily put more effort into researching about class topics and sharing the outcomes with others for discussion and feedback.

IMSSAP includes a feedback system that helps students assess their progress. Teachers should monitor the learning process to recommend answers, review references used and to keep students challenged through the course by either setting a timed test, a challenging topic or post a group debate assignments which could enhance student's collaboration and boost their knowledge exchange [54].

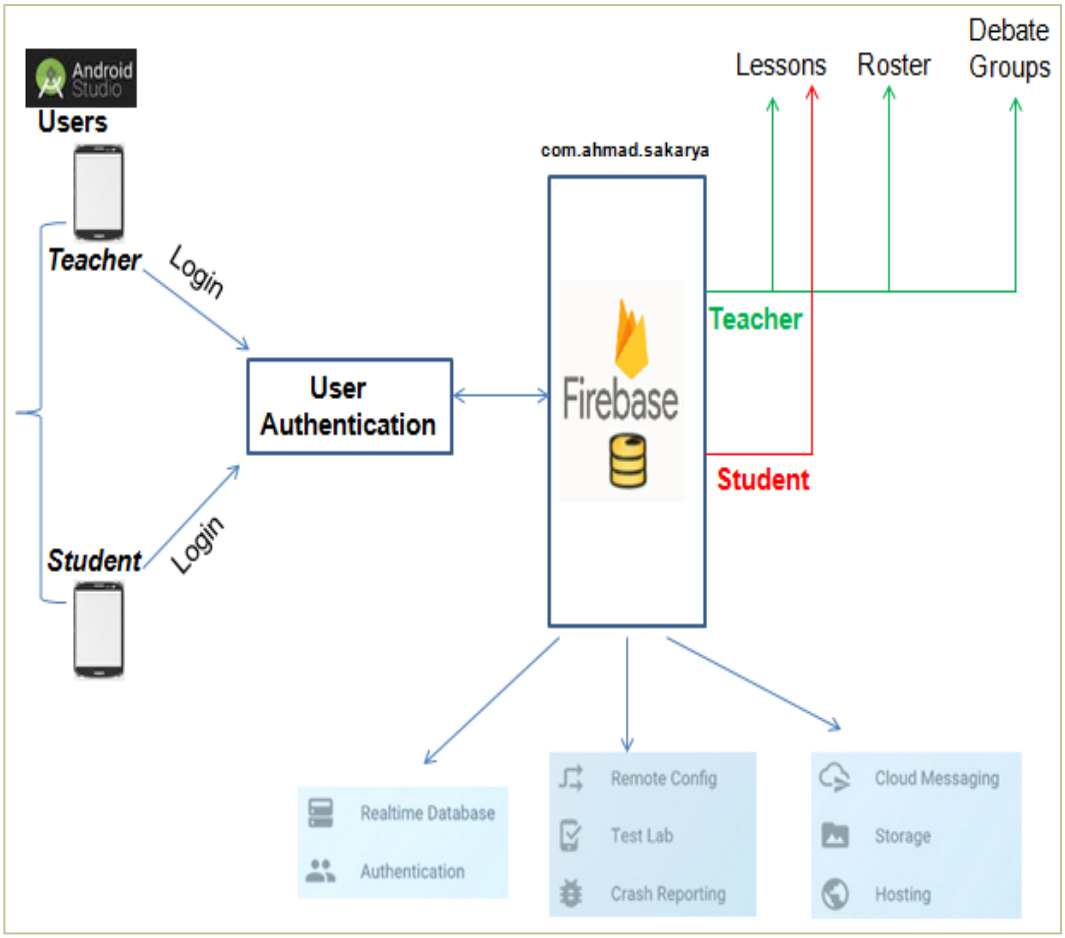

Figure 5.1. After-school interactive mobile learning tool (IMSSAP) architecture.

5.2. Learning Principles in IMSSAP

5.2.1. Personal ınquiry method

Personal Inquiry is evidence-based learning. Groups of students will be provided with real world evidence data derived from real life experiments besides being allowed to benefit from mobile technologies capabilities. Students need to investigate, comment, compare and add their personal experience to the task. Mobile technologies can simplify and enhance the learning experience of teachers and students. They enable interactive science learning and enhance inquiry learning method. Teachers should simplify the process and provide students with scientific tool kits for data collecting, sensors, cameras and data analysis software to support and evaluate student's progress after each phase.

The toolkit manual will guide students through the process of gathering evidence and running experiments. Each step is illustrated and supported by an example prioritizing, organizing and presenting the task which makes it easy for students to monitor and plan their running activities progress. Students need to gather data then analyze them using the toolkit software and compare their personal data with the original results then write a conclusion and a report. Student can get their data from websites designed for school use which will provide students with accurate scientific data. It's important that students share their findings and allow others to see projects in progress. Students who participated in personal inquiry learning project have enjoyed investigating facts about their preferred daily life topics, collecting data, comparing and analyzing them and making decisions. Personal inquiry projects are flexible and sociable, parents and friends could share their experience and knowledge. A family has changed their shopping habits after their child's research about product branding [55].

5.2.2. Progressive ınquiry

Nowadays teachers are expecting students to search, explore, discover and integrate information that allows them to create and build theories to answer their own questions

and not to count on the instructor's in class content explanations only. Progressive Inquiry-based learning is a method used in schools to build up student's knowledge, strengthen subject understanding and make students see themselves as active knowledge contributors and not passive information receivers. It is a teaching method where students learn by generating questions and using all helpful resources to find answers. Students can even develop possible answers and explanations, test them then note down the outcome and the evidence for knowledge sharing. There are many sources available for students that might help them clarify ambiguous topics like blogs, interactive books and educational video tutorials [56].

5.2.3. Continuous feedback

All students during the learning process benefit much from receiving immediate feedback from instructors because the feedback will help them rectify errors on questions and assignments, improve subject understanding, help them rate their progress during the term and enables them to focus and pay more attention to course critical and confusing areas. On the other hand, feedback help students set their goals through the academic year and build a plan to help them assess their own performance and achieve these goals. This is why teachers should pay more attention to instant feedback after each class activity. Students often appreciate if their mistakes are corrected instantly. They consider this critical to evaluate their progress and thoroughly understand the contents [57].

5.2.4. Collaboration motivates learning

Critical thinking is an academic and intellectual process that should be mastered by all students. Learners should analyze information, gather and experiment data, find evidence and determine the extent of its usability in real life and experience accuracy and relevance to the topic in hand. Collaborative learning promotes critical thinking, is a process that immerses students in depth with the subject contents. The process is held better by group of students working together, discovering knowledge, sharing results and learning from one another and teaching each other. Discussion and debate

among students took place as a result of group learning knowledge exchange activities. Social networks interaction plays a role in motivating adults in their daily lives. Collaboration as a useful tool in education is cloning social networks motivational power. Discussion forums are motivating learners to use collaborative learning tools which allow students to work together as one to clearly expose experimental studies and outcomes, share and contribute to knowledge [58].

5.3. Application Usage and Benefits

5.3.1. Guiding learners and creating space for questions

Instructors should create a space for learners to ask questions and to allow sharing ideas, talk about and prove them. A space that assures the information is available to all students. Instructors should help students manage their time more efficiently as it is one of the most challenging issues students face especially at the beginning of each new academic term. The application is monitored by instructors, this will enable students to interact with teachers anytime and help instructors to walk students through the course contents and simplify ambiguous ideas. Participation gets easier as students are familiar with the social communication media and online dialogue and debate platforms and discussion “netiquette”, Students must also understand that the postings must be solely related to the discussed topic.

5.3.2. Identifying data quality and varied resources

interactive bite-sized online discussions engages students more in the topics and helps them digest the contents and build deeper understanding of the discussed topics. Besides books and scientific articles, it is very important to integrate online learning tools and technologies as new and motivating learning methods side by side with books. These tools will teach students how to initiate an experiment and conduct serious research process interactively thus improving student’s critical thinking capabilities.

