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Course delivery and module learning via learning objects (knowledge map) in mobile learning environment

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Abstract

This paper focuses on the integration of the learning objects and knowledge map as the learning sequence suggestion in the mobile learning environment and explains the technologies involved, the applications and the issues of usability, accessibility, evaluation and effectiveness. Mobile learning has open up new path for learning support and opportunities to reach wider audience (learner) for education. This research focuses on using the knowledge map to store the characteristics of each learning object via concept schemas and represent the corresponding learning accessibility in the mobile learning environment. The proposed architecture provides a medium for the learning accessibility of learners through mobile applications and wireless portable devices such as smart phones, PDAs and tablet PCs. The approach using the combination of "touch" and "observe" spatial learning objects provides an intelligent solution to creating, sharing and improving the efficiency of mobile learning. The proposed mobile learning environment architecture consists of knowledge map components mainly, navigation, concept schemas and learning object path. By using these knowledge structures, this study may enhance and enrich the concept and activity of adaptive learning in different individuals and communities. The spatial knowledge map constructed was useful in identifying the characteristics of the learning objects (e.g., learning object 1: lesson with navigating sentences, learning object 2: lesson with navigating sentence and code explanation, etc) and automatically matches the most appropriate learning content and path suitable for learners. The architecture of the platform discussed in this study using the learning objects approach and knowledge map would facilitate a more widespread use of mobile learning, including courses or modules delivery of individualised learning path and learning style analysis.

Introduction

The proposed architecture in this paper is derived from the potential of extending e-learning to mobile e-learning (mLearning) with the rapid generation of knowledge- map (K-Map) and the growth of mobile users. The availability of advance mobile technologies and sophisticated contents provided for mobile users have actively engaged more mobile users in learning activities. According to Yuen and Wang (2004), the demand for mLearning which provides learning opportunities for learners to "learn while you earn on the go" has grown (Fu et al., 2010). Mobile e-learning introduced the wireless teaching and learning to the world and is

useful for the organisation. The focus of this research is to present the learning objects using K-Map (Zheng et al., 2010) via mLearning. K-Map is used as a tool to combine digital resources and the e-learning environment that integrated related digital and module resources with knowledge which is turned to the form of map for better understanding of learners. K-Map can serve as a learning platform by the active work with, e.g., expert information addressed in direct bilateral exchanges or project-oriented documents. In this case, knowledge is not a static supply of interlocked learning processes, but is continuously generated and associated with the actors (learners). The challenge in an information-rich world is not only to make information available to people at any time, at any place, and in any form, but specifically to present the right knowledge at the right time in the right way in an ubiquitous mobile computing environment (Yan & Xiao, 2009). The significance of K-Map is reflected on the integration of knowledge concepts and the right cognition and values for the learners. By using these technologies, K-Map and learning objects, the proposed architecture in this research generates various learning object navigations in mobile presentation layer and prepares the learners to observe using the aid of concept schemas. Concept schemas stored in K-Maps consist of generic concept data structure that contains mainly the concept attributes, theory explanations, links to definitions, descriptions, examples or learning objects in e-Learning.

The goal of this paper focuses on extending the delivery of e-Learning to mobile, smartphones and handheld devices, and providing additional reach to new groups of learners with the use of learning objects.

Knowledge map in mobile e-learning (mLearning)

In the mobile learning environment, K-Map assists in acquiring relative content presentations and build corporative knowledge path to enable students to learn more effectively (Zheng et al., 2010). The main function of K-Map to achieve knowledge sharing and reusing is adapted and implemented in the mLearning approach. K-Maps are node-link representations in which ideas are located in nodes and connected to other related ideas through a series of labelled links or learning objects in the same domain or learning module. K-Map differs from other similar representations such as mind maps, concept maps and graphic organisers in the deliberate use of a common set of labelled links that connect and represent ideas. Links have arrowheads to indicate the direction of the relationship between ideas.

Since e-learning techniques have grown quickly nowadays to complement the conventional learning system, integration of K-Maps and learning objects has been a tendency to improve the creation, organisation and delivery of a learner-oriented knowledge management system (KMS) in mLearning environment. K-Map can be used as primary sources for knowledge mapping, adjunct aids to navigation processing, organisation of ideas, and story-board assistance in e-Learning.

