Platform Independent Mobile Learning Tool (M-LT)

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ABSTRACT
Mobile Learning (M-Learning) is an electronic learning (E-learning) using mobile devices and wireless computing technology as a communication media to make learning ubiquitous and personalize. The objective of this paper is to present the design and development of a platform independent mobile learning tool (M-LT) for Structured Programming course in Universiti Teknologi PETRONAS (UTP) as a case study. J2ME, XML, and J2ME midlets are used for the system development of this platform independent tool. It consists of two modules, lecture materials and quiz. M-LT is helpful for all students who are taking this course. Supported devices are smart phones, Personal Digital Assistant (PDA), and laptops. It supports offline accessing of lecture materials. In addition, due to the supported file format M-LT may have a potential to support native technology which is a type of online access method of the contents. The type of supported users is only for learners who are taking the above mentioned course.

Keywords
M-learning, conventional learning, E-leaning, J2ME, XML

1. INTRODUCTION
Due to a great advancement of wireless technology and handheld mobile devices such as Cell phones, Palms, smart phones, PDA (Personal Digital Assistant), and Pocket PCs, information can be accessed everywhere [1, 2]. It has become more important in teaching and learning process where it is used as a blended learning technique. Mobile learning used mobile device as a learning instrument and wireless computing technology as a communication media to make learning ubiquitous. M-learning supports both individualized (individualized) learning and collaborative communication. In addition, mobile learning has a potential to complement and add value to the conventional learning.

Due to the purpose of use, limitations and heterogeneity of mobile devices, and other external factors, there is no standard or specification to design and develop mobile learning system (M-LS) [3]. For those reasons, development of M-LS is challenging. In addition, it does not have a potential to replace either electronic or conventional learning rather than complementing and adding value [4]. However, if it is leveraged properly, mobile learning can complement the existing learning system [5]. Because of the above mentioned factors, different M-LS development uses different specifications or standards for specific environments. This paper discusses on the development of M-LT, and designing of a new standard or specification as a roadmap to evaluate its performance. This M-LT is development for Structured Programming course in Universiti Teknologi PETRONAS as a case study which is compulsory course for all students.

Generally, under the development of M-LT there are two main identified areas of difficulties: limitations or constraints of mobile devices, and content creation for all types of mobile device. Both hardware and software constraints are categorized under mobile devices' limitation. The main hardware constraints are memory, processing power, battery consumption, screen size, and resolution. On the other hand, software constraints are operating system (platform), and types of technology it supports either online or offline. Meanwhile, there are two types of online accessing which are web browser and native technology. Online access method requires permanent or temporary communication between the system and user's mobile devices. On the other side, there is offline access method which does not need of wireless communication between M-LS and mobile devices. Therefore, the developed courseware should contain the basic concepts of the course then deploy in the mobile devices. The main goal of this paper is to design and develop platform independent M-LT using Java 2 Micro edition (J2ME). Moreover Extensible Markup Language (XML) and J2ME midlet are used as a data format.

The objective of this paper is to present the design and development of platform independent M-LT. The rest of the paper is organized as follows: in section 2, discusses some related works; section 3, presents the methodology of M-LT; section 4, presents the result of the system; section 5, discuses advantages and limitations of M-LT; finally, section 6 presents conclusion and the future works.

2. LITERATURE REVIEW
Currently, mobile devices are used for different purposes such as education, commerce and etc. In this paper, mobile devices are used for education purpose to improve learning from specific area such as Labs. In addition, wireless handheld mobile devices are highly individualized and support collaborative communication to make learning beyond classroom and support ubiquitous learning. As mentioned in section 1, there are two major factors which affect the development of M-LS: mobile phones' limitations, and content creation. Both hardware and software constraints are the main mobile devices' limitations. The hardware limitations are like, memory, processing power, battery consumption, screen size, and resolution [5, 6]. Moreover, software constraints are types of operating system and technology to access materials, either online or offline while there are two types of online accessing which are browser-based and native technology [7]. On the other hand, due to heterogeneity of mobile devices, content creation is a bog challenge. Technically, creating of contents which is device size independent or can be rendered in all types of mobile devices is a big challenge. Therefore, to make M-LS effective the following requirements should be considered and also answered: types of learners' mobile devices, purpose of the system, nature of the contents, and other external factors [7].

