Personalizing M-learning Systems Using Recommender Systems

Mahsa Baniardalan and Mehregan Mahdavi

Abstract—*In mobile learning, there is no limitation for the number of learners; it is more attractive than traditional learning, more convenient and cheaper for updating, quicker in terms of broadcasting, less bulky and it is easier to transfer information. In addition, the studies show that today, personalization is an important prerequisite for attracting learners in order to consider their requirements and interests and to provide proper context for the learners. This can result in improving the quality of learning. In this paper, a comprehensive model is presented which includes personal, contextual, and environmental properties. Based on these parameters, the recommender system suggests educational materials in a proper manner such that the learner is attracted to the learning system. The system's performance could be evaluated using questionnaires.*

Index Terms— Content, Context Aware, Mobile Learning, Personalization, Recommender Systems.

1 Introduction

At the present era of information technology, it is possible to have a mobile form for every application, such as is learning. The category of mobile learning is a new concept which has been introduced after electronic education has been developed in order that learning and training can be available in everywhere and every time and it can be evaluated as well.

Mobile learning has been given various definitions including:

Mobile learning can be considered as a combination of "distance education" and "electronic" because the trainer and learner are separated by a distance and the learning is facilitated by advanced technologies using electronic tools [1]. According to another definition, mobile learning is an introduction to ubiquitous learning in which the learner can access to his or her required information everywhere and every time [2].

As the whole, this method of learning can be considered as everywhere and every time learning through mobile tools such as portable computers and mobile phones, with no need for physical connection to the network [1, 4].

Mobile learning can provide effective methods of learning, specifically educational courses for those who are not able, for any reason, to attend in full time classes. Mobile learning has been successful in Europe and Africa [3].

In another definition, mobile learning is defined as any learning in which learner is not in a preplanned and stationary place and the learning is processed through mobile technology [5]. In other words, mobile learning does not depend on a specific place and it is flexible in terms of place of learning and mobile technology. In fact, the mobility of learning is on focus [17]. Therefore, the importance of mobile learning is that it makes possible to access learning everywhere [6]. In addition, it is interactive and enjoyable and it is easily used to learn efficiently and more amusingly.

The previous research has shown that educational outcome is not the same for all people and it often fails in spite of spending much money and consuming a lot of time. Users and learners in these systems differ in terms of their previous knowledge, learning achievement rate, age group, skill and profession and personal intention to learn [7]. If mobile educational system is designed based on the user properties, the quality of electronic education will be improved.

This research presents a simple but efficient model for personalizing mobile learning in order to meet all needs of learners.

This paper is organized as follows: Section 2 presents content analysis and the way the required content is developed. It also presents existing models. An efficient model is introduced in Section 3, which considers different aspects and priorities of learners in order to provide learners with suitable educational materials according to their needs. Finally, Section 4 concludes the paper.

2 Literature Review

2.1 Recommender Systems

A recommender system in electronic education recommends

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the optimal content to learners. In recent years, a lot of studies have been conducted on the process of guiding users in educational systems [11, 13]. Generating useful recommendations to a group of users for items or products that might interest them is the main purpose of recommender systems. Some examples of operation of industry-strength recommender systems are suggesting books on Amazon, or movies on Netflix.

Most of the time, the so-called information overload problem makes a lot of difficulties for users to locate the right information at the right time. Recommender systems have come out as an important answer to it. It has been completely spread out in variety of applications, mostly in the form of intelligent virtual assistants in a variety of e-commerce domains. Recommender systems have demonstrated to be effective at delivering the user a more intelligent and proactive information service. They use techniques borrowed from user profiling, information filtering and machine learning, in order to make proper recommendations for products or services based on users' preferences and needs [14].

Generally two recommendation strategies are more important. One of them is Content-based recommenders which rely on rich content descriptions of items (products or services) that are being recommended [15]. A content-based movie recommender which typically rely on information such genre, actors, director, producer is an example of and matches these criteria against the learned preferences of users in order to select a set of promising movie recommendations. Clearly, the designet of such a content-based system should perform considerable knowledge-engineering activities since the required domain knowledge may not be readily available or easily extracted. The collaborative filtering (CF) recommendation strategy takes advantage of the fact that in real world we often look at our friends for recommendations. It does not need item knowledgeand instead uses user profiles which also include the past rating history or bahaviour of the users. It is also called social filtering. By using ratings history of a set of suitable users, it can generate useful recommendations for a target user. The set of users that are chosen by the system are chosen based on the similarity of the ratings history with the target user [14].

2.2 Context Definition

Context is defined as a collection of all information about a certain entity [10]. In mobile learning, the collection of information is related to properties and situation of learners which can be collected explicitly (asking directly from the user) or implicitly (the system draws out what it needs secretly from the user) based on the behavior of users and suggests the best alternative to the learners [18].

In fact, any information related to improved interaction among learners, software and environment is called context [8]. The learners' needs are often latent and mostly they can be identified from habit, morals and even from learners' motivation. To decrease the interaction challenges, the system designer must identify learner properties to know how the learner can be attracted to the system and how he or she can constantly attempt learning [9].

2.3 Personalization Process

Personalization is based on the modeling of learning context, in a collection of information that characterizes the situation and environment in which the learner is. It comprises the information and assumption about the learner (such as personal profile, goal, knowledge, interest preferences, interaction, and presentation history) and the information about the environment (such as location, devices, time, date and weather) [11].

It is clearly recognized that the personalization process is essential. Each person's properties differ so his or her capabilities vary and we have to consider these properties. Personalization process is implemented using the identified context related to the learner. The purpose is to suggest a packet of activities to the learner based on his or her priorities and interests such as links, articles, materials, tests, homework and so on [10].

By personalization based on learning context, we mean that certain learner-related information such as goal, situation, environment and assumptions are gathered and categorized as described in the followings.

Various definitions are previously provided for context. For instance, primary types of context can be considered as location, identity, time and activity [18]. Context can be considered in defferent categories. Computing context include information such as: network connectivity, communication costs, communication bandwidth. Information such as users' profile and location create user context. There are also information on the environment that create environment context, such as noise levels, lighting situation, and temperature [19]. Moreover, attributes of people and objects around a user and the changes in such information can be considered as context [20, 21]. Context-aware systems are defined as systems that are able to sense the context and act upon available context information [22]. In a deferent caregorization of context it can be considered as i) environment (physical and social), ii) self (device state, physiological and cognitive), and iii) Activity (behavior and task) [23]. In other words, context can be defined as any information that can characterize the situation of an entity (e.g. person, place, or object) [24, 25]. Context can also be categorized as externally-imposed, externally-induced or internally-induced [26]. An ontology-based context model may considere time, place, user knowledge, user activity, user environment and device capacity [27]. In some previous research, a situation model was defined to give a view on the context model describing temporal properties. It used the following context parameters: variety, priority, granularity, implementation, and cost-effectiveness [28]. Data gathering techniques about the context is an essential issue in pervasive computing [29]. Moreover, a prevous research in mobile learning has argued that a context aware mobile learning system should also include the learner's willingness to participate in the proposed learning activity [30].

3 THE PROPOSED MODEL

In this model, as it is illustrated in Figure 1, assumptions and information about learners are categorized into many parts.

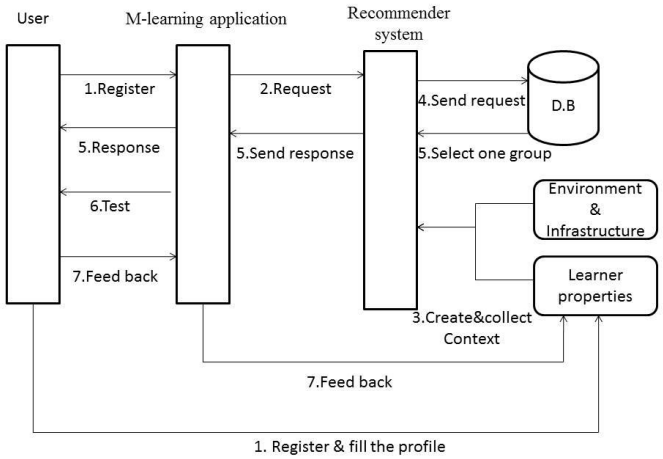

Figure 1. The proposed model for mobile learning recommender system

The recommender systems development process includes the followings:

1. Register: There are two modes. In the first mode, an intended user for learning, registers in his or her application and fills the questionnaire in the system and gives the primary information. In the second mode, the content is sent according to the learner's needs. Learner's profile is empty and it is gradually filled implicitly in the system or partly filled by the learner in order for the system to identify the learner's interests. The studies show that learner's priorities are static. However, it is possible that the priorities change. We can permit the system to select automatically for the learner and overcome this challenge.
2. The learner's application is sent to recommender system (of course, it can be spontaneous in certain cases and the information is sent to learner without primary application).
3. Content creation and collection: The information is collected in various ways such as the followings:
   - The learner defines certain variants such as demographic data and level of education, favorite orders such as using blue color for the texts or using audio or video. His or her field of interest (math, science and so on), his or her goal of learning (practical use or professional use), physical disabilities in terms of hearing, weight, social behavior such as if the learner is introvert or extrovert, whether the learner thinks positively or negatively, what is the learner's motivation to learn, what about his or her feelings and intelligence index, and so on.
   - Certain variants can be identified by the trainer (learning theory).
   - Some variants can be identified by the parents (expenditure limit and security measures).
   - Variants which are identified by partnership companies (evaluations).
   - Variants which others such as physicians, psychologists, scholars, friends, producers and suppliers in communication networks identify.
   - Pretests which are given to learners to evaluate and achieve certain variants (such as learning style and learner's level).
   - Some variants are achieved through software and hardware systems (such as health, weather, location of learner and maps).
   - Data mining techniques can develop learner related knowledge (such as interests, media exchange, equipment feature) or using online or offline database such as social networks, state database.
   - Computer producers can monitor certain variants to build up data (such as current situation, feelings and emotions, results and achievements).
   - Tracking using sensor, GPS and wireless sensor network (WSN) or radio frequency identification (RFID).

User personal properties and environment data can be obtained by these variants.

4. To request user's properties from database with various formats such as text, audio, video, animation and so on which are collected and categorized by the experts for different groups.
5. To send the materials from database to recommender system and through mediatory to the intended user.

6,7. After the user finishes the learning, the system examines the learner spontaneously by self test approach and the result is stored in user personal profile in order for the user know what should be sent during the next session (if learner has learned well, more advanced materials will be received and if it should be repeated, the previous material would be explained for the learner).

The compomemts of the proposed recommender system include the followings:

1. User (learner): The one who uses system and helps to improve it.
2. Mediator: The operational system which performs software and plays as an interface between the user and recommender system to facilitate their relations.
3. Recommender system: It contains three inputs and a collection of best recommendations for the user as the output. The total goal and system assessment and whether it is suitable or not will depend on the output.
4. Database: It contains related educational information for user personal profile and priorities which is designed and categorized by the experts and is presented to the user based on the user needs. Of course, for a real time and secure system, a high memory and high secure database is required. In addition, learning contents must be also modified before being sent to the receiver's

device by agents or filters that made the format transformation and serve contents adapted to them. This filter should act depending on the type of devices [16]. The contents can be classified as: Text, Image, Audio and video

- Text: Text can be easily converted to another mobile device's adapted format, but, due to the increase on e-book readers, there are a lot of new standards that modify the pagination and font size automatically. Thesemake text easily readable on those devices. Among these new formats, the most used are EPUB and PRC and LIT.
- Image: Although most of the image formats can be watched properly on mobile devices, it is useful but not essential, to scale them or to modify them before being sent.
- Audio: Mobile devices, ipod/iphone and MP3 players support most of the audio formats, so a recording is not necessary. However, it will be necessary in case of video stream.
- Video: For a good visualization, the video format must be transcoded [17] to be adapted to the basic mobile devices format as MP4 for iphones or ipods, and 3GP for rest [18].

5. User environment which includes:
   - Location: It is very important for applications, especially in location based learning, to use WSN, RFID and GPS technologies.
   - Tools: Mobile tools play the main role for presentation and projection such as screen size, power of processing, data store, connection method, battery consumption.
   - Time: The type of content depends on the intended time
   - Weather: The type and framework of content depends on the environment condition, crowded or not crowded, rainy or not rainy, cold or warm.
6. Learner's properties: These properties may include:
   - Personal profile: Personal information of learner is used to classify the learner in a proper category and to assign him or her suitable learning content.
   - Goal: Learners have a specific goal when they use a learning system. By identifying their goals, the system can supply the proper content for the learner. So, it can be regarded as a filter which is able to classify the learners with the same goal.
   - A history of interactions and presentations: It is useful in terms of: (i) The learner is aware of what he or she has learned (for example, the learned books can be colored blue), and (ii) the personalization process can be improved by the system.
   - Knowledge level: It seems that it is the most important role of learning system and can be measured by scalable tests in terms of quality (in three category: beginner, middle and advanced) and quantity (0-10). The system does not have any information about the learner so it updates knowledge model constantly. For example, when a learner learned the material, the system examines and according to the results, it raises or decreases the knowledge level (knowledge propagation process).
   - Interests: They are categorized as well and if the learner shows interest towards the content, it will be explained in detail and if not, the content is overviewed. It is noted that at first, the interest rate is null and it is gradually improved and updated.
   - Priorities: The learner can set up what is presented and how it is presented (page by page, as slides or all-in -one). The alternatives can be various media such as audio, video, animation, text and so on which can be presented by spontaneous selection in the system or by directly selection of the learner.

Figures should de numbered consecutively as they appear in the text.

4 Conclusion

In general, learners can learn using various tools, in different environments and through many networks with diverse levels of learning and interests. Learner must be supported by adjustable recommender systems. The suggested model considers the entire user's needs and tailors the content properly for the learner using the database of the system. But the proper feedback is implemented by post-tests. Although the previous models considered certain useful details, in the present paper, we attempt to design a model which incorporates entire needs of the user and suggests the proper content in order to meet the needs of user and raise the satisfaction of learner.

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