The K-Map implemented into mLearning combines several knowledge oriented information systems, mainly (Yan & Xiao, 2009):

1. Transition of flexible learning and individualisation (learning wherever and whenever one wants to).

2. Individualisation of learning (self navigation of necessary learning objects or components by individual learning format).

3. Course interactivity (learning environment with direct access and communication with course provider and peers in real time).

4. Transition of Relational Data Format (RDF) via knowledge management systems (KMS)/content management systems (CMS).

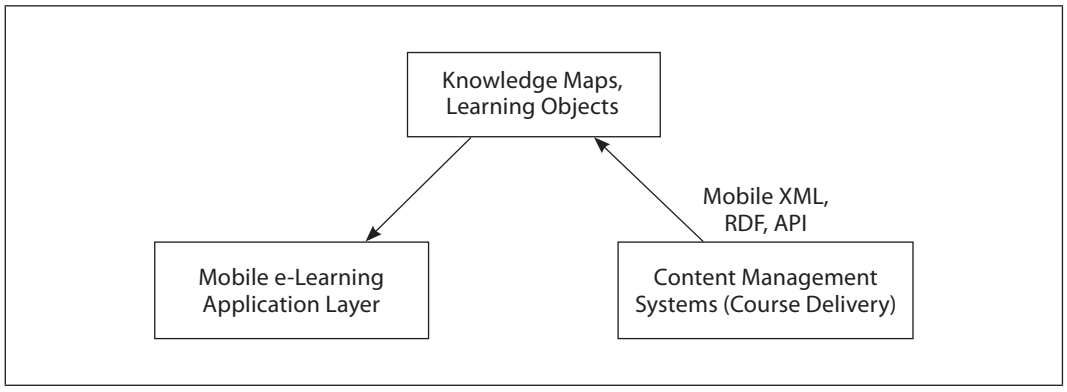

Figure 1 Roadmap of K-Map and learning objects in mobile architecture

Learning objects in mobile e-learning

The proposed architecture in **Figure 2** consists of K-Map and learning objects that compromised the navigating system generating various types of learning objects based on relational schemas and concept schemas.

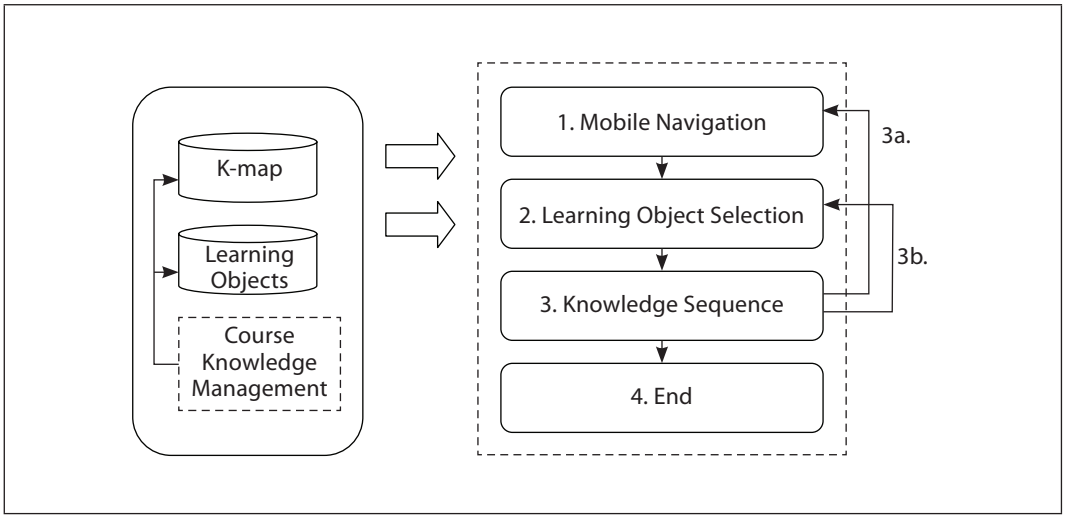

Figure 2 Course delivery sequence via mobile e-Learning using K-Map and learning objects