5.3.3. Developing meaningful assessment tools

Assessment tools and feedback methods allow teachers to evaluate student's progress and assure that students are having good command of the contents. This assessment motivates students and increases class interaction, encourages students to research more and put more effort to experiment theoretical ideas and find answers and proofs. Instructors can ask students to read a chapter, answer the questions and receive an immediate feedback regarding the accuracy of their answers.

The exams, assignments, presentations and participation are not the only tools that help assess student's performance in class. For example, Instant Feedback Exercises. The instructor can use the application to set an instant feedback question. The instructor's instant feedback shows students how well they understand the material and help them rethink and correct their mistakes. The exercises can take a variety of forms, including multiple choice and true/false, fill-in-the-blanks or item ordering (Debate and Evidence approach).

5.3.4. Learning through research

Project-Based Learning PBL is an effective approach to learning in which students list a set of questions and teachers guide and supervise students through the research process for answers and proof of evidence. PBL is used to replace passive receiving of information and to motivate students to engage more in the learning process which in return improves their critical thinking and research capabilities. New technologies like databases and data visualization platform resources helps students perform a research in a short amount of time (basically an academic term).

5.3.5. Encouraging collaborative learning

Formal and informal discussion types, before and after class or during class time both motivate learning. Instructors can use the application to post a topic and students are required to respond and comment on each other's answers. Students are strongly

advised not to rely on the main course book only but to use other resources like observing data in a laboratory experiment or to start a thorough research about a topic. Our main goal for students is to get them engaged in debates. The application will allow two or more students to play the role of a discussion moderator posting a challenging question and respond to answers posted by other students and report to teachers for accuracy and guidance. Learning principle 2 described how the supervising students are motivated and impressed by social factors like popularity. Another effective learning method is to give particular tasks and encourage students to make their own experiments, show the outcome to other students and receive feedback and suggestions.

5.3.6. Responding to questions

It’s important to provide students with various opportunities to ask questions. Hard questions and ambiguous topics is time consuming if answered through e-mails especially if other students are asking the same question again and again. Some teachers take days to reply to student’s e-mails which might affect their learning progress.

- By using the application, all questions and answers posted by instructors, students or student moderators can be used to answer student’s questions. The main benefit is that everyone in the class can view the answer.
- Online Office Hours: If many students are having trouble understanding a topic, the instructor can arrange a conference online, especially prior to final exams, which give students a chance to ask different questions and to clarify unclear topics.

5.4. Application Etiquette

- Pursue a Unique Idea: Good discussions boards offer learners the excitement of "the chase mood" to find an idea, proof it and share it in an energetic yet competitive manner.

- Plan: Practice critical thinking before replying. Try a variety of solutions and approaches and assess alternatives. Set creative strategies to use when you reply to others, this will keep the discussion active and vivid.
- Talk: Discussion board is not for formal writing, simply cast away editing errors. The main purpose is to be interesting, encouraging, informative, clear, informal but fresh. Never summarize learner's replies and always write new ideas.
- Read Everything: Read everything posted by your classmates or assigned mentors. Make sure that you have reached a large audience and what you have said has been read and interpreted clearly.
- Respond to All: Make sure that all students get a response and a feedback. Check if there are any posts that no one has responded to yet, respond at least to one of them first but make sure everybody.
- Engage: Write socially and in a motivating way inviting others to join discussion and share thoughts. Discussion boards run on posts, quality replies means better discussions.
- Interwork: Use student's posts in your answers and mention and quote your friend's names and ideas. Show that the discussion board is a community to read, reuse and value shared information.
- Mind Your Manners: Read everybody's answers, provide thoughtful response, criticize politely, and quotes others reply's as credibility.
- Loyalty: Visit the board frequently, many unread posts will discourage you from reading. Read posts and insure that you are giving proper attention to the work of others.

5.5. Application Design and the Architecture

Understanding the student's needs, what students expect from mobile learning and whether they are ready for it or not is very crucial for the design of a productive, beneficial and efficient learning tool [59]. The application scenario suggests that a teacher posts a question emphasizing the lecture's key concepts. The students need to contribute to the topic (researching, experimenting, comment on each other and share

outcomes). The app is designed for communicating and collaborating, students should be able to ask help from each other or from their instructor while studying or solving a home work or preparing for a test. The user's phone memory, mobile data or battery consumption were taken into consideration while building the application. The tool is a lightweight application. To fulfill these requirements, we have chosen to build an Android application using Android studio and Google-Firebase as a real-time cloud hosted database (BaaS).

Students need to download the learning tool from Google Play to be able to interact with the software (frontend) and to access other parts of the program. The student signs up and selects the classes they are enrolled in. The students will be registered in the database and the add request will be forwarded (backend) to teachers for only authenticated students can access the discussion forum. Students can access the program features only after teachers' approval (frontend). We have decided to simplify the learning tool usage for teachers. As developers we will create the user account for teachers through Firebase (backend). Teachers don't even need to add lessons because we the developers will add the lessons as well. The teacher just needs to login, authenticate students, add a topic, monitor the discussion, select a mentor, create discussion groups and set grades using the rating system (see Figure 5.1.).

Social structures and conversational structure are being used while designing the learning tool. Social structures represent social relationships between community members and reflect which topics the users are interested in. Conversational structure involves interactions between users. Conversational structures are formed by replies. In a popularity-driven culture, interaction between users enriches discussions and promotes knowledge share.

Having discussed the usage and benefits of the learning tool to students, it is now necessary to explain to teachers how to use the tool effectively and efficiently. Teachers can either initiate the discussion topic or assign a student as mentor to initiate the topic, selecting different student each week. This will motivate students to contribute to the topic and share their knowledge and expertise with their class mates,

driven by social networks popularity motive [60]. The topics can either be answered individually or in groups. Students prefer debate discussions; the tool will allow instructors to assign different groups for each discussion. Instructors will use the rating system to give grades and track student's progress. Teachers can post a timed question as a quick quiz which will reflect student's capabilities of understanding and interpreting critical topics. The tool represents a space for students to communicate any time to discuss ambiguous topics or to contribute to the learning process. This will indirectly strengthen the relation between students-instructors, students- students and students-school (see Figure 5.2.).

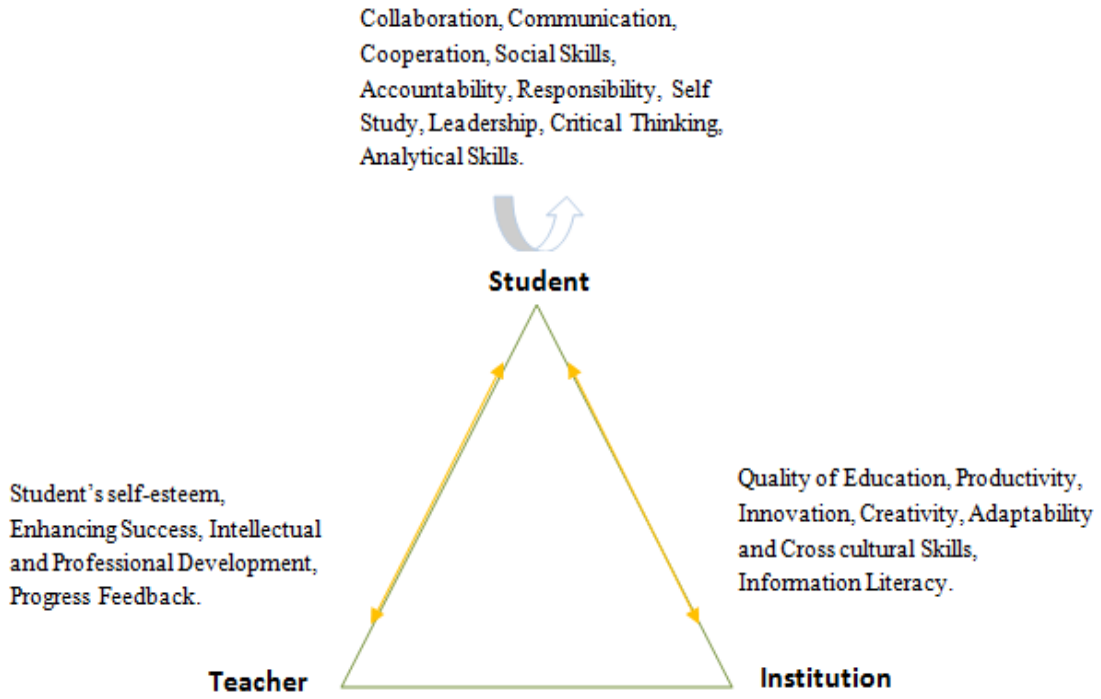

Figure 5.2. IMSSAP learning model

We have deleted all distracting elements available on social networks tools. There will be no notification sounds. Students should deliberately and voluntarily access the application and use it for learning purposes. We need students to get used on using their smart devices for learning purposes and not just for entertaining. Besides discussing or sharing knowledge, students will also be able to act as mentors, group leaders, innovators and contributors. The tool will help strengthen the relation between learners and their institutions and help develop true education skills. It would be better

for us to obtain the exact definitions, highlights, specifications and capabilities of frebase, android studio, google play and cloud storage from the main source.

Before examining and evaluating the technical elements needed to develop an M-Learning tool, we started questioning the feasibility of the application, how to differentiate the app and how to design an academic, productive, beneficial and efficient learning tool. The main assets in the app are the students, the teachers and the academic institutions. First we need to target the app major asset which is the students and we should have a good understanding about their needs and what they expect from M-Learning and whether they are ready for M-Learning or not. The application scenario is, after the lecture ends, the teacher adds one of the lecture's main ideas, then the students need to contribute to the topic (researching and experimenting then replying or commenting on each other (nested style) or add images). The app is designed for communicating and collaborating, students should be able to ask help from each other or the instructor to clarify an idea while studying or solving homework or preparing for a test. The app should not consume much of the user's phone memory, mobile data or battery, simply a straight forward lightweight application built with social networks motives that should fit in today's post era, an easy to use and adopt learning tool. To fulfill these requirements I have chosen to build an android app using android studio and firebase as a real time cloud hosted database. If there is any data modification or software update Firebase Real time Database will make all these changes available to all authenticated devices. Firebase Real time Database provides consistency in data transfer between source and target. Developers don't need to create back end servers because Firebase offers all the functionalities and features needed for the application. User authentication is processed through Firebase Authentication service offering users variety of login options like username, id, password or social-media login credentials. Firebase is mainly assembled and designed for user generated contents like text, audio, image and video that needs to be saved and made available for all users. It provides users with a secure way to transfer data from servers to applications despite the connection speed. In our project we opt-in only for text and images in our application IMSSAP. Firebase Storage is controlled and maintained by Google Cloud Storage. We can consider Firebase Storage as a solution for uploading

user-generated content like images and videos from Android device. Firebase Storage is designed specifically to provide security, and ensure network efficiency cost free. The application was developed using Android Studio. Android Studio is bug free and provides a secure and fast performance and demands low system requirements to run.

Administrators need to access firebase server first to create teachers accounts, set them as administrators and assign lessons. After installing and initiating the app on their devices, teachers will be able to add discussion topics. The discussion topic is actually what will differentiate our app from other tools in the field. Earlier, we have mentioned that we need to understand and embed learning pedagogies in the M-Learning tool. This should be reflected through discussion topics. The app was developed because students are missing the true shape and aspects of true education. The discussion topic should challenge learners, introduce students to new research methods, teach them to read between the lines, improve their analytical capabilities and critical thinking skills. Students should be prepared for the industry, be productive, and learn knowledge exchange and knowledge share. Academic institutions should graduate innovators and contributors to education and not just passive data consumers.

5.5.1. Instructor's part

Teachers can either initiate a discussion topic or assign a student as mentor to initiate the topic, selecting different student each week. This will motivate students to contribute to the topic and share their knowledge and expertise with their class mates, also driven by social networks popularity motive. The topics can either be answered individually or in groups. Students prefer debate discussions, the tool will allow instructors to assign different groups for each discussion. Instructors will use the rating system to give grades to individual answered questions or to groups. Discussions can either be timed or open. Teachers can benefit from the app to post a timed question as a quick quiz which will reflect student's capabilities of understanding and interpreting critical topics. The tool represents a space for students to communicate any time to discuss ambiguous topics or to contribute to the learning process. This will indirectly

strengthen the relation between students-instructors, students-students and students-school.

5.5.2. Student's part

We meant to create a simple straight forward app. Students need to register and set a user name (email) and password. Students will click select their lesson, an add request will be immediately forwarded to instructors, who in return accept or deny the request. When a teacher accepts the add request, students will be able to join and contribute to discussions. We have deleted all distracting elements available on social networks app, there will be no notification sounds. Students should deliberately and voluntarily access the app and use it for learning purposes. We need students to get used on using their smart devices for learning purposes and not just for entertaining. Smart devices are occupying people's daily life and changed the way people communicate and do things. Smart devices have the capacity to have a negative effect on learners, but we should examine the broader impact of smart devices on education. Besides discussing or sharing knowledge, students will also be able to act as mentors, group leaders, innovators and contributors. The tool will help strengthen the relation between learners and their institutions and develop true education skills.

5.5.3. Learner's perception of flexible learning

1- Accessing mobile learning tools at convenience.
2- Formal and informal learning spaces.
3- Variety of knowledge sources.
4- Collaborative and self-administered learning activities
5- Different learning and teaching pedagogies and methodologies.
6- Gathering and analyzing data.
7- Presentation tools for knowledge sharing [61]. (see Table 5.1.).

Table 5.1. Flexible Learning Components

Flexible Learning Components		
Process	Components	Establishing flexible learning
Learning design	Syllabus design	Help students acquire skills for self-administered learning skills in science and math.
	Lesson and activity planning	1- Teachers should discuss learning contents with learners. 2- Teachers must link educational material with daily life. 3- Bite-sized learning activities. (Our learning tool)
	Learning applications	1- Allow students to use smart phones to collect data. Inquiry learning 2- Mobile learning tools that supports learning.
Lesson formalizing	Ruling and control	Orienting school goals with curriculum design.
	Adaption and flexibility	1- Teachers present contents in a creative way when technology fails to simplify the materials.
	Assessment	1- Visibility of the thinking process. 2- Easily track, grade and comment on students answers. 3- Teachers should be open to all responses and answers from learners.
	Learners and educators dependency	1- Teachers develop and innovates learning methodologies that makes active learners.
Knowledge dissemination	practice	1- Time restrictions. 2- innovative learning and teaching solutions 3- Knowledge and expertise sharing between senior and prospective teachers.
	Academic institutions affordances	1- Professional development of learning contents. 2- Going through lessons plans and refining them to align with institutions and learners goals.

CHAPTER 6. RESULTS AND DISCUSSIONS

In this research we aimed to study the factors that affect and motivate students to accept integrating their own mobile devices in their own learning process. On one hand, we have noticed that the number of mobile devices usage on campus is very high and the number of hours that students spent voluntarily using these devices is remarkably high. On the other hand, some studies have shown that these devices are distracting students and affect the quality of learning. Students are getting less interested in reading and are losing the real shape of education. We thought to discover what attracts students in mobile devices, especially the social network applications, try to create a learning tool and expected that this tool if well designed and empowered with the factors that students like to find in an application, which in return can attract students and encourage them to use the tool as a learning method and accept it as part of their learning process. The basic theoretical framework we have adopted in this research is generated from a deep study of the learner needs and expectations especially the native mobile device learners, analyzing learning methods in schools and discovering why students are getting less interested in science courses and what should be done to solve this issue, studying the mobile devices capabilities and the social network applications and analyze the tactics and social aspects used to attract users and get them to stick to applications for long periods of time. Merging all these together would help us design and develop a tool suitable for mobile learning (see Figure 6.1.).

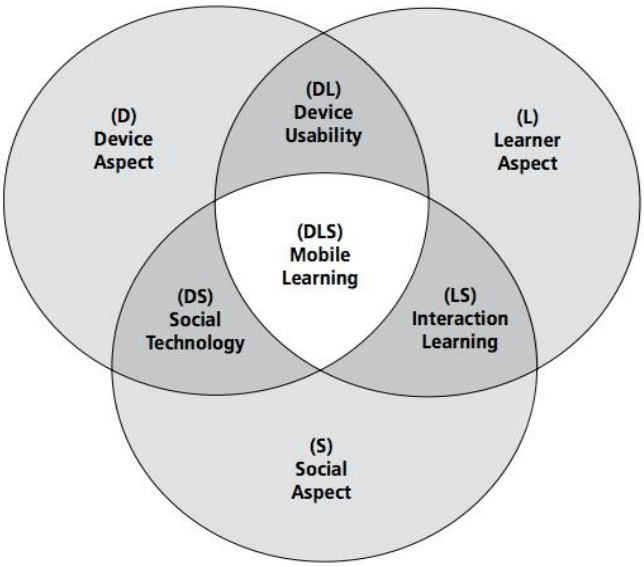

Figure 6.1. Mobile Learning Framework

Many other studies have been conducted to discover possibilities for integrating mobile devices in formal learning process. Some of these studies didn't even develop a tool for testing instead they have just studied the capabilities of mobile devices and used it in class. For example, a teacher used SMS in a term project asking students to communicate and interact with each other through SMS messages. Students were exchanging data with each other to fulfill the project needs. Another educator asked learners to use sensors and smoke detectors to gather information about weather change throughout the day and analyze the data. Many studies have been studying the social factors that attract mobile users. Based on this we have designed and developed a learning tool empowered with factors that attracts native mobile users. The tool is expected to provide learners with a space to learn and exchange data, share knowledge, contribute to the learning process and have fun.

The application was introduced to four different groups of students from different departments, Literature, Science and Engineering. We had a total of 50 participants from Introduction to Computer Networks, Discrete Mathematics, Data Mining and English Language classes. After using the application, a questionnaire was given to students. The survey questions were measured using Likert method of assessing outcomes. We have decided to apply descriptive statistics to measure and analyze responses accuracy using the Statistical Package of the Social Sciences (SPSS).

Designated questionnaire is divided into three parts, the first part relates to the application performance and efficiency and that users are not facing any technical difficulties. The first part includes questions like “all expected functions were available, navigating around the app was smooth; the application didn’t affect the mobile device battery or memory, no technical glitches during installation or using the tool”. Then students were interviewed for feedback and recommendations on how to improve the learning tool. It was obvious during the sessions that most of the students were very satisfied by the learning tool. They found it easy to use, productive, efficient and reliable. The second part of the survey is meant to evaluate the learning benefits of the application. This part reflects how efficient, reliable, accountable and effective the learning tool is. It includes questions like “the tool helped improving my critical thinking and analytical capabilities, the tool made me closer to my classmates and the instructor, the tool is motivating and engaging, productive and accountable, I was able to assess my skills development”.

The third group of questions is the most critical aimed to understand what social factors mostly motivate users and keep them engaged. Students were asked questions like “I like sharing, contribution to topics increased my popularity in the class and I was able to make friends”. At the end of the survey, we asked participants whether they accept integrating mobile learning tools into the classroom or they will always see mobile devices as entertainment devices and not meant for educational purposes. The data had shown that 44 students were very enthusiastic and highly motivated by the learning tool and are willing and ready to adopt and embed our learning tool in the classroom. Frequent bite-sized discussion topics will enhance interaction, active contribution and promote M-Learning acceptance.

Before developing the application we made some oral interviews with some students and asked them if they would adopt learning tool if designed in the way mentioned above, most of the students were positive and highly motivated to accept the idea. After developing the learning tool we have selected some science and literature lessons and thought to introduce the learning tool to them and asked the teachers to adopt the tool as part of their lesson. We have noticed that the students and the teachers alike are

not encouraged to adopt a new learning or teaching method. They mentioned that the application is well designed but having the idea of using their mobile devices for learning for some of them is not accepted at the moment. This may be due to the fact that mobile devices are for entertainment and not for formal education.

We have compared our research and the data analysis results with other studies and we have compared our learning tool with another tool and compared the factors used in designing the application, the results were very close to other studies in the field. Our learning tool is very well designed we have added all the factors that attract native users in any other social media application. It is apparent that the other studies support our learning tool. We think that integrating mobile learning in formal education is not mature yet. Though we are dealing with native mobile device users, schools still need to talk more about this issue and gradually embed the mobile devices in the lessons. Teachers need to adopt this method and create learning methods that fits mobile learning.

A major drawback in our research is that we couldn't test our learning tool for long period of time and with more students. The results have shown that IMSSAP has created a perfect bite-sized learning environment and they have appreciated that the learning tool was blend with social networks motives that will enhance interactivity and help improve learning and teaching qualities.

6.1. Assessment Method

We assign a value to an unknown mainly to describe it as data. Then the values will be presented within circumstances and purposes to be useful. Qualitative and quantitative are forms of data: People turn to data because they have a story to tell or a problem to solve. Most people start with a question then analyze data for answers. In a service setting, questions might include, "who is receiving educational services?" and "who does best in it?" What if you do not have a question to begin with? Exploring data without a defined question, sometimes referred to as "data mining", can sometimes reveal interesting patterns in the data that are worth exploring. Regardless

of what leads us to look at data, thinking about our audience is helpful to shape the story and guide our thinking about the data. Whenever we look at data, it is important to be open to unexpected patterns, explanations, and unusual results. Sometimes the most interesting stories to be told are with unexpected outcome. Statistics is used to analyze data in two ways either to describe data or to compare data.

6.2. Data, Definition and Types

6.2.1. Qualitative data

Qualitative data is descriptive. It provides us with information describing the quality of something like the smell of flower. Smell can't be described in numbers so we use words to describe it. This is why we can't use qualitative data to compare values. Interviews and questionnaires are methods to collect data, the data are not qualitative but it can clarify and reveal the difference between tested elements [62].

6.2.2. Quantitative data

Quantitative data can be arranged into groups for measuring or ranking. The data is expressed in numbers. Quantitative data can be statistically analyzed and plotted on graphs and tables. Quantitative data is continuous but there should not be a noticeable discontinuity space between the values. Rating scale is an example of quantitative data [62].

6.3. Using Statistics to Describe Data

Briefly, a frequency table presents aggregate data and tells us the number of times each particular data value occurred. Central tendency is a value that measures the mean, mode and median of a data set. The average or the mean is the most used measurement of central tendency to represent and illustrate the data set or the data package. If we divide the sum of all the values in the data set by the number of the elements or observations (interviews, people, etc.) we will get the mean value. When we opt to

compute the mean value, all the elements in the data set must be included. This is a major attribute of the mean value measurement. Another commonly used statistic to describe data is the standard deviation.

Standard deviations describe the variability of the data or how close the data are to the mean of the data set.

6.4. Using Statistics to Compare Data

Usually we compare two groups using some statistics methods to discover if the difference is significant. Computing the probability that the outcome is not correct due to chance is called statistical significance. The difference mentioned is just from a mathematical point of view [62].

There are many factors that influence statistical significance, which is why it is important to be careful with how much importance is placed on a finding, even when it is statistically significant. These factors include the number of data points involved in the test (for example, number of people answering the questions), the number of statistical tests being conducted, and more. When conducting tests of statistical significance, the tester determines a “probability level” (often called “alpha”) to be used in determining significance. The alpha indicates the level of confidence that the person can have that any statistically significant results found are not simply due to chance. Alpha levels of .05 and .01 are used in the Statistical Significance.

Using an alpha of .05means that the tester can be 95% confident that the results are not just a coincidence (.01 would equal 99% confidence). The smaller the alpha, the more confidence the tester can have. If an alpha of .10 were to be used, then the tester can only be 90% confident that the results were not simply due to chance.

“Effect sizes” are used to compare groups of data to determine how much change has occurred within a group. For example, an effect size might be calculated to evaluate the impact a new learning tool has. Effect sizes are like the mean, but are comparative

in nature. They are calculated by taking the difference between the means then dividing by the standard deviation.

The benefit of effect sizes are that they standardize the differences in data so that they can be compared with the differences in other data. Another advantage of effect sizes is that they go beyond simple questions of "is there a difference" and give answers such as "the groups differ by X amount." While effect sizes are reported as a single number, it can help to put that number in context such as a "large" effect size versus a "small" effect size. Depending on the effect size calculation, different conventions are used to categorize effect sizes.

6.5. Outliers, Another Commonly Used Statistical Term

"Outliers" are values that are far from the mean; an outlier is a value that is very large or very small with respect to the other members in the set. Such values can have a large impact on the mean if the sample is small, but are less of an issue when working with a larger sample.

Small sample sizes can affect data analysis and interpretation as well. For example, if you have a group of ten individuals who answered an item, each individual represents 10% of the data and therefore heavily affects the percentage of responses. However, if you had a group of 100 persons then each one is only 1% of the data so any change in their reporting has much less of an impact [62].

6.6. Populations and Samples

Data is often collected to make statements or tell a story about a group or "population" of interest. However, often a population is so large that we cannot possibly measure the variables of interest for every person in the population. The alternative is to carefully choose a "sample" from the population we aim to study. We have to make sure that the selected sample covers almost all the population segments and entities before making decisions. This is what we exactly did while testing our new learning

tool IMSSAP. It would be difficult to ask every student to use the tool. Instead we have selected a sample of different lessons and asked students to test the learning tool.

6.7. Methods for Statistical Data Analysis

The following parameters were used to analyze the data we collected in our study:

6.7.1. Mean

The arithmetic mean or the average is calculated by summing the numbers in a given set and divide the result by the number of items on the set. Mean value can be determined easily. The mean gives us a quick look at the behavior of our data and is useful in understanding shifting and norms of our data [62].

6.7.1.1. Drawback

Mode and median values are very close to the mean. However, if we a data set with a high number of participants and we are expecting a high number of outliers, the mean is not the method we need to use as it will not provide us with accurate values that helps in taking a solid decision [62].

6.7.2. Standard deviation

The standard deviation, represented with the Greek letter sigma σ, this value reflects how close data are to the mean. If the standard deviation value is high this means that data is spread far from the mean, but if the value is low standard deviation means that the data is close to the mean. Standard deviation allows us to determine the dispersion of data [62].

6.7.2.1. Drawback

From a statistical point of view the mean and the standard deviation are misleading values. For example, if the data have a strange data dispersion trends and shifting and curves, this might not provide us with accurate results and information needed for decision making [62].

6.7.3. Regression

Regression models can be drawn and mapped on a scatter plot, the generated regression line is important as it tells the relationship between dependent and independent variables whether they are strong or weak. Students use regression to determine tendency and shifting of data over a specific period of time [62].

6.7.3.1. Drawback

Regression is not a details oriented-value and it doesn't provide fine details to understand data behavior. Outliers might have a great impact on a regression scatter plot. Some data on the regression scatter plot might point to a loyal customer or high sales territory but the regression line might opt to ignore such critical data [62].

6.7.4. Sample size determination

This is very close the holistic approach when we want to make a study about shopping behavior, we don't collect data about every customer, instead we take some from different areas with different attributes, accurate sample size leads to accurate outcomes, and apply our study to. To make a data collection statistically significant we can use statistical methods like standard deviation. These methods will help us designate and set the sample size needed for a study [62].

6.7.4.1. Drawback

A major drawback in sample size determination is that the proportion equations counting on certain assumptions some of them might be inaccurate if we are observing new variables. This inaccuracy might lead to errors which will make it harder to determine a correct sample size hence accurate data analysis [62].

6.7.5. Hypothesis testing

Also called t testing, hypothesis testing tells if an argument or theory is accurate for a specific data set. The result of a hypothesis test is considered statistically significant if the results didn't happen by chance [62].

6.7.6. Spread measurement: range, variance and standard deviation

In statistics data are defined and categorized. Scale of measurement helps us determine the appropriate statistical analysis. Researchers study the spread of data over many measurement scale possibilities. The standard deviation is used to understand how the data set is spread and how far from the mean value.

To calculate variance we take the square of the standard deviation $\sigma 2$. Standard deviation reflects distance between the mean and the farthest point on the curve, the variance is the average squared distance from the mean.

1- Compute the distance of each value from the mean.
2- Take the square of both.
3- Add the squared values.
4- Divide by the number of values in the dataset (number of values -1) [62].

6.8. Common Statistical Formulas

Statistical formulas are used to calculate and analyze values related to statistical hypothesis. We are going to discuss common statistical formulas, symbols and uses.

6.8.1. Population mean

Population mean is the average score of the population on a given variable, represented by the following formula (Equation 6.1):

$$\mu = (\Sigma Xi) / N \quad (6.1)$$

The symbol ‘μ’ is the population mean. The symbol ‘Σ Xi’ is the sum of all scores present in the population. The symbol ‘N’ is the total number of individuals or cases in the population (students).

6.8.2. Population standard deviation

The population standard deviation is used to measure of the variability of the results on a given variable. We use this formula to calculate it (Equation 6.2):

$$\sigma = \text{sqrt}[\Sigma (Xi – \mu)2 / N] \quad (6.2)$$

The symbol ‘σ’ is the population standard deviation. The term ‘sqrt’ means square root. The term ‘Σ (Xi – μ)2 is the sum of the squared deviations of the resultss from their population mean. [62]

6.8.3. Population variance

The population variance is the square of the population standard deviation. The population variance formula is (Equation 6.3):

$$\sigma 2 = \Sigma (Xi - \mu)2 / N \quad (6.3)$$

The symbol ‘σ2’ is the population variance.

6.8.4. Sample mean

The sample mean is the average outcome of a sample on a given variable. The sample mean formula is (Equation 6.4):

$$x\_bar = (\Sigma x_i) / n \quad (6.4)$$

where “x_bar” is the sample mean. The ‘Σx_i’ in this formula is the sum of all results present in the sample. ‘n,’ symbol is the total number of individuals in the sample [62].

6.8.5. Sample standard deviation

Is a measure of the spread of the questionnaire points in the sample on a given variable. The sample deviation formula is (Equation 6.5):

$$s = sqrt [\Sigma (x_i - x\_bar)^2 / (n - 1)] \quad (6.5)$$

where ‘$\Sigma (x_i - x\_bar)^2$’ is the sum of the squared deviations of the results from the sample mean.

6.8.6. Sample variance

The square of the sample standard deviation gives the sample variance. Sample variance formula is (Equation 6.6):

$$s^2 = \Sigma (x_i - x\_bar)^2 / (n - 1) \quad (6.6)$$

where ‘s^2’ means the sample variance.

6.9. One-Sample t Test: (Used For Our Data Analysis)

This is the method we used for our research data analysis. We can figure out if the sample mean is different, from a statistical point of view, from an identified or hypothesized population mean by using the parametric test one Sample t Test. “test variable” is the variable used in One Sample t Test. A "test value" or the hypothesized value of the mean in the population is compared to the “test variable” for chance level.

6.9.1. Common uses

We use One Sample t Test to test the following:

- The statistical difference between a sample mean and an identified or hypothesized value of the mean in the population.
- The statistical difference between the sample mean and the sample point of the test variable. Coin toss sample point is head/tail [62].