Even though, mobile learning is a fun and exciting approach to enhance students' understanding by making learning ever-present. But, as mentioned above there are many factors that are affecting the development and creating a common standard or specification of M-

LS. According to the capabilities and services of M-LS technical classifications written in some of the previous studies using the following indicators [3, 8-10]: types of mobile devices supported; location it covers either inside or outside campus; communication technology; access method (online or offline); types of supported information either academic, or administrative; supported users (learners or educators); supported learning types; and types of communication between learners and educators. Among the above indicators the following are: types of supported mobile devices, type of the data format, access method, information type, users, learning system, communication technologies, and availability of content. These indicators are used to design roadmap for the platform specification in order to examine the system, M-LT.

Currently, there are thousands of different brands of mobile phones with different capabilities and constraints [3]. In other word, that is very difficult and challenging to develop M-LS which are fully supported by all kinds of mobile devices. Due to their less limitations, most of the current M-LS are using Smart phone [11], PDA [12, 13], notebook [14], Pocket PC [14, 15], Palmtop [16], and Tablet PCs [4] as a leanring instruments.

Content of materials in HTML [13], WML [11], and XHTML [7] format are generated in Browser-based technology, and XML [17] format is used in native technology. In this paper native technology is adopted.

The last parameter from the selected list indicators, depending on the types of information, there are two types of services: Educational and Administrative. Educational service means when M-LS support an access to the educational content materials, tests, etc [18, 19]. Administrative service [12] means when M-LS support an access to the educational administrative services like, SMS (Short Messaging Service) concerning the educational process (changes in timetable, marks of exam, etc.). M-LT is developed for educational purpose for Structured Programming course.

A number of studies currently adopted mobile learning approach and developed M-LS using different platforms. Amin, et al. (2006) focuse on the development of mobile learning management tool in campus-wide environment using Microsoft.NET infrastructure [14]. Razieh Niazi and Q. H. Mahmoud [7] present on the design and development of a new application and system using java enabled platform [19]. M-LT developed using Java enabled platform to make it platform independent.

As mentioned above, the main unique feature of mobile learning is its mobility which makes students more excited to use this application. Mobile learning is the most entertaining learning approach which does not have any boundary to use. It is able to enhance students' level of understanding about the course and to complement the conventional learning. On the other hand, due to the memory, and processing speed, it is difficult to support all kinds of multimedia format; however it has a potential to improve teaching and learning process.

3. METHODOLOGY

The following three main steps are used:

- Parameter selection for the system reference
- Design the architecture and specification of the system based on the parameters.
- System development.

Finally, based on the analysis made on designed architecture, specification of the system, and other external factors, the platform independent M-LT was developed using Java 2 Micro Edition (J2ME). This can be seen in Figure 1.

3.1. Parameter Selection

Due to a variety of current M-LSs, the M-LT was developed based on the following parameters which are specified in [3]. The indicators are: types of supported mobile devices, users, access method and technology, and types of information (either for educational or administrative), data format, communication technologies, learning systems, and availability of content. Due to heterogeneity of mobile devices, theses parameters are used to design a roadmap of specification or standard for the given user domain which are used to design, and evaluate the tool performance.

3.2. Architecture Design of M-LT

Currently, there are different types of approaches to design M-LS. It is not supported by specific standard since numerous varieties of mobile devices and contents of the tool are found. In the context of this study, a simple M-LT architecture was designed based on the architectures specified in Razieh Niazi and Q. H. Mahmoud (2008) and Sharples, M., D. Corlett, et al. (2002).

3.3. Implementation Tools

To ensure platform independent, J2ME and Extensible Markup Language (XML) are used to develop M-LT. As shown in Figure 1, J2ME is used to develop applications that run on small constrained devices like, cell phones, Palms, PDA, Pocket PCs and others using K-Virtual Machine (KVM) as a compiler. Through the system development, mostly Java Specification Request (JSR) 118 uses for Mobile Information Device Profile (MIDP) 2.1 and JSR 139 for Connected Limited Device Configuration (CLDC) 1.1. XML is designed to transport and store data. Additionally, it uses small memory space. XML parser is used to read XML data and create a way for programs to use XML [20]. There are three fundamental types of XML parser: model, push, and pull parsers. The first two, model and push parsers use significantly more memory than pull parser, is suitable for J2ME applications. Due to its size K-Extensible Markup Language 2.0 alpha (K-XML, 9Kb) parser is one of the pull parsers and is used as XML parser in this M-LT development.

4. RESULTS

The results of this tool are discussed under three subsections which are: specification model, architectural design, and implementation of M-LT.

4.1. Specification Model of M-LT

Due to the existing wide diversity range of mobile devices, that is difficult to have one solid specification or standard and which gives an opportunity to realize different systems for mobile education. Georgieva, et al. (2005) proposed a general classification for the existing mobile learning systems and used in this paper to model a roadmap for the platform specification or standard (Refer Figure 1).

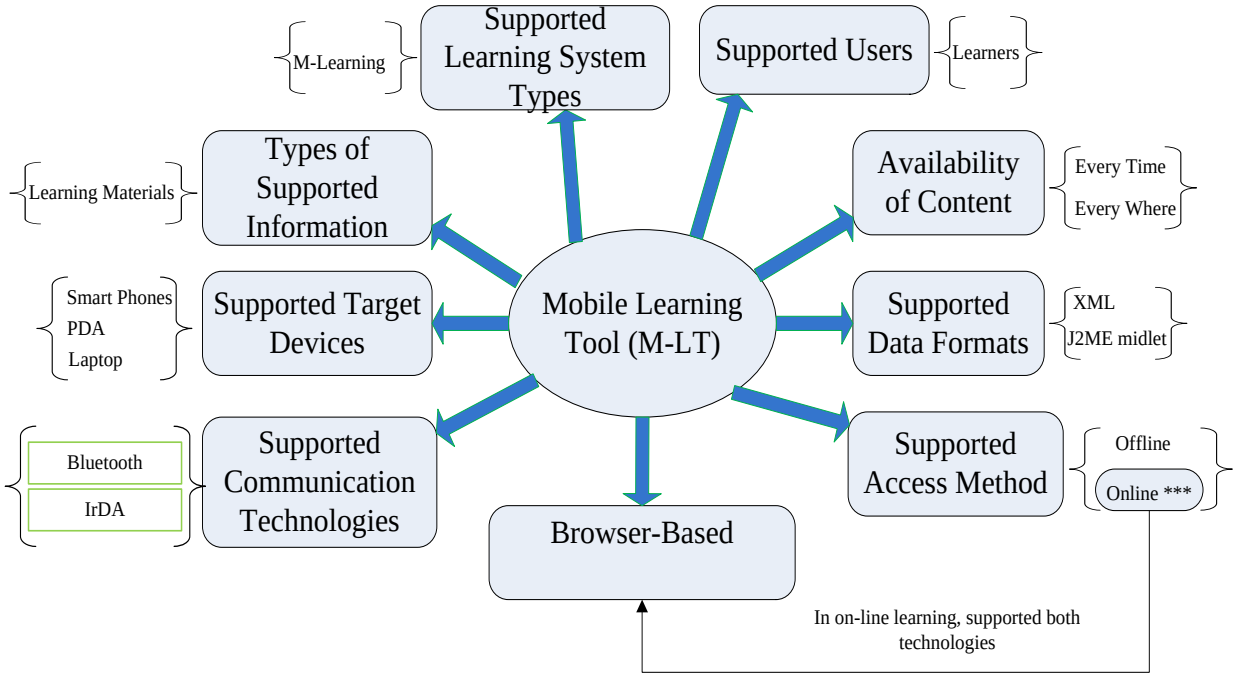


Figure 1: Roadmap for the platform specification of M-LT

Figure 1 depicts the platform specification roadmap of M-LT. The following sections present about the M-LT by considering the above specification roadmap model:

In this system, the contents are adopted in a variety of mobile devices on different platforms including smart phones, PDA, and laptop. This tool is designed to provide educational materials anytime and anywhere. It contains two main modules lecture materials, and quiz. The supported data formats to store the educational contents are XML, and J2ME midlet. This system supports offline access to learning materials, and quizzes. In addition, XML data format is used to support native technology; is one type of online technology by developing a light-ware platform which should be deployed on the mobile devices and used Hyper Text Transfer Protocol (HTTP) to talk with the server [7]. In the other word, in native technology the application should compile and can be run in a runtime environment.

Structured Programming is a compulsory course for all students in UTP which is used as a case study for this research paper. Moreover, E-learning facility is also available in the campus. Therefore, this tool is developed to support only M-learning and complement the existing learning systems. M-LT is developed only for learners. Due to low power consumption, inexpensive, and interoperability, Bluetooth and IrDA are selected as a communication technology.

Generally, this method is cost effective and hardware constraints are the main factors that are considered in the development of mobile learning system. In addition, the context of being user friendly and customized environment is necessary.

4.2. Architecture Design of Platform Independent ML-T

The architectural design of M-LT contains four layers: User, Logic, Application, and Storage layers. Figure 2 shows the architecture of the system:

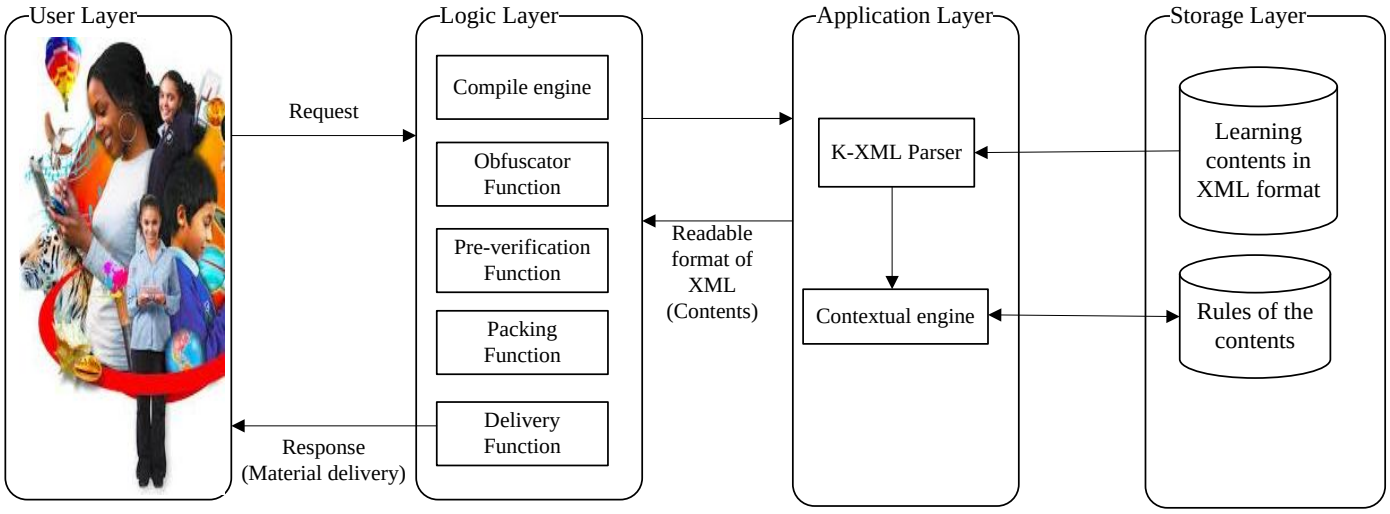


Figure 2: The architecture of the platform independent M-LT

4.2.1. User Layer

User layer is mobile terminal (client side) supported by J2ME technologies. In addition, M-LT is platform independent which makes possible to use any kind of platforms without other limitations. The tool is developed only for learners.

4.2.2. Logic Layer

This layer mostly provides and performs functions to generate, compile, obfuscator, pre-verify, pack and delivery of materials in XML format. The followings describe theses functions: compile Engine, obfuscator, pre-verification, packing function, and delivery function. Compile Engine has the responsibility for compiling Java source codes to bytecode class files. This architecture used J2ME compiler. Obfuscator Function improves the size, performance and security of J2ME mobile application. Pre-verification Function J2ME bytecode class files should be valid bytecodes to be run on mobile phone devices. Therefore, pre-verification must be applied to convert J2ME bytecodes to valid bytecodes. This function only acts on J2ME CLDC application bytecodes. Packing Function is necessary to generate special format such as jar or code files that can be able to run on mobile phone devices. Delivery Function is responsible for delivering educational materials.

4.2.3. Application Layer

This layer is responsible for reading the XML using K-XML parser, and checking the compatibility of the platform and content size using contextual engine process. These are: K-XML, platform adaptive content, and application layer. K-XML is a software module used to read XML documents and a means to provide access to their contents. Platform Adaptive content analyzes the platform of the devices and deploy by considering rules of the contents like, hardware constraints of the mobile devices. Application Layer provides and performs functions to generate, compile, pre-verify packing, and deliver educational materials in different formats including XML, and J2ME Midlets.

4.2.4. Storage Layer

It includes tables for educational materials, and knowledge-based quizzes in XML, and J2ME midlet format. In addition, metadata are used to define the data, and contains rules of the contents, used to check compatibility platform and its size in contextual engine, application layer.

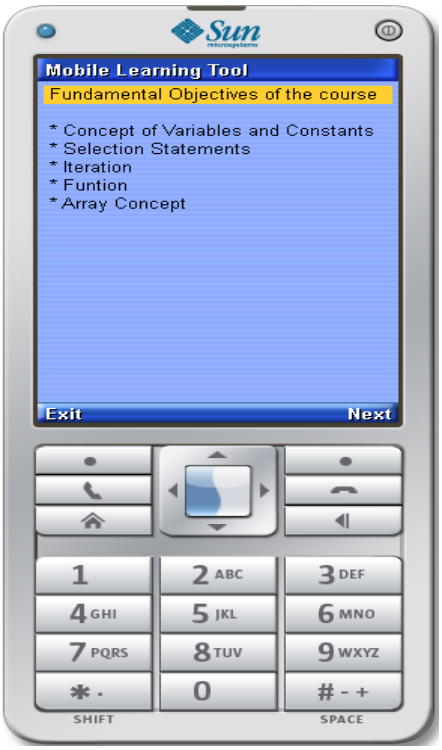
4.3. Implementation

M-LT is supported only learners for educational purpose through offline accessing techniques. Moreover, XML file format has a potential to support Native Technology which is a customized application is deployed on the device and used XML. Figure 3 shows some screen shots of system on Java ™ Platform Micro Edition SDK 3.0 device simulator

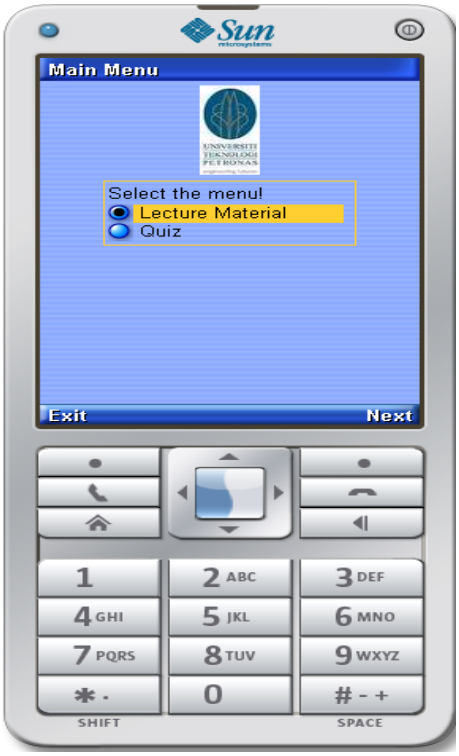
Learners are able to download this tool onto their mobile phones in different ways including infrared, and Bluetooth technology. This method is very cost effective, low power consumption, and inexpensive because they do not have to use bandwidth to download.

A mobile learning approach courseware for Structured Programming has been developed which supports only learners. The tool starts by presenting learning objectives of the course. Therefore, the purpose of having objective page play as the opening page is to capture the attention among students and give the aims of the course. However, students can skip the objective interface if they so desire. The interface for the objective is as shown in Figure 4.3 (a).

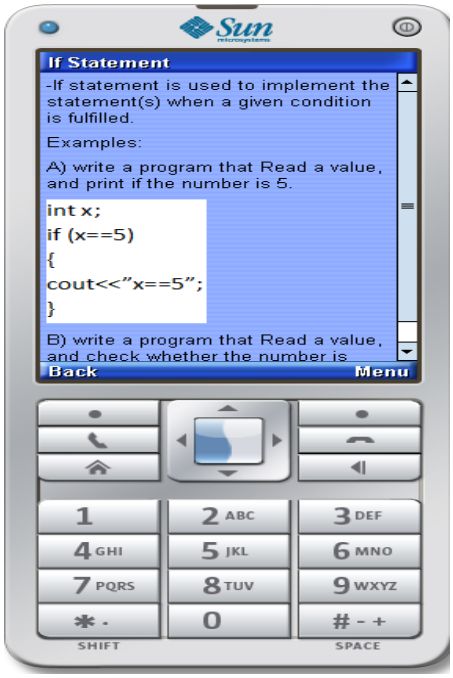
The next page after the objective presentation is the main menu page (See Figure 4.3 (b)). Then the users are free to explore and navigate the courseware since M-LT applies the perpetual navigation concepts. The main menu interface screen shot of M-LT, has two main modules which are lecture materials (See Figure 4.3 (b)), and quiz (See Figure 4.3 (c)). Moreover, Figure 4.4 depicted that the detailed classification of the two main modules of M-LT prototype. These modules have been designed according to the Structured Programming course syllabus.



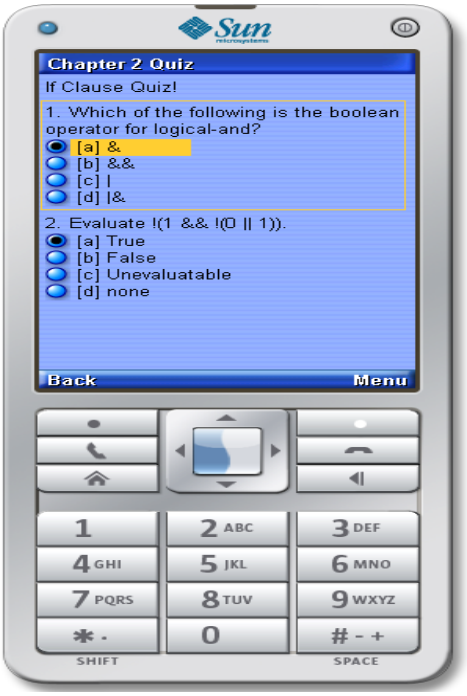
(a) Objectives



(b) Main Menu



(c) Lecture Material



(d) Quiz

Figure 3: Interface of the modules

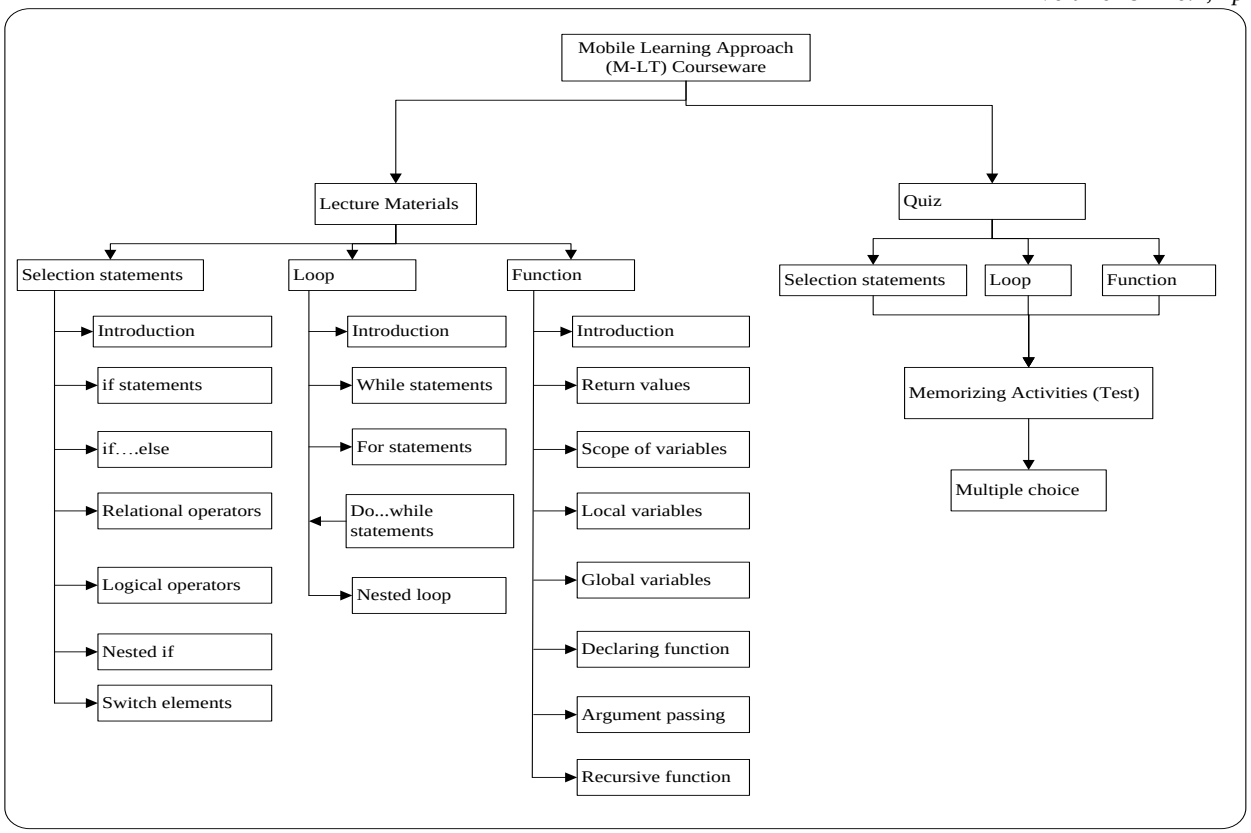


Figure 4 the main modules in M-LT prototype

5. DISCUSSION

The findings of this study show enhancement and value addition on the effectiveness of the current conventional learning system. The study is in accordance to studies made by [5, 15, 17] that have been used mobile devices as a learning instrument to develop courseware for the purpose of teaching and learning to complement conventional learning. Mobile devices have a potential to make learning accessible anywhere and anytime [12]; [21] which is called ubiquities learning.

This designed and specifications study uses parameters: supported mobile device, information type, types of contents and access method, and support platforms and users. M-LT was developed on J2ME and XML which are platform independent tools. The main advantage of being platform independent i.e. it can be deployed on different platforms. In addition, M-LT adopts the above mentioned advantages of mobile learning. This system is supported only for learners in the form of native technology to access information.

6. CONCLUSION AND FUTURE WORK

This paper presents the design of specification and platform independent mobile learning; the development of platform independent M-LT. It contains two major modules which are lecture materials and quiz. The benefits of this study include: its mobility, no need of data traffic over the network, no need of using bandwidth, and student can use anywhere even if there is no Internet access.

For future work, researcher proposes to evaluate its effectiveness and usability of the tool. In addition, to include Browser-based application, administrative information, and mobile learning objects like, audio, video, multimedia, and animations.

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