Figure 2 depicts the flowchart of the navigation using the mLearning environment with the implementation of K-Map and learning objects. The first two steps, step 1 and step 2, are locating the suitable learning path through identification of relational schemas, concept schemas and related learning objects from K-Map. The navigating system generates human readable navigation sentences for students in step 3. If there is no further learning objects to learn, the navigating system goes to the last step, which is step 4. If there is any other learning object required for learning in the same learning spot, the system goes back to step 1 "Mobile Navigation" via step 3a and, if there is any other learning object that is required for learning but is located in other spots, the system goes to step 2 "Learning Object Selection" using step 3b.

	mLearning	K-Map mLearning	Moodle
Descriptions, features	Handheld learning platform with dynamic web contents	K-Map in mLearning is introducing the concept maps in order to achieve meaningful learning for learners	Moodle is a course management system which is easy to develop, maintain and use through the modular manner
Learning theory support	Dynamic pages	Dynamic pages, Meaningful learning	Dynamic pages, Constructivism
Concept maps support	No	Yes, Concept Map, Learning Objects	No
Specification support	SCORM, IMS	SCORM, IMS, RDF	SCORM, IMS

Table 1 Comparison of related research in e-learning systems

Constructing knowledge maps in mobile presentation framework

In mobile learning environment, K-Maps application for knowledge presentation is proposed to enable learners with the multi-level navigation and collaborative interaction. Here, we will discuss about how to achieve those goals via displaying and implementation of managing knowledge maps.

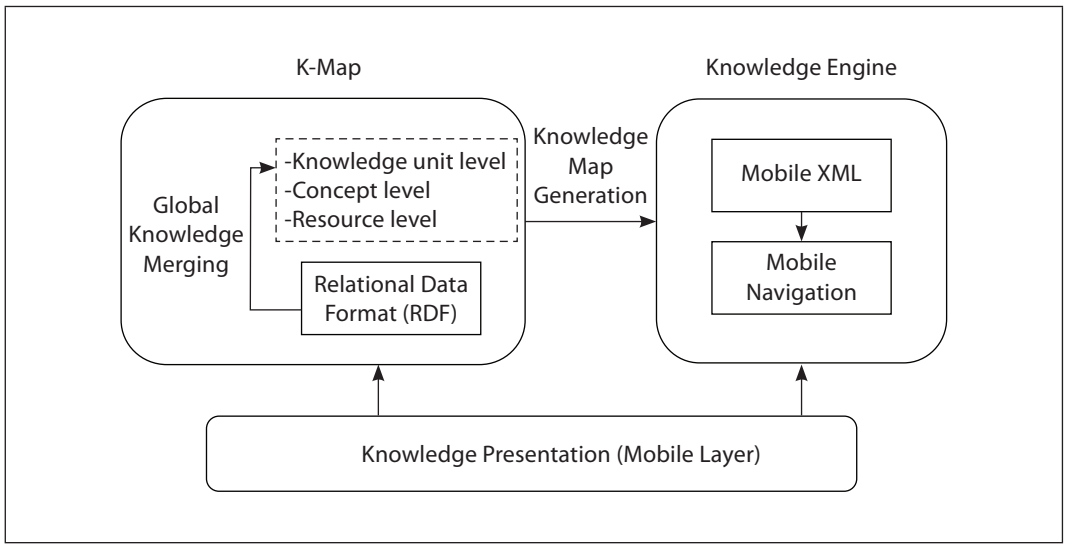

Figure 3 Proposed framework of K-Map implementation

In **Figure 3**, the K-Map presents the acquired knowledge of concepts and knowledge resources with inherent association at different level: the concept level, knowledge unit level and resource level (Kuo et al., 2007).

The concept level is similar to ontology which presents the domain concepts and concepts' relations. The knowledge unit level (Wei et al., 2009) comprises knowledge units and knowledge units' cognitive associations, i.e., the "pre-order", "analogy" or "illustration" relationship between knowledge units. The knowledge unit level also bridges the gap between concepts and resources, as knowledge units are connected to their core concepts in the concept level, and connected to their occurrences at the resource level. As the facility of providing multi-granularity and multi-level mode for e-learning, knowledge maps should be designed to be beneficial for both knowledge presentation and information management. The following criteria were adapted for spatial K-Maps module creation (Yan & Xiao, 2009):

1. K-Map navigation: this application provides learners with a knowledge map based interface (instructional management system, IMS), which enables them to navigate through the inherent associations of domain knowledge, and pinpoint their learning objective through the knowledge unit, concept and resource level approach.

2. Collaborative Relational Data Format (RDF) construction: Global knowledge maps can be enriched by allowing users to create knowledge maps on local resources in RDF format. K-Map generation is designed to eliminate manual annotation that enable learners to improve the quality using the three level of knowledge map extracted from RDF.

3. K-Map merging: When the user-created knowledge maps are reviewed and accepted, they can merge those local knowledge maps into the global knowledge protocol. During this process, duplicated nodes and edges will be automatically eliminated.

The K-Map structure consists of concept schemas (Wang et al., 2009) as shown in **Figure 4**. Concept schema is the generic concept data structure in memory which stores the concept attributes and links to definitions, descriptions, examples or learning objects. The links that connects each concept schema are known as relation schema. The hierarchical relationship of *Java Programming* from upper level (theory) to lower level (practices and code executions) is shown in **Figure 4**.

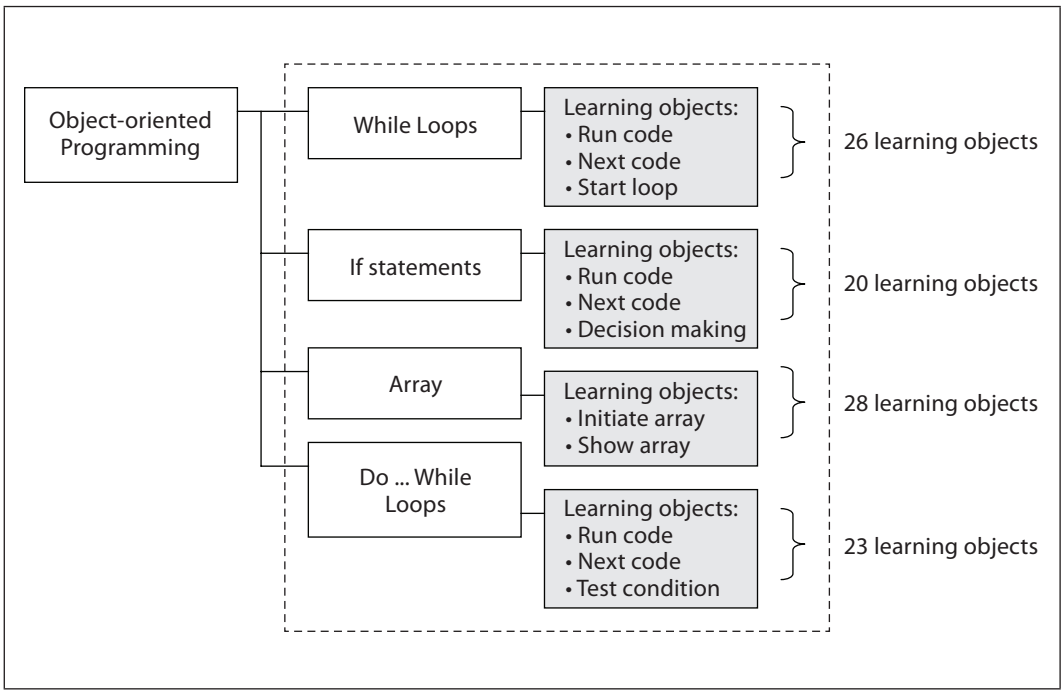

Figure 4 Knowledge map structure constructed using concept schemas

K-Map implementation and evaluation in mLearning

In the implementation of mobile learning environment, K-Maps application for knowledge presentation is proposed to help learners in the multi-level learning object path and collaborative interaction. This is because K-Maps can guide learners with inherent associations among knowledge within different granularities, composing of chapters specified by the knowledge content provider. In this section, the focus is on describing how the development of a system can achieve meaningful learning from theory to practice through the K-maps and learning objects in three-tier surrounding. The system is divided into three tiers: the instructional tier, learning tier and technological tier.

Integration of K-Map in knowledge management tool with mLearning helps learners to discover the knowledge. We can use it as a knowledge collecting means to gather knowledge from database and perform the codification of knowledge. To construct a K-Map, first we should collect the ideas from the information resources; second, we collect the information needed by the knowledge maps and lastly, we give the ideas and information orders and combine them. Instructional tier emphasised that the better instructional qualities are based on the theory of instructional design, context and resources (Wang & Lee, 2008). In terms of authors, they are responsible for integrating the knowledge-creating process into instruction. It facilitates the author to make suitable instructional concept maps through the concept maps of a spatial learning domain. In the instructional tier, problem-solving learning, collaborative learning and resource-based learning, which are associated with concept maps in specific learning modules are created. Therefore, they will produce a learner-centred instructional process through systematic design of instruction (i.e., analysis, design, development, implementation and evaluation). **Figure 5** shows the instructional level that consists of courses information (i.e., CourseID, CourseName, LecturerID, TutorID). Authors acquire feedback from the concept maps made by learners to improve their instructions.

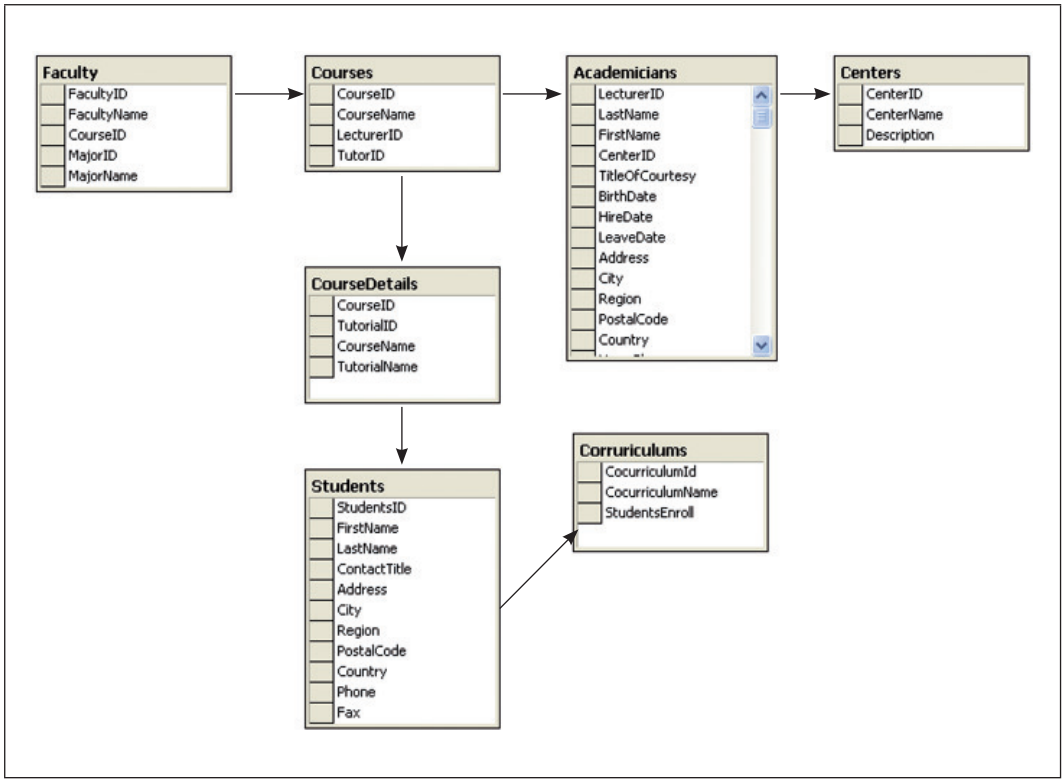

Figure 5 mLearning Database Central

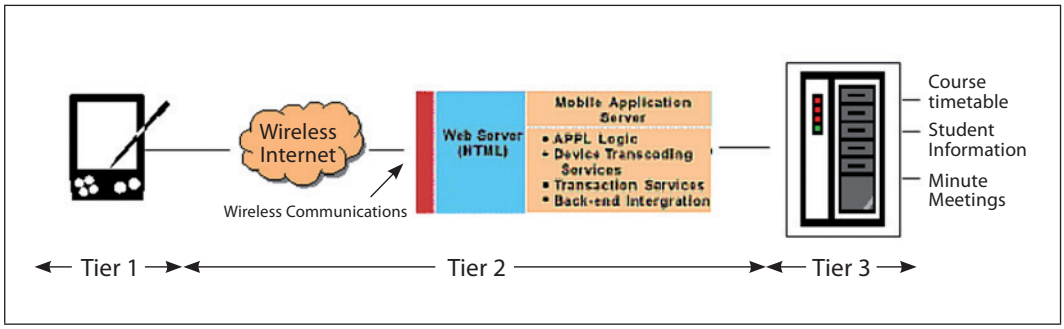

Figure 6 Learning tier and technology tier in mLearning Architecture

Learning tier emphasised that the better learning qualities are based on the five attributes of meaningful learning (Wei et al., 2009). In terms of learners, they use the concept maps to study knowledge, facilitate thinking, clarify misconception and evaluate learning effort. In the technology tier, the learners emphasised that using existing technology of learning to support the above three tiers can be implemented successfully. Therefore, the unified process (UP) was adopted to realise the KMLS in practice (Wei et al., 2009).

Figure 7 depicts the learning object for "while loops" in problem solving technique as the fundamental concept in *Java Programming*.

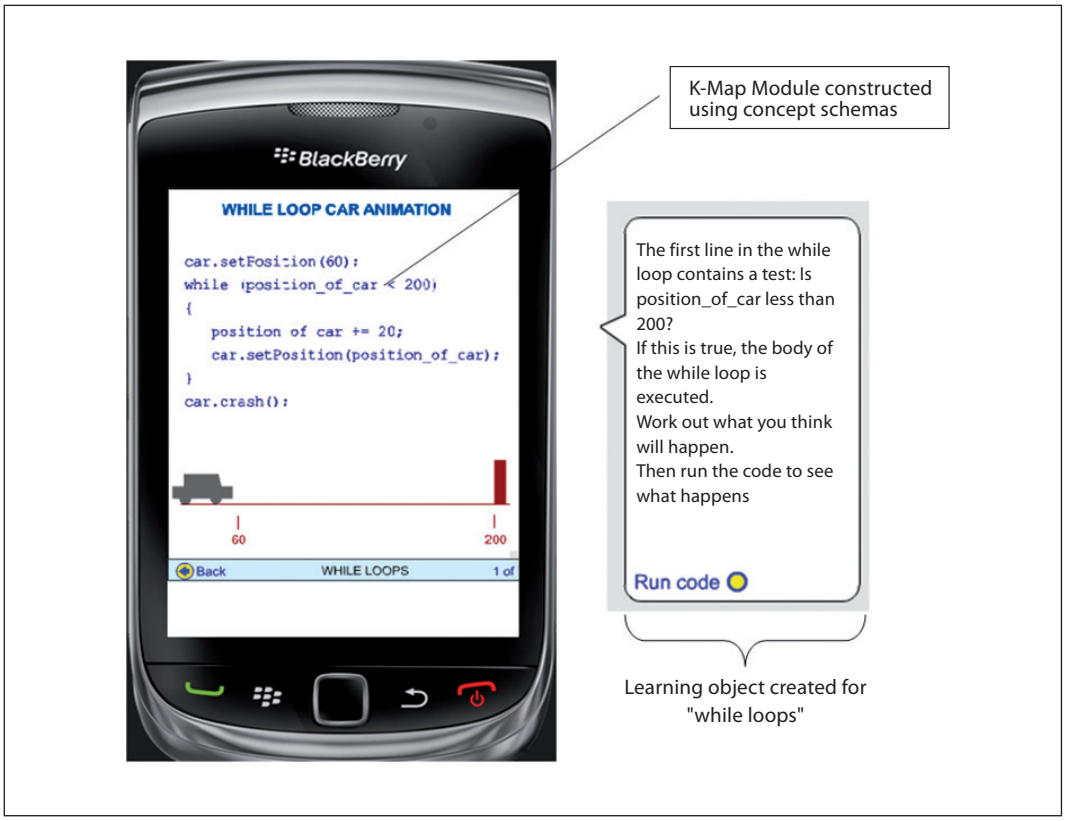

Figure 7 mLearning with K-Map
(Example of learning objects created within the page for "while loops")

In this section, we focus on a specific knowledge domain, *Java Programming* and use concept mapping to identify key concept, sub-concept, generalised concept, non-generalised concept and show the relationships between them, which are formed concept maps of a specific domain. The K-Map linking process can transform the knowledge assets and learning objects in **Table 2** (i.e., code execution and navigation sentences) into the instructional design, context and presentation as depicted in **Figure 7** and **Figure 8**.

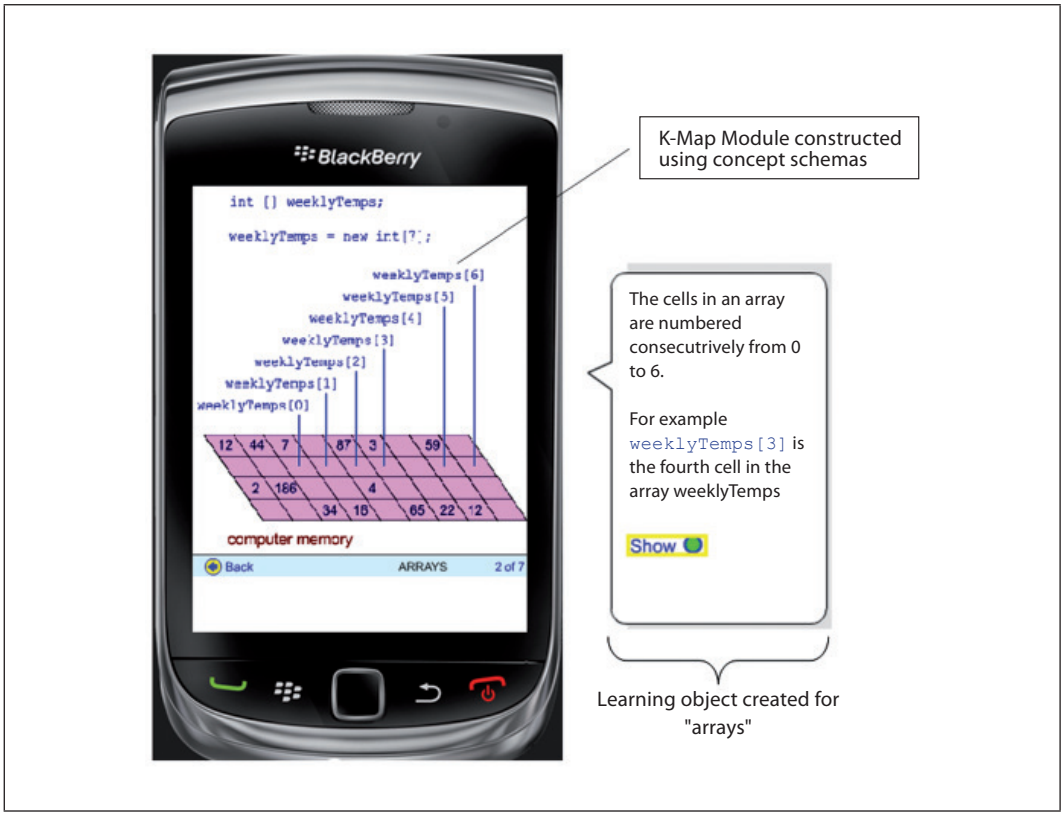

Figure 8 mLearning with K-Map
(Example of learning objects created within the page for "Arrays")

Learning modules	Number of K-Maps	Number of learning objects
While Loops	25	26
If Statements	21	20
Arrays	31	28
Do…While Loops	24	23

Table 2 Learning objects constructed using knowledge maps within the learning modules

Conclusion

The presented delivery model for module learning in mLearning which is managed by using dynamic KMS, can be further researched and improved. This paper described how K-Maps and learning objects may be implemented to enhance the learning experiences and module learning in the wireless environment. Mobile e-learning is a new trend of e-learning which will be essential to educational institutions by implementing suitable concepts and relational

schema architecture and display the distribution of a learner's knowledge. There is a demand to maintain and manage a large amount of data in an educational institution efficiently which made the emergence of mobile technology necessary. The approach which uses the combination of both K-Maps and learning objects plays an important role in mLearning. The ultimate goal of K-Map integration in mLearning is to provide an intelligent solution to store the characteristics of learning objects and provide learning accessibility in mLearning environment. It is hoped that such approaches would facilitate widespread use of mLearning, including group discussions between learners, course participants and academicians, for further research.

Future work

The future work involves the deployment of competency assessments onto mobile phones for more courses delivery, capturing the assessment output including learners' feedbacks and synchronising back into the student's web based e-portfolio. This assessment was then reviewed by the course provider with feedback and mapped against competencies achieved in mLearning environment. Mobile e-learning may not always be of value, and sometimes your materials may not be suitable for display on a mobile phone. However, in many instances, these delivery models that incorporate learning object path are becoming increasingly popular.

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