6.9.2. The one sample t test data requirements

The test data requirements:

1- Continuous test variable could be interval or a ratio level.
2- Independent test variable scores, observation wise.
   - There is no relationship between compared scores on the test variable
   - Produce inaccurate p value if we violate this assumption.
3- Selecting random sample of data from the population
4- Normal distribution of the sample and population on the test variable (approximate)
   - Non-normal population distributions may reduce the power of the test
   - A violation of normality may still yield accurate p values in case of large samples.
5- Variances approximately equal in the sample and population.
6- No outliers included.

6.10. Hypothesis

The one sample *T* test null hypothesis (H_0) and the alternative hypothesis (H_1) can be explained like this:

H_0: μ = x bar (add bar above x) ("the sample mean is equal to the [proposed] population mean")

H_1: μ ≠ x ("the sample mean is not equal to the [proposed] population mean")

Where μ is the population mean suggested constant and x is the sample mean.

The One Sample *t* Test statistical test is denoted *t*, can be calculated using the following formula: $t = (\bar{x} - \mu) / (S / \sqrt{n})$

μ= population mean suggested constant
$\bar{x}$ = Sample mean
n = Sample size (i.e., number of observations)
s = Sample standard deviation
($s/\sqrt{n}$) = Estimated standard error of the mean (s/sqrt(*n*))

The *t* value outcome is then compared to the critical *t* value from the *t* distribution table with degrees of freedom *df* = *n* - 1 and an accepted confidence level. If the calculated *t* value > critical *t* value, then we reject the null hypothesis.

6.11. Statistical Significance

In testing a hypothesis we check the *p*-value to determine the statistical significance. The *p*-value is the probability when the hypothesis is true or by chance. The population mean is equal to μ_0, we use

$t = (\bar{x} - \mu) / (S / \sqrt{n})$

Statistical significance at the $p < .05$ level, $\alpha = 0.05$. Sig P should be less than 0.05 to reject the null and to have evidence that the sample is different than the population. Reject null or reject H_0 if: t value is greater than t critical. Higher *t*-value means greater confidence we have in the coefficient as a predictor. $H_{0:}\ \mu < 3$, $H_{1:}\ \mu \geq 3$. (Hypothesized Mean $\mu = 3$). Based on the questionnaire data analysis t critical has a value of 1.676. We have observed the data provided by students, especially the second and the third parts, the benefits of the learning tool and the social networks factors. We checked the p value ($p < 0.05$) and the t stat ($t > 1.676$) [62].

6.12. Test Environment

We distributed the our survey during winter semester preceded by a preliminary survey on spring 2015, which gave us a general overview of the mobile technology usage among students and provided us with enough data to understand how students look at mobile learning and their expectations. In the 2015 survey, our goal was to introduce the concept of mobile learning to students, the questionnaire contained questions aimed at obtaining more in-depth information about mobile technology in school, what are the features that the students prefer to find in a learning tool, do they accept to embed such tools at school. The survey consisted of a set of questions rated using a five point Likert scale featured various question types, including some that let students design their own mobile learning tool and suggest factors and functionalities that fits their own learning needs.

We distributed the survey in class to all students in courses that granted us permission. We collected data from ($n = 50$) students currently enrolled in courses: Discrete Mathematics, Computer Networks, English Language and Data Mining.

6.13. Questionnaire

The questionnaire offered to students after using the mobile learning tool. I used a likert-scale for my questionnaire where users can strongly agree or strongly disagree with a number of issues related to the proposed mobile learning tool design and

performance. The questionnaire is divided into three parts reflecting performance and efficiency, benefits for learners and social networks factors effecting learner's decision to adopt mobile learning in their own learning process:

6.13.1. Application efficiency, performance and usability

a- Easiness-of-use: I was capable of easily using the app features.
b- Organized Features: The tool items were well organized and functions were easy to find.
c- Functionality: I immediately understood the function of each menu item.
d- Reliability: All of the functions I expected to find in the tool were present.
e- Ease-of-navigation: I found navigating around the Application screen smooth.
f- Efficiency: The application didn't affect the device memory or battery life.
g- Effective: I didn't encounter any technical difficulties or errors while downloading or using the app.

6.13.2. Benefits for learners

a- Critical thinking and problem solving:

I feel that the application has improved my Critical thinking and analyzing capabilities.

b- Social Interaction:

I feel that the app made me feel closer to my classmates and the educator.

c- Motivating and engaging:

The app creates a challenging environment to keep students motivated and engaged.

d- Productivity:

The application enables us to focus on the subject main topics.

e- Accountability:

I found the application very helpful to ask questions while studying.

f- Progress and performance assessment:

I used the app to assess my learning progress and skills development.

6.13.3. Social networks factors:

a- Knowledge sharing: I used the app to share information with other learners.
b- Social Networking Motivations: The application includes social networking motivational factors.
c- Contribution leads to Popularity: I feel that sharing and contributing to the lessons has helped in increasing my popularity in class.
d- Making friends: I was able to make friends through the app.
e- Office hour alternative: I think that the app can be an effective substitute to office hours.
f- Decision Question: I accept and support integrating Mobile Learning into Education.

The application was introduced to four different groups of students from different departments, Literature, Science and Engineering. We had a total of 50 participants from Introduction to Computer Networks, Discrete Mathematics, Data Mining and English Language classes. The survey questions were measured using likert method of assessing outcomes. We have decided to apply descriptive statistics to measure and analyze responses accuracy of data using the Statistical Package of the Social Sciences (SPSS). Our questionnaire is divided into three parts, the first part relates to the application performance and efficiency and that users are not facing any technical difficulties. The first part includes questions like “all expected functions were available, navigating around the app was smooth; the application didn’t affect the mobile device battery or memory, no technical glitches during installation or using the tool”. Then students were interviewed for feedback and recommendations on how to improve the learning tool. It was obvious during the sessions that most of the students were very satisfied by the learning tool. They found it easy to use, productive, efficient and reliable. The second part of the survey is meant to evaluate the learning benefits of the application. This part reflects how efficient, reliable, accountable and effective the learning tool is. It includes questions like “the tool helped improving my critical thinking and analytical capabilities, the tool made me closer to my classmates and the

instructor, the tool is motivating and engaging, productive and accountable, I was able to assess my skills development".

The third group of questions is the most critical aimed to understand what social factors mostly motivate users and keep them engaged. Students were asked questions like "I like sharing, contribution to topics increased my popularity in the class and I was able to make friends". At the end of the survey, we asked participants whether they accept integrating mobile learning tools into the classroom or they will always see mobile devices as entertainment devices and not meant for educational purposes. The data had shown that 44 students were very enthusiastic and highly motivated by the learning tool and are willing and ready to adopt and embed our learning tool in the classroom. Frequent bite-sized discussion topics will enhance interaction, active contribution and promote M-Learning acceptance.

6.14. Results and Discussion

The questionnaire data were analyzed using a one-sample t-test data analysis tool to examine the level of significance. In testing a hypothesis we check the *p*-value to determine the statistical significance. The *p*-value is the probability when the hypothesis is true or by chance. For testing the null hypothesis where the population mean is equal to a specified value μ_0, we have used: $t = (\bar{x} - \mu) / (S / \sqrt{n})$ where x bar is the sample mean, S is the sample variance, n is the sample size, μ is the specified population mean. Statistical significance at the $p < .05$ level, $\alpha = 0.05$. Sig P should be less than 0.05 to reject the null and to have evidence that the sample is different than the population. Reject null (reject H_0) if: *t* value is greater than *t* critical. The higher the *t*-value, the greater the confidence we have in the coefficient (the predictor). We have set our hypothesis as H_0: $\mu < 3$, H_1: $\mu \geq 3$. (Hypothesized Mean $\mu = 3$). Based on the questionnaire data analysis using a One Sample t-test analysis tool, *t* critical has a value of 1.67. We have observed the data provided by students, especially the benefits of the learning tool and the social networks factors.

Table 6.1. Questionnaire data analysis: mean, standard deviation, t and p

	t	**P**	**Mean**	**STDEV**	**Margin of error**
Reliability	3.55	0.00042	3.5	0.99	0.27
Critical Thinking	5.36	< 0.0001	3.72	0.94	0.26
Social Interact	7.74	< 0.0001	4.08	0.98	0.27
Motivating	7.66	< 0.0001	3.94	0.86	0.24
Productive	7.63	< 0.0001	4.0	0.92	0.25
Accountable	10.95	< 0.0001	4.3	0.83	0.23
Assessment	5.38	< 0.0001	3.8	1.04	0.29
Sharing	9.01	< 0.0001	4.1	0.86	0.23
Social motives	4.03	< 0.0001	3.62	1.08	0.30
Contributing	2.33	0.012	3.4	1.21	0.33
Friendship	1.120	0.13	3.2	1.26	0.34
Office Hours	5.16	< 0.0001	3.84	1.14	0.31
Acceptance	11.88	< 0.0001	4.4	0.83	0.23

Based on the results in Table 6.1., the users were satisfied and agreed that our learning tool is reliable ($p = 0.0004$, $t = 3.55$) and was built with factors and design that will help them improve their critical thinking and analytical capabilities ($p < 0.0001$). In future enhancements, vivid activities and exercises should be created and embedded in the tool in the interest of improving students analytical and critical thinking skills. Literally, contribution means helping something to advance. The data shows that 34 students liked the learning tool because they had a chance to contribute to topics and share their own knowledge and experiences with others. Students usually engage more if they feel that their knowledge and effort is appreciated. Moreover, some students mentioned that participating more in discussions have increased their popularity in class, contribution factor has a ($p = 0.012$, $t = 2.33$). Additionally, the tool has made them feel more close to their class mates, instructors and their academic institution ($p < 0.0001$). Though students have agreed that contribution and sharing lead to popularity, it was clear that most of the students didn't see the mobile as an environment to make friends like social networking apps ($p = 0.134$, $t = 1.12$). Before using the learning tool, students were asked to test the application for performance and usability. The data analysis had shown that our learning tool is easy to use ($p < 0.0001$, $t = 8.94$), all the items were well organized ($p < 0.0001$, $t = 8.41$), easy to find items and to understand the function of each item ($p < 0.0001$, $t = 7.88$), an efficient and effective ($p < 0.0001$, $t = 5.49$) interactive learning tool. Furthermore, 43 out of 50

students have found that the learning tool is productive, accountable and reliable. The tool helped them draw special attention to key concepts and emphasize the important keywords and topics. 38 students found that the grades they receive from the teacher for participating in discussions helped them assess their progress and involvement ($p < 0.0001$). What mainly attract users in any mobile application is the ability to share information and contribution to lessons and ability to share own experience and being surrounded by friends and the ability to contact them any time. 44 participants have mentioned that IMSSAP has created a perfect bite-sized learning environment and they have appreciated that the learning tool was blend with social networks motives that will enhance interactivity and help improve learning and teaching qualities.

6.15. Comparing IMSSAP with IMMAP

Comparing experimental studies results with another would help eliminate anomalities, add value to an experiment and prove clarity and reliability of outcomes and conclusions. We have compared our application with Interactive Mobile Messaging Application (IMMAP) (see Table 6.2.). IMMAP was built with factors intended to enhance student interaction with the learning contents and to impact students and influence them to adopt mobile technology in classroom. The factors are easiness, usefulness, effectiveness, joyfulness, quality, information quality, and accuracy assurance. The study stated that there are many educational benefits for teachers and students if they integrate mobile technology in the learning and teaching process. Mobile learning emphasizes the importance of student centered teaching method as this will motivate students to contribute, engage more and interact with other learners. Mobile learning tools are not designed exclusively to support interaction. It is rather designed to prepare students to get accustomed to self administered studying and show them the importance of interaction, collaboration and knowledge sharing.

Table 6.2. Comparative data about IMSSAP and IMMAP

IMSSAP				IMMAP		
	Mean	STDEV			Mean	STDEV
Usefulness	4.08	0.98		Social Interaction	3.9	0.51
Ease of use	4.08	0.85		Easiness of use	3.984	0.69
Enjoyment	3.62	1.08		Social motives	3.905	0.49
System quality	3.86	1.1		Effectiveness	3.953	0.58
Information quality	4.02	0.91		Functionality	3.963	0.51
Adoption	4.4	0.83		Acceptance	3.879	0.46

The mean lower bound is 3.0 and the upper bound is 4.6 and the standard deviation the closer to zero the better. Based on the factors specification of IMMAP, it was clear that the study meant to evaluate the technical quality of the application. The tool just offers a space for students to access sessions and ask questions. It is just another form of learning resource materials tool. Student-student or student-teacher interaction requires a better understanding of the students needs in education. On the other hand, this research learning tool IMSSAP, after school interactive mobile learning app, offers students and teachers with variety of options to select from besides asking questions. The application allows teachers to post a topic that requires active participation and contribution from students. Students interact with each other through commenting, replying, share outcomes with their mates. The teacher can set the discussion topic for individual work or as group work (debate). The grading system will help students assess their development through the course. Students can send images of their work or snapshots from books or scientific journals.

Obviously IMSSAP offers students and teachers with a rich interactive learning tool that will not only enhance interaction process but also improves the learning and teaching qualities. Table 2 displays the mean and standard deviation values for the common factors between the two applications, the easiness of use, social networks motives, data and system quality and adoption or acceptance. IMSSAP mean is slightly bigger than the mean values of IMMAP. The standard deviation of IMMAP is lower than that of IMSSAP. This indicates that our application data values are spread out. We believe that IMSSAP is a consistent and effective application, though if further investigations are conducted, higher accuracy results may be retrieved.

Most of the aforementioned studies have studied the factors that would motivate students to adopt mobile learning to develop true education skills. We agree with [13] that easiness of use and usefulness acceptance factors have a positive impact on learner's readiness to adopt mobile learning. IMSSAP is a light weight user friendly, efficient and accountable mobile learning tool. Data analysis has shown that students had enjoyed learning using the tool. Vimala et al., [12] noted that students were attracted to learning tools that supports social media functionalities. In our study we took in consideration the necessity of embedding social media factors in IMSSAP. Social factors are critical to young students. IMSSAP offers learners contribution, knowledge share and instant feedback capabilities. [18] Have agreed with [22] that assigning students in groups has effected positively student's engagement and increased students' motivation to learn and participate in social networked activities. Moreover, students working collaboratively usually achieve better than those working individually. Through IMSSAP, teachers can assign class activities to groups to enhance student-student interaction. Wang findings [21] demonstrate that engagement, self-assessment and social interaction, have a significant effect on improving students-students and student-teacher interaction. IMSSAP is designed to create a learning environment which requires active contributions from students. Popularity is one of the top reasons why students use social media. It will motivate students to contribute to class activities, share the outcomes with others for discussion, feedback and self-assessment.

Although the findings of this study were promising and provided supportive data from different academic departments about the viability of engaging the social media and mobile learning as learning tools, the authors believe that these findings can be further strengthened in another future researches through merging the instructors'/professors' vision and expectations for M-Learning. Furthermore, the revealed results are believed to be applicable to a wide variety of students and to different academic institutions, yet different aspects of student's background knowledge, learning environments and experience in other institutions might affect the outcomes and may be further assessed. The commonalities between this research study and the other studies around the world had transformed the case from local to global issue. In future studies, data may be

collected from participants with different educational background and from different institutions with larger groups of students. It is also planned to add more knowledge share facilities to the application to allow students from different academic institutions get connected. Moreover, studying the effect of empowering our system with a game sense approach for educational purposes on motivating students to engage more in the class activities is being considered for our future research works.

CHAPTER 7. CONCLUSIONS AND FUTURE WORK

7.1. Conclusions

Mobile learning is still reflecting informal learning because it is not officially a part of the traditional educational environment. But how can we use mobile technology to create a balance between formal and informal learning? Instead of focusing on the devices, schools should focus on the activities and the functionalities mobile devices can offer. This would provide us with a learning environment where students and teachers are well aware of mobile devices capabilities to support the learning process.

Our research besides many other studies reveals Students are becoming more aware of the importance of mobile technologies in learning activities whether these activities relate to problem solving or practical to prove an idea. The portability of these devices makes them more accepted mainly because they are owned by the learners themselves. Mobile devices make learning more enjoyable and resourceful and promote interaction and collaboration.

In this research, we are engaging in the process of developing m-learning around the world. Social and pedagogical factors are being used while designing the learning tool. In a popularity-driven culture, interaction between users enriches discussions and promotes knowledge share. Popularity is one of the top factors why students use social media.

The application was designed and created using android software development kit and java programming language. Google cloud storage a real-time database infrastructure was used to save data. The application was offered to students in different majors in engineering departments in Sakarya University, Turkey, for testing and feedback.

Before conducting the questionnaire we introduced mobile learning concept to students and explained its importance in their own learning process. After using the application, students answered the questionnaire. The questionnaire reflected three major points: performance, gain and the social factors effecting mobile learning acceptance, we have analyzed the survey data outcomes using the t test one-sample method applying it to SPSS the Statistical Package for the Social Sciences. Questionnaire was rated on likert agreement scale.

The following conclusions can be drawn based on our research findings

1- An extensive literature review lead us to the fact that despite technology advancement and the impact it has on people's different life aspects, technology, especially mobile devices, with all its powerful capabilities, is still not adopted and embedded fully in education. The main motive for this research is the lack of a learning tool that can fulfill learner's needs without ignoring the entertainment part. Learners also look for a less authoritative tool, a tool that can build confidence in them to take control in learning and feel like active contributors in life.
2- Motivating students and having them to participate and contribute to the learning process is one of the major issues that academic institutions are facing nowadays. The leaning material should be redesigned to include interactive learning pedagogies that develops collaboration skills and motivates students to engage more in learning.
3- IMSSAP was built after thorough research about the factors that influence users to adopt M-Learning in class. Previous researches were proposing tools but still function as a learning material resource like. We built our interactive learning tool to fit learners need for a simple and less authoritative learning tool. The survey results have proven that students are willing to accept M-Learning in class if the learning tool has features like IMSSAP, offering them the opportunity to contribute to the learning process and allow students to see their effort, contributions, knowledge and experience are valued and appreciated.

4- Based on the results, users have agreed that the learning tool is accountable and reliable, it has offered students a chance to contribute to topics and share their own knowledge, motivated them to participate in discussion which in return has increased their popularity, strengthened student-student and student-teacher relation, teachers spent more time emphasizing key ideas, the tool instant feedback and grading feature helped students assess their progress, IMSSAP is seen as a reliable bite-sized learning environment with social networks motives that will enhance interactivity and help improve learning and teaching qualities.
5- The survey data analysis results are clear evidence that a successful learning tool should be technically feasible and efficiently adaptable to any mobile operating system, should include teaching pedagogies that help improve learning qualities of learners and should have social networking factors to keep students entertained, engaged and motivated.
6- In comparison with other available mobile learning applications, IMSSAP was proved to be an effective learning tool that has the potential to be used as a learning tool in Sakarya University and in other universities.

7.2. Future Work

For future studies, we are studying the possibilities of the gamification of learning resources and creating ways to embed it into our mobile learning tool. Nowadays students are very familiar with technology and have higher expectations and requirements for teaching and learning. Thus we need to discover different teaching and learning strategies with social elements to motivate students to engage more in the learning process and be active learners. Gamification of learning contents is an effective approach and can have a positive impact on students and might inspire them to change their attitude towards mobile learning and can improve participation skills.

Nowadays, video games and interactive entertainment had an effect on students. Academic institutions are expected to provide students with interactive learning methods that motivate them to engage and participate more. Through mobile learning

tools learners will be capable of contacting, exchanging knowledge and expertise with professional educators without barriers that might hinder the learning progress. This interaction will create an active learning environment and reinforce the importance of participation and engagement [64].

7.2.1. Gamification in education

Since students voluntarily spend many hours playing games, we have been exploring ways to utilize the motivational power and effect of games on students and figure out methods to apply it to the learning process in a form of active learning. As a student, I still remember that I and my classmates were extremely motivated, productive and collaborative when the teacher set us in groups and asked us to solve a problem within a form of a game. Gamification is the application of rules and guidelines of a leisure activity and identifying rewards that will motivate users to compete and engage more [65].

Although we have many learning and teaching approaches and tactics, little effort has been made to understand the importance of integrating gamification in the student's learning materials. We think that gamification can be used to encourage learning and increase motivation and engagement. Students often are more comfortable to learn in gaming environments.

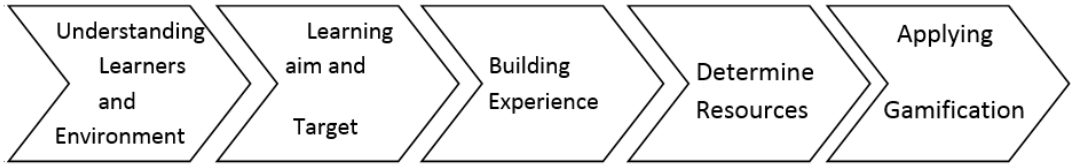

Figure 7.1. Implementing gamification in the Learning Process

This flow chart explains how to implement gamification in the learning process (see Figure 7.1.) [66]. Primarily with knowing who the students are and how the course fit into the framework (individuals, groups, class size, face to face, online). Identification

of factors that prevent learning advancement. Finally we implement our gamification strategies.

Gamification is independent of knowledge or skills. We will use gaming tactic to affect student's engagement and motivation. Gamification indirectly leads learners to gain more knowledge and improve learning skills [66].

7.2.2. Benefits to gamification in education

Gamification in education motivates students for learning and offers many possible benefits: students feel like researchers and contributors, in a more relaxed learning environment since they can simply try solving problems without the fear of failure or feeling shy to ask question, adds more fun to the classroom, instant feedback and points gathering will show student's progress in learning.

7.2.3. Application

There are many ways that gamification can be applied to a learning environment. This includes contribution points, communicating differently with students and modifying the structure of the class. Instead of using letter grades, we can apply contribution points. Then translate points to letter grades. Regarding changing the language that is used in the classroom, (we can use words like contribute, comment, add, share, experiment)." To gamify the structure of the classroom, a teacher might organize students into debating groups competing to finish first and collect points.

Gamification of the learning materials is the most challenging part. Specialized educators are needed to figure out how to gamify mathematics, physics, chemistry and STEM courses to encourage students to participate more, learn sharing knowledge, conduct scientific investigations and experiments, improve analytical skills and critical thinking capabilities without losing the academic and scientific value of the learning material. Students should know that the learning materials are not meant for gaming,

rather used in gamification to offer them a deeper look at science in a flexible format to better understand and digest the information provided.

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RESUME

Ahmad Khachan is a PhD candidate in Computer and Information Systems Engineering in Sakarya University, Turkey. He earned his bachelor's degree in Information Systems Engineering from Cyprus International University in 2005. He earned his Master's Degree in Management information systems from Fairleigh Dickinson University, Gildart Haase School of Computer Sciences and Engineering, New Jersey, USA, 2009. In 2013 he pursued his PhD studies in Computer and Information Systems Engineering in Sakarya University in Turkey. His current research is about Information systems and education, the factors that affect the acceptance of mobile devices in the learning process in Engineering Education. His future research fields include the gamification of learning and educational materials. Currently he is studying the behavioral activities of online users and the possibilities of improving online recommendation systems by creating a web based motivational system, an intermediary between social networking services and e-commerce.