

Learner Open Modeling in Adaptive Mobile Learning System for Supporting Student to Learn English

<http://dx.doi.org/ijim.v5i4.1789>

Viet Anh NGUYEN and Van Cong PHAM

University of Engineering and Technology, VNU, Hanoi, Vietnam

Abstract—This paper represents a personalized context-aware mobile learning architecture for supporting student to learn English as foreign language in order to prepare for TOEFL test. We consider how to apply open learner modeling techniques to adapt contents for different learners based on context, which includes location, amount of time to learn, the manner as well as learner's knowledge in learning progress. Through negotiation with system, the editable learner model will be updated to support adaptive engine to select adaptive contents meeting learner's demands. Empirical testing results for students who used application prototype indicate that interaction user modeