Proposing a New Design Approach for M-learning Applications

Al-Harrasi, H.\textsuperscript{a}, Al-Khanjari, Z.\textsuperscript{a} and Sarrab, M.\textsuperscript{b}

\textsuperscript{a} Department of Computer Science, College of Science, Sultan Qaboos University, PO Box 36, Al-Khoudh 123, Muscat, Sultanate of Oman
\textsuperscript{b} Communication and Information Research Center, Sultan Qaboos University, Al-Khoudh 123, Muscat, Sultanate of Oman
m104933@student.squ.edu.om, {zuhoor; sarrab}@squ.edu.om

Abstract

As Information and Communication Technologies (ICT) are developing frequently, new learning approaches have been introduced to facilitate teaching and learning processes. Mobile devices are growing in popularity and there has been an increasing interest in their potential as innovative tools for learning. Mobile learning or shortly (M-learning) is a new learning approach intending to use mobile devices such as laptops, smart phones and personal digital assistant (PDA) in learning process in any place and at any time. M-learning application needs to be designed in a way that considers the special features and constraints of mobile devices such as screen size, available storage, processor speed and battery life. This paper explores the existing design approaches for M-learning and highlights their main limitations. As a step forward in this direction, this paper also proposes a new design approach for M-learning applications focusing mainly on three main aspects: learner, learning content and technology. The approach consists of three phases: starting dimensions (SD) phase, M-learning Development (MLD) phase and Learning Content Design (LCD) phase. Finally, this paper provides a case study scenario to demonstrate the feasibility of the proposed approach.

Keywords: ICT, E-learning, M-learning, Learning Content Design, M-learning Development, Learning Management Systems

1. Introduction

The Internet technology in association with the World Wide Web (WWW) information network opens new avenues for improving the existing education system. In the 1990s, using devices such as PDAs or laptops in educational contexts for learning and training received more researchers’ attention. From that date many projects were introduced to support the concept of M-learning and the use of handheld devices which help the promotion of M-learning. The continuous proliferation of personal smart phones with advanced web browsers has created an incredible opportunity that cannot be ignored. M-learning spread widely in 2000s and many conferences were organized to specifically discuss the future of M-learning. M-learning is a new approach of learning where it enable learners to access knowledge anytime and anywhere. Moreover, M-learning considered as the next generation of distance learning. Learner, content, technology and environment are the basic elements of M-learning where learners are at the center in all learning activities and M-learning builds on learners’ interest, experiences and needs.

Moreover, M-learning provides learners with different types of mobility for instance, mobility in the physical space where the location in M-learning approach in most of the time is irrelevant, mobility of technology because of the availability of portable devices such as PDA, smart phone, laptop, tablet PC, cell phone and MP3 to be carried around and mobility of learners. M-learning content is essential as it shapes the learning...
process and contributes in M-learning successfulness. M-learning content is considered as a digital content where it has the ability to be presented in several formats including text, audio, video and graphics. In addition, learning content is designed in consultation with all stakeholders such as instructors, learners and parents in order to obtain the desired results.

In M-learning, learning setting is continuously changing due to the mobility of learners, learning technology and the learning content. In 2000 Chen and Kotz defined four categories of mobile context which are: 1. Computing context, 2. User context, 3. Physical context and 4 [7]. Time context. Computing context is about network connectivity, communication bandwidth and the used resources. User context is defined by the learner profile and location. Physical context is about the noise, lighting, traffic conditions and the temperature of learner’s physical location. Finally, time context defines the specific time of learning. Developer of M-learning must consider the different learning context of the learners to ensure high dynamic mobility learning environment. Moreover, mobile device has constraints for instance: screen size, input key size, battery life and limited memory that must be taken in consideration by designers and developers when developing M-learning applications.

In order to ensure the successfulness of M-learning applications, it is necessary to consider basic design principles, starting with the recognition of learner's profiles and requirements, types and considered learning environments, design of technology infrastructure and the design of learning content. This paper aims to: explore and analyze existing M-learning design frameworks, develop a new design approach for M-learning applications and demonstrate the feasibility of the proposed design approach through a case study scenario.

The paper is organized into five sections. Section 1, the introduction, presents an overview about M-learning. Section 2, the literature review, explores the existing design approaches for M-learning and highlights the main limitations of these approaches. Section 3, the new proposed design approach, describes of the proposed design approach and its phases: SD phase, MLD phase and LCD phase. Section 4, the case study scenario, attempts to provide a scenario for developing M-learning applications using the Advanced Software Systems Development course as a sample course to show the efficiency of the proposed approach. This course is offered in the Department of Computer Science, College of Science, Sultan Qaboos University, Oman.

2. Literature Review

Many researches and projects focused on the design aspects of M-learning. Most of these approaches concentrated on one aspect of M-learning design and omitted other aspects such as design of the learning content, learners’ requirements and content presentation models which are essential for the acceptance of the application among learners. Table 1 summarizes approaches those are related to M-learning design. Our aim is to provide a comprehensive design and development approach for M-learning applications that overcomes the limitations of the existing design approaches and covers the important aspects of M-learning design.

<table>
<thead>
<tr>
<th>Source</th>
<th>Components</th>
<th>Approach concepts</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| [8]    | • Design issue  
        • Dimensions of learning context  
        • Structural factors and their  | Designing issues mentioned are: user role and profile, work on the move, interface design, media types and collaboration support. Designing issues are mapped to the dimensions of learning context. These dimensions are: identity, learner, activity.  | • Does not consider the design of M-learning content  
        • Functional |
|instantiation| Objectives| spatial-temporal, facility and community. Each design issue was mapped to one or more learning context dimensions. For the structural factors and their instantiation element. It considers the rules (Business rules and Learning rules), goals and objectives, conflict and competition challenges, representation and finally interaction. The first three elements of the framework are important to carry out the final element which is objectives. | requirements analysis for learners, learning content and the application are not stated

- The framework does not show a clear process for developing the application |

| [9] | Personalized content | The content delivery is more useful and effective when it is delivered using both push and pull mechanisms. Push mechanism is implemented using SMS messages, alerts and scheduling calendars. While pull mechanism is implemented using M-learning websites, discussion boards and chat forums. The framework defined two types of content delivery for M-learning applications: personalized content and collaborative content. | The framework focused on delivery techniques of learning content.

- The design framework is ambiguous in terms of its components and structure |

| [10] | M-Learning activity design | M-learning activity design include: learning objectives, learning tasks, learning strategies and learning resources and tools. Requirement and constraint analysis grouped into two levels: general level and concrete level. M-learning scenario describes how a specific learner with specific characteristics carries out learning activities in different contexts in order to achieve the needed goals. Technology environment design includes: learning tools, platforms, interfaces, content databases and the network. Learner support means a group of services that enable the learners to overcome the difficulties that they may face in the learning process. | Does not consider the design of the learning content

- M-learning application evaluation is not included in the framework

- Requirements analysis does not cover the entire project |

| [11] | Learners’ profiles and needs | Context that surrounds mobile learners includes: physical, temporal and social. The physical context is concerned with the physical location of the learner, while temporal and social context are concerned with the different cultural information, situations and moods of the learner. Educational paradigm or model is concerned with the pedagogical methodologies and practices to be applied with the learning application. Possibilities and limitations of mobile and wireless information and communication technologies. | The framework is abstract

- It does not cover all aspects of the application requirements

- No clear process for developing the whole M-learning application |
| [12] | • Theories of learning  
• Generic mobile environment  
• Mobile learning context  
• Learning experience  
• Learning objectives | Theories of learning are important as they will affect the design of the materials and the interaction approaches used. For generic mobile environment, demographic data may need to be collected from the parties that are involved in the learning scenario. Mobile learning context consists of identity, learner, activity, spatial temporal, facility and collaborative. M-learning application designers should focus on the impact of application design on the learners, because learners look for a pleasing and attractive experience besides acquiring the knowledge. Goals and objectives of the whole learning process are important as they provide learners the directions of learning. | • No consideration for designing the learning content  
• Functional requirements analysis for learners, learning content and the application  
• Requirements analysis does not cover the entire project |
| [13] | • Analysis  
• Design  
• Development  
• Implementation  
• Evaluation | The idea of ADL M-learning framework based on ADDIE model (Analysis, Design, Development, Implementation and Evaluation) for instructional design. These phases can be performed in a linear manner, but in fact they are interrelated with each other and performed in an iterative fashion. | • The framework follows a clear process for the instructional design development, but does not consider the design of the learning content instead |
| [14] | • Editor  
• IR  
• Mobile runtime engine  
• Front end subsystem  
• Back end subsystem | The framework provides a design approach for User Interface (UI) that supports multiplatform for the native apps. The framework has two sides: front and back end subsystems. The front end subsystem is an editor that provides the designer with the facility to design user interface independently from the developer. On the other hand, back end system provides a run time environment for the targeted platform which consists of codes and libraries. | • The framework focuses only on the design of User Interface in mobile native apps. |
| [15] | • Demand analysis  
• Core factors analysis  
• key factors analysis  
• Evaluation design | Demand analysis is to promote the suitability of learning contents for M-learning, to analyze the ability of learners and whether they have mastered the required knowledge. Core factors analysis is about the subject of learning activities, learners’ profile and technology ability. Key factors analysis considers about the division of large learning activities into sub-micro activities. Learning evaluation design means that the feedback of learners is documented to be used for the process of M-learning activities improvement modification. | • The framework is abstract  
• It does not consider all design aspects of M-learning  
• There is no clear process for developing the whole M-learning application |
3. The New Proposed Design Approach

The proposed design approach has three phases: Starting Dimensions (SD) phase, M-learning Development (MLD) phase and Learning Content Design (LCD) phase. The approach starts by evaluating the appropriateness of the learning materials to be delivered using M-learning approach and also the added value from developing M-learning application for learners, instructor, other stakeholders and the institute. In other word, if there is no obvious benefit to delivering a piece of learning using M-learning approach, it does not worth the effort.

![Figure 1. The New Proposed Design Approaches for M-learning Applications](image)

3.1. Phase 1: Starting Dimensions (SD) Phase

The SD phase consists of four components: stakeholders, technology infrastructure, learning environment and learner support services. The overall purpose of this phase is to give an idea to the developers about the basic aspects those involved in the learning process and learning application. A summary of phase 1 is shown in Table 2 and the details are provided in the following sub-sections.
Table 2. SD Phase Summary

<table>
<thead>
<tr>
<th>components</th>
<th>Tasks</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholders</td>
<td>▪ Identify stakeholders involved with the app</td>
<td>▪ Directly involved stakeholders profile</td>
</tr>
<tr>
<td></td>
<td>▪ Indirectly involved stakeholder profile</td>
<td></td>
</tr>
<tr>
<td>Technology infrastructure</td>
<td>▪ Identify targeted mobile devices</td>
<td>▪ Mobile devices types that can be used for the app</td>
</tr>
<tr>
<td></td>
<td>▪ Identify supported platform</td>
<td>▪ Target platforms</td>
</tr>
<tr>
<td></td>
<td>▪ Identify the type of database</td>
<td>▪ Type of the app (either native or web based app)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Type of the database for storing the content and other information (e.g.: learners information, learning contents)</td>
</tr>
<tr>
<td>Learning environment</td>
<td>▪ Identify the style of learning environment</td>
<td>▪ Style of learning environment that the app will support</td>
</tr>
<tr>
<td>Learning support services</td>
<td>▪ Identify the type of support services that will be provided to learners</td>
<td>▪ Types of learning support services provided for learners</td>
</tr>
</tbody>
</table>

3.1.1. Stakeholders: Stakeholders can be defined as anyone who is directly or indirectly affected by the system being developed or deployed [16]. M-learning stakeholders includes: learners, instructors, administrators and technician staff.

3.1.2. Technology Infrastructure: M-learning technology infrastructure includes network, learning tools, platforms and content database that support various activities of M-learning environment [10]. Generally, his component consists of three different layers: mobile devices, platforms and learning content database. The mobile devices are the learning tools used to access learning content database through various mobile devices platforms supported by wireless network access.

3.1.3. Learning Environment: Wilson in 1995 defined learning environment as a location where learners can meet, work together and support each other. Learning environment contains the learner, the space and the learning tools that the learner use to acquire information and knowledge from the whole learning environment [17]. M-learning as a learning environment redefined the relation between learners, instructors and the physical
location. Figure 2 shows M-learning environment styles depending on the type of learning activities that M-learning application is provided for the learners.

**Blended Learning Environment:** combines traditional learning with any form of technology based learning.

**Interactive Learning Environment:** involves learners with different kinds of learning interactive activities. M-learning developers should provide different levels of interactivity to utilize mobile devices technologies.

**Ubiquitous Learning Environment:** supports learners to learn the right thing in the right way at the right place and time.

**Instance Information Learning Environment:** provides instant information and communication experience since learners are using mobile devices as tools for learning. According to [18], learning content in M-learning should provide materials that enable the learner to quickly zone into information. Examples of instant information include: definitions, equations and formulas.

**Collaborative Learning Environment:** supports interaction between different parties within the environment.

**Private Learning Environment:** provides an environment, where each learner uses his/her own mobile devices and accesses learning content dependently from other learners.

### 3.1.4. Learner Support Services

Learner support services (LSS) is the last component that comes from distance learning (D-learning), which means variety of strategies, activities and administrative systems that are designed to support the learning process. M-learning uses different types of LSS including: training services, consultant services, community support services, navigation and supported information [19].

### 3.2. Phase 2: Mobile Learning Development (MLD) Phase

The MLD phase is the most important phase in designing and developing M-learning applications as it is interconnected with SD and LCD phases. This phase consists of interrelated processes including: analysis, design, development, launching and evaluation. The purpose of MLD phase is to design M-learning content and develop M-learning activities that focus on the aspects: technology, learning content, learner and the learning context. A summary of phase 2 is shown in Table 3.

<table>
<thead>
<tr>
<th>Table 3. MLD Phase Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step</strong></td>
</tr>
</tbody>
</table>
| Analysis | ▪ Identify problem statement  
▪ Set possible solutions for the problem  
▪ Identify application’s goal  
▪ Collect learners’ requirements  
▪ Collect functional, and non-functional requirements of the application  
▪ Defining learners’ profile  
▪ Overall learning objectives | ▪ Overall learning objectives  
▪ Application’s goals  
▪ Learner profile  
▪ Application functional and non-functional requirements  
▪ Existing constraints |
| Design | ▪ Identify learning specific objectives  
▪ Design the learning content  
▪ Design the learning activities  
▪ Design user interfaces | ▪ Learning specific objectives  
▪ Design of learning content  
▪ Design of learning activities  
▪ The design of user interfaces |
3.3. Phase 3: Learning Content Design (LCD) Phase

The third phase of the design approach is the LCD phase. Since learning is a dynamic process, several aspects have a significant role in the process in mobile context such as learning content. Learning content is the central aspect that contributes in shaping the learning process in M-learning. Moreover, learning content can determine whether the learner will be engaged in M-learning experience or not. The purpose of this phase is to design quality learning content that promotes effective learning, attracts learners to M-learning, suits the special features of mobile devices and meets the needs of learners. This is a challenging process. It requires an accurate planning, analysis and design of learning content and learning content delivery. Moreover, a good quality of the learning materials requires a continuous evaluation and improvement to satisfy learners’ preferences. Quality is a feature that is normally defined by the user, and in M-learning environment quality is defined by the learners using M-learning application to learn new information and skills and therefore increase their knowledge. At the end of learning content design process, learning quality evaluation step should be established to ensure the qualitative aspects of the content before delivering to the learners. Quality matrix attributes for learning content include: Accuracy, significant, presentation, effectiveness and cost. A summary of phase 3 is shown in Table 4.

<table>
<thead>
<tr>
<th>Step</th>
<th>Tasks</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development</td>
<td>• Implement the application using any programming language</td>
<td>• M-learning application</td>
</tr>
<tr>
<td></td>
<td>• Instructions of how to use the application</td>
<td>• Instructions of how to use the application</td>
</tr>
<tr>
<td>Launching</td>
<td>• Release the application for the learners</td>
<td>• Feedback of learners after using the application</td>
</tr>
<tr>
<td></td>
<td>• Train the learners to use the application</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>Formative Evaluation</td>
<td>• Evaluation report for the next process</td>
</tr>
<tr>
<td></td>
<td>• Evaluate all tasks after each step</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summative Evaluation</td>
<td>• Documentations about stakeholders’ comments and needs</td>
</tr>
<tr>
<td></td>
<td>• Evaluate the overall project</td>
<td>• Decisions about how to improve the quality of the application</td>
</tr>
<tr>
<td></td>
<td>• Check the learning quality</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. LCD Phase Summary

- **Overall course learning objectives**
  - Identify the learning objectives of the course
  - Overall learning objectives

- **Learning modules**
  - Identify the learning modules that the application will cover
  - Divide modules to topics
  - Modules names covered with app
  - Topics classification of each module

- **Learning objectives for each module**
  - Identify the learning objectives for each module
  - Learning objectives for each module

- **Learning theories**
  - Identify the type of learning theories. [20], defined the current learning theories for M-learning, e.g., behaviorist learning, cognitivist learning, collaborative learning, informal learning and lifelong learning.
  - Learning theories support by M-learning app

- **Presentation models**
  - Identify the presentation models for each module
  - Presentation models for each module

- **Learning quality**
  - Evaluate learning overall quality
  - Documentations about the quality learning, and recommendations for improvement
4. Case Study Scenario

Advanced Software Systems Development (COMP6015) course has been selected for the case study scenario. This course is used as a core course for master program in the Department of Computer Science, College of Science, Sultan Qaboos University. This course will be developed as M-learning application following the phases and steps of the proposed approach. The development of the application starts by evaluating the appropriateness of the course materials to be delivered as M-learning. COMP6015 materials are suitable for M-learning approach so, the development process moves to phase1: SD as shown in Figure 3. After phase1: SD, the developers got a clear image about the basic components of M-learning that will help in processing phase 2: MLD. Figure 4 shows clearly the steps of phase 2: MLD. Starting from analysis step moving to design, the designers design prototypes for the learning activities and the user interface in consultation with other stakeholders. The prototypes help the designers to obtain stakeholders’ comments and opinion related to design aspects in early stage before moving to the actual development of the application. Moreover, the prototypes assist designers and developers to highlight functional and non-functional requirements of the targeted stakeholders. In development stage, developers start building the learning activities based on agreed prototypes produced in the design stage. As mentioned in Figure 4, Android studio is the development environment of the application running in Windows 7. There are system requirements needed to run Android studio properly in Windows 7 such as: 2 GB RAM minimum, at least 1 GB for Android SDK (including emulator system images and caches), 400 MB hard disk space, 1280 x 800 minimum screen resolution, and Java Development Kit (JDK) version 7 or above. Eventually, launching the application will be supported with needed training and consultations to ensure the clearness of application usage for targeted users.
**Problem statement:** Students registered in COMP015 course need a way to utilize their mobiles to review the course and have continuous practice for the course as a private environment.

**Possible solution:** M-learning application

**Application goal:** Provides the course for the students in an efficient way that helps them to get the needed knowledge and have frequent practices for their lessons.

**Learners’ requirements:** Ability to review course’s lessons at any place and at any time, and get continuous practice for the lessons to increase their knowledge and improve their skills.

**Functional requirements:**
- Effective design of the app’s activities, with suitable font size and color
- App’s UI should be clean and easy to navigate to other activities
- Navigation screens must be clear and easy to reach
- App’s total size must be reasonable to be downloaded into student’s mobile devices
- Effective design for the learning content, with suitable font size and color
- Achieve lesson’s learning objectives

**Non-functional requirements:**
- Availability: the app will be available for the students 24/7
- Security: Login id and password are required from the students to login to the app
- Efficiency: the app needs internet connection to work as efficient as its intended
- Accessibility: the app will be accessible in any place and at any time using any mobile devices support Android/OS

**Learners’ profile:** Targeting undergraduate and postgraduate computer science learners who have good level of technology knowledge and experience.

**Overall learning objectives:**
- Understand the software process models
- Decide a process model
- Decide the software system architecture
- Design architecture for software systems
- Use the reuse mechanisms
- Develop software systems with components
- Develop software systems with services
- Develop software systems with aspects

**Learning specific objectives:**
- Identify different software processes
- Understand agile software development process
- Understand service oriented architecture
- Understand component based software development

**Design the learning content:** The design of the learning content will be discussed and designed as part of LCD phase.

**Design learning activities:** The design of activities should be friendly and easy to navigate between them.

**Design of User Interface:** App interface should be friendly, clear and understandable by learners. Design UI as a storyboard and ask instructor and learners for their comments and needs.

**Android studio as the development environment for app implementation:**
- Using JAVA programming language
- Android studio is an open-source software supports Java language
- For the database WAMP server will be used, because it helps responsible stakeholders to frequently update database content.

**Launch the application:**
- For the learners and provide the needed support.
- Train the students and instructors on how to use the app.
- Identify who will help users if they need any help, or they face any problem.

Figure 4. The Scenario for Phase2: MLD

Figure 5 represents examples of User Interface (UI) for the Advanced Software Systems Development course as M-learning applications.
Phase 3: LCD is interconnected with phase 2: MLD as mentioned previously. It is worth to mention that, for the COMP6015 course, total of five chapters are used in M-learning application and each chapter is divided in three parts for the purpose of learning activities fitness with mobile devices. Therefore, learning quality assurance process is implemented for the whole materials to ensure achieving high quality materials that are provided in M-learning. Indeed, the process is iterative that gives the flexibility to LCD phase to be modified based on the results of materials quality assurance and summative evaluation of the application. Figure 6 shows the steps of phase 3: LCD for the design and quality assurance of learning content.
After launching the application for learners, summative evaluation will be implemented for the purpose of improvement of the whole project. The performance of students registered in the course in a specific semester will be observed and also taking their comments and opinions. In addition, other stakeholders’ comments to improve the application will be considered. Summative evaluation process will be documented, and any needed improvement should be considered to increase the level of our application’s acceptance.

5. Conclusion

Our research starts from a known fact: the popularity of M-learning applications as learning tools and the existence of highly powerful mobile devices and a generation of digital natives. At the same time, the proliferation of M-learning applications introduces the need for framing the design process for the purpose of ensuring the successfulness of these types of applications. The paper proposed new design approach for M-learning applications. The new approach consists of three phases including starting dimensions (SD) phase, M-learning development (MLD) phase and learning content design (LCD) phase. SD phase consists of four components: stakeholders, technology infrastructure, learning environment and learner support services. Its purpose is to give a general idea about the basic aspects or dimensions involved in the learning process and learning application. MLD phase consists of five processes: analysis, design, development, launching and evaluation. It aims to design M-learning content and develop the M-learning activities. LCD phase consists of: overall learning objectives, learning lessons, learning objectives for each lesson, learning theories, presentation models and learning quality. LCD phase is purposed to design learning materials that clearly suit the special features of mobile devices and meet the needs of each individual learners. The feasibility of the approach has been evaluated through a scenario of developing M-learning application for the Advanced Software System Development (COMP6015) course, which is offered in the Department of Computer Science, College of Science, Sultan Qaboos University.

Acknowledgements

This article is based on the research work funded by The Research Council (TRC) of the Sultanate of Oman, under Grant No: ORG/SQU/ICT/13/006, (www.trc.gov.om). Thanks go as well to the Department of Computer science, College of Science, Sultan Qaboos University for accepting me in the MSc program and allowing me to pursue my degree.

References

Authors

Halima Ali Al-Harrasi, she is a MSc. student at the Department of Computer Science, Sultan Qaboos University, Oman. She is working on project ‘‘M-Learning in Oman: Development, Adoption, and Dissemination’’. She has completed her Bachelor degree from the College of Applied Sciences, Oman

Zuhoor Abdullah Salim Al-Khanjari, she is an Associate Professor and Head of Department of Computer Science, Sultan Qaboos University, Oman. She has more than fifteen years of teaching experience. She served as member of several committees in the department and university. She has published more than fifty papers in reputed journals. Her main area of research is Software Engineering, M-Learning, Web development, and Mobile application development.

Mohamed Sarrab, he is a Researcher at Communication and Information Research Center, Sultan Qaboos University, Oman. He has completed his PhD (De Montfort) from UK. He is an active researcher and has published several papers in international journals and conference proceedings. He is the Project investigator of ‘‘M-Learning in Oman: Development, Adoption, and Dissemination’’. His research interest is in software engineering, M-Learning, and educational technology.