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M-Learning through Semantically Annotated Learning Objects and Ontologies

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Abstract

Number of mobile subscriptions has increased tremendously due to rapid development of mobile technologies. The performance and accessibility of the e-learning process can be enhanced through mobile devices which is-called m-learning. M-learning makes learning resources available anywhere and anytime, provide strong search capabilities, and offers easy interaction features to the learners. M-learning also points the opportunity for interoperability than existing e-learning system. The integration of semantic web in m-learning can improve the efficiency of searching for learning objects and reduce the time and cost of learning process. Semantic web can be integrated with the help of ontologies and learning objects in semantic web. They offer rich medium to assist m-learning via semantic annotated learning objects and shared repositories. Two types of ontologies, such as learning object content ontology and learning object structure ontology are used in this system. These ontologies facilitate the reuse, sharing and retrieval of relevant learning objects which are the backbone of m-learning.

Keywords: M-Learning, Semantic Web, Learning Object, Ontology, Reusability, Sharing, Repository

Introduction

The goal of mobile computing is to offer transportable computing, anytime and anywhere connectivity, high interactivity, and powerful processing. The combination of mobile computing and e-learning forms a learning system which provides easily accessible learning resources, strong search features and high interaction-learning is more than a form of teaching or studying using mobile devices. Although it is a method to access resources and communicate to others, it can be considered as a constant mobile situation of the learner. Relevant information can be delivered whenever needed is the prime advantage of this technology and can increase performance for the working learners. It supports the high performance cultivated by other in-depth training techniques. Since there is a tremendous increase in the number of mobile phones, the scope of m-learning will expand year by year. As the quality of the mobile phones increases, technological advancements will also expand and hence increasing feasible options which can be chosen by the trainers. M-learning holds the promise of offering interesting new opportunities for learning as shared, ubiquitous, collaborative, fluid and with an integral access to applications that support learning, anywhere and anytime (O'Malley, 2003). Kukulska-Hulme (2002) suggests that mobile devices have to be seen as an extension to current e-learning tools rather than replacing it. Goh and Kinshuk (2004) suggest that m-learning can compliment e-learning by creating additional channel of access for mobile users with mobile devices.

Use of Mobile Technology in Learning

The inclusion of e-learning in the learning process and its becoming widespread as a component of traditional education has caused positive changes in extend of pedagogical, technological and economic aspects (Birch & Burnett, 2009). Requirement to save the time and place has increased the requirement of mobile technology in learning process (Uysal & Gazibey, 2010). As the well-known Chinese quotes "I hear and I forget. I see and I remember. I do and I understand. "When seeing the learning materials in front, e-learning provides more understanding than hearing in the class. M-Learning adds more facilities like saving time to e-learning. Since the usage of mobile phones is increasing tremendously

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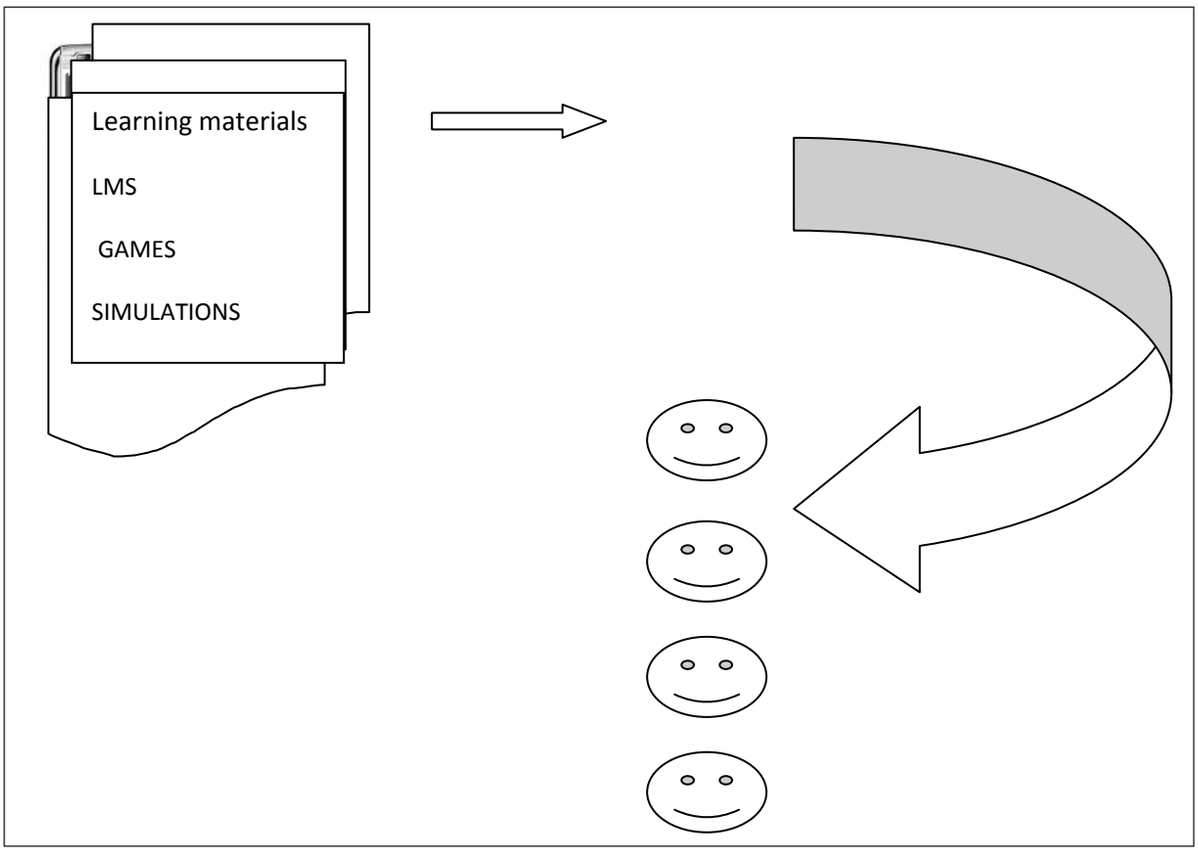
during the last two decades, this is the time to think about their potential to be used in learning environments.

The enhancement of mobile technologies and transition from computer based technologies to web based learning have prepared mobile learning as one of the most popular learning styles.The increase in data transfer through mobile networks reveals that mobile technologies are being used more often and they prefer mobile environment to get learning materials and to access information.

As a result of promising methods in addition to the traditional methods, web based distance learning preferably mobile learning has gained importance (Yildirim, Goktas, Temur, & Kocaman, 2004). The pictorial based lectures will be more understandable if they can see it anytime. Moreover video recording will be more useful for recording the lecture and reusing. With the introduction of mobile technology, online learning also has become more effective. Several useful applications like translators, dictionaries etc., will provide students a quickly look up for terms and meanings which is a very good service for the learning. One of the highlights of mobile learning apps is that it encourages self-learning. These handy devices provide a range of possibilities that allow for learning outside the classroom. M-learning is considered as a method to implement learning objectives through Internet. The primary feature used is portability. Context based awareness about location also can be provided through this. To achieve exclusive educational experience, five properties can be identified. They are portability, social interactivity, context sensitivity, connectivity, and individuality. Portability represents the size and weight of the mobile device. The sharing capacity with other learners –which is referred as social interactivity is also another criteria. If the mobile devices can use the context information such as location, time and environment to provide context-aware resources, it will accelerate the learning process in a better way. This is known as context sensitivity. The connectivity of the mobile devices to other devices using wireless technology is also an important concern. How mobile device can be personalised according to each learner's requirement is the key factor which decides the efficiency of the learning process.

Fig.1: M-learning



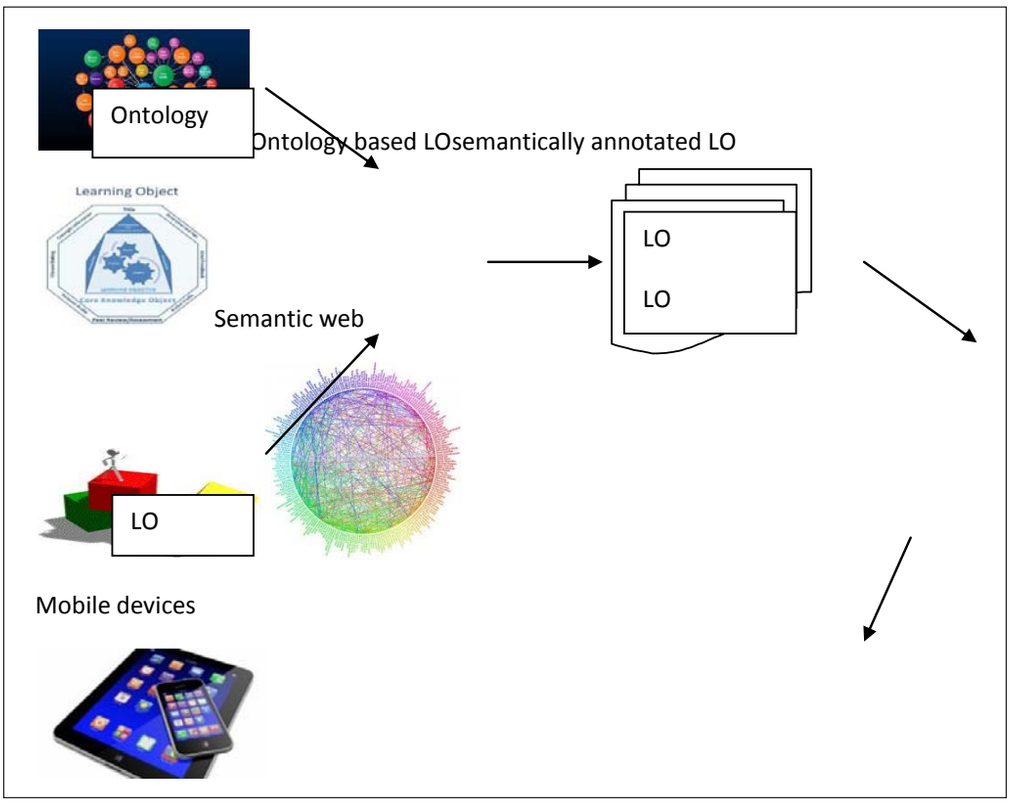
Learning Objectives in M-Learning

A learning objective (LO) is a statement of what students will be able to do when they have completed instruction. A learning objective has three major components: 1. a description of what the student will be able to do, 2. the conditions under which the student will perform the task, and 3. the criteria for evaluating student performance. LO can be a piece of a lesson that has educational content like a simple image, audio or text file, video, simulations, digital pictures, or web pages that include text, image and media, etc. The learning objective has a vital role in elaborating e-learning or m-learning content with pedagogical way. The IEEE Learning Technology Standards Committee (LTSC) defines learning objects as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" (LTSC, 2000). The prior intention of learning objective in m learning is to gain maximum reusability and hence reduce the production cost without affecting the quality. Reusability helps to deliver learning objectives in different learning scenarios. Learning objective (LO) is also defined as "any digital resource that can be reused to support learning" (Wiley, 2000). LO can be multimedia content, teaching content, teaching tools of both hardware and software, persons, organisations etc. Each Learning object should support learning tolls which are of two types, synchronous and asynchronous. Synchronous tools are interactive and pedagogical. Learners or trainers will be online to share orally or by script. Examples are shared application, chat, video conference, games etc. Asynchronous tools such as emails, forums etc. do not need trainer's presence at the moment of exchange. According to learner's point of view, m-learning can be said to be about learning through electronic devices which makes connectivity to information sources and communication even though they change physical location. In short mobile learning can be defined as context aware learning.

How Semantic Approach Useful in M Learning

Since reusability is the prime focus of LO and m-learning, a method to support this is very vital in m-learning. Learning through mobile device will be more effective if more sharing, reusability, and interoperability is there.

Fig. 2: Semantic Web Based Mobile Learning



The lack of semantics makes it hard to share and reuse learning objectives in m-learning. If LO have semantic contents all the above factors can be increased in learning environment. To support semantic discovery, retrieval and search a semantic based m-learning should be introduced.

Semantic web is the extension of current web in which information is given a well-defined meaning and will be searched/retrieved on the basis of concepts rather than syntax. XML and RDF are the two main components of semantic framework. XML allows users to add arbitrary structure to documents without saying what these structures mean. RDF is for allowing meaning to be specified between objects on the web. To represent conceptualisation (Soualah-Alila, Nicolle, & Mendes, 2013), Semantic web has a powerful component which is called ontology. It is a specialisation to describe concepts and relations between concepts in the real world. By using well-defined ontologies on the web, it is possible for computers to meaningfully process data since there is a common understanding of terms used and the relationships between these terms.

Use of ontology integrated semantic web will improve the quality and efficiency of learning materials in m-learning. Since ontology can represent relation between concepts, interoperability of the learning objects between learning environments can be enhanced.

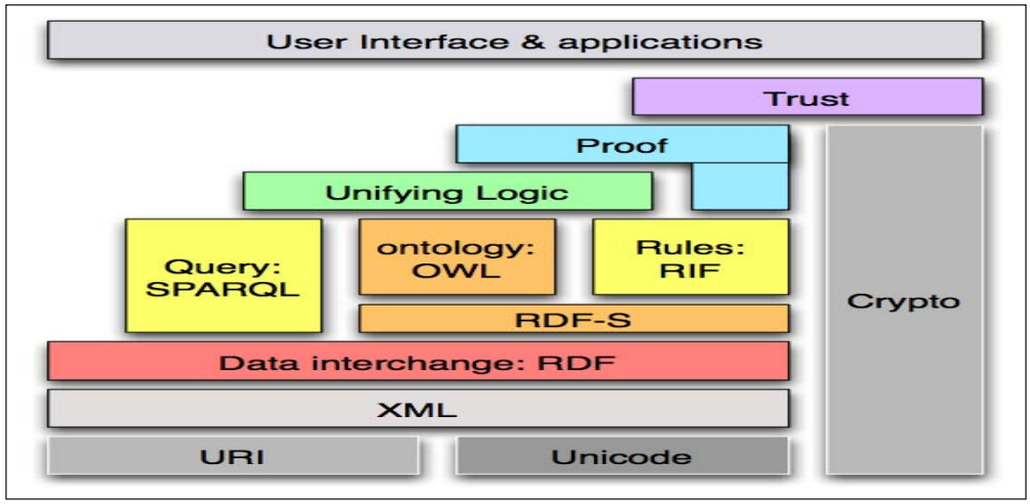
How learning Objects are Integrated in Semantic Web?

The framework of semantic web is shown in Fig. 3.Data are separated from presentation by XML.Name spaces and schemas are the components for conceptualisation. The lowermost layer URI is for locating information in the web. RDF, the first layer stores the metadata of learning objectives as statements. RDF schema is a modeling language for defining and describing classes of resources in the RDF model. Complex relationships between concepts are handled by ontology. Concepts are represented as classes and properties in ontology.

Metadata of learning objects are stored in RDF format which is also called as triple. The structure of RDF format is subject, property and objects and is named by URI references. This RDF can be accessed through the query language called SPARQL. It processes the query and provides information in the form of RDF graph. SPARQL is also used to discover relevant learning objects based on query within the learning object depository also.

The web ontology language (OWL) increases expressiveness of RDF schema by adding the constructs of description logic (DL) to RDF. OWL is the ontology language which is principally designed to describe and define classes. The concepts are represented as classes in ontology. There are six ways to represent classes in

Fig. 3: Semantic Web Layer (http://www.w3.org/2007/Talks/0130-sb-W3CTechSemWeb/# (24))



OWL. They are named class, intersection class, union class, complement class, restrictions, and enumerated classes. Intersection operator forms intersection class by combining two or more classes. Union classes are formed using the union (OR) operator with two or more classes. This ontology is integrated within the online learning object repository to facilitate the discovery of learning objects by various search engines and applications.

Learning objects (LO) are the backbone of any learning system. Developing the content for each learning objects every time is expensive and time consuming. If we are able to reuse LO screated by others, it can reduce the time and cost. But the prior challenges in e-learning and m-learning are the issues of reusability and sharing of these learning objects. Here semantic web can play a crucial role since it is concerned about the meaning of all kinds of information in the web. Few studies and suggestions happened on the standardisation of LOs. Recently, the IEEE 1484.12.1-2002 Standard for Learning Object Metadata (LOM) (ltsc. ieee.org) was released, the first accredited standard for learning technology. The LOM Standard uses nine categories of XML data elements to describe a learning object: general, lifecycle, meta-metadata, technical, educational, rights, relation, annotation, and classification.

Reusability of LOs through Repositories and Ontologies

Integrating learning objects with semantic web is an intelligent solution for the problem of reusability. By placing LOs in semantic web, they can play a fruitful role in search process and can interact intelligently with each other. If the LO is able to decide its fittingness for an instructional situation, then search agents will be able to provide effective searches for LOs and are able to store a pool of LOs which are likely to achieve instructional goals. This will reduce the process time of the learners, and hence increase the effectiveness of the m-learning. Instructor should manually examine the retrieved LOs through semantic search and fine tune their integration to the course to make sure the accuracy of the LOs. However searching time will be substantially reduced since retrieved results are only relevant learning objects as per the query of the learner.

To achieve the reusability feature, it is important to make the availability of learning objects on the web. This can be achieved by storing them in various kinds of repositories that match the mode of production of learning object producers. Also these stored learning objects must provide semantic information to make the searching fast. In order to achieve this, ontologies must be created for providing concepts and structure of the learning objects. Besides this, pedagogical information, techniques and corresponding tools also should be developed to support making and reuse of learning objects on the web.

Each LO has to specify how it is related to concepts in a particular domain and all possible learning outcomes that are occurred in that domain. If this ontology of concepts in each domain is present, it is possible to compare course structure with LO on a common understanding of how they relate to each other. Ontology also helps search agent to decide which LOs are matching for a specified course. It is important that instructor/course designer hasto use the same concept ontology in specifying the course structure.

According to Dragan *et al*. (2004), two kinds of ontologies are needed to develop a learning object repository. One is ontologies that describe learning object metadata and other is ontologies that describe learning object content. Ontology of metadata is useful since it helps a LO to identify the kinds of techniques to speed up learning. Both these ontologies together help to personalise instruction to individual learners based on learning preferences, learning designs etc. The ontology of metadata is for representing physical structuring of LO and it allows LO to be interpreted in different learning systems. Concepts of same words will be different for LO of different disciplines. Developing ontology is an important process in m-learning. Ontologies can be shared after developing. By using shared ontologies, it is possible for software agents to perform most of the processing required in discovering and assembling learning objects. The reusability and sharing of the LO is possible through the sharing of ontology. After building a course using LO, a semantic interpretation of the LO will be created using appropriate ontology. During searching, matching LO will be found according to the query. There may be different LOs that are linked to the same ontology. On the semantic web of learning objects, it is thus possible to perform more meaningful searches for learning objects.

Conclusion and Discussion

This paper outlines the concept of m-learning and issues which affect of the performance m-learning. It points out that reusability and sharing of learning object can improve the performance of learning process in m-learning. As a solution of this, integration of semantic web is suggested.

It is presented how learning objects are being treated to make them reusable. The involvement of ontology for this process is discussed in the paper. It also describes how ontology helps to find the concept wise matching between learning objects of the course materials and queries entering. Paper concludes by saying role of ontologies in semantically integrated m-learning promotes reusability and sharing of learning objects and hence reducing the time and cost for learning process through mobile devices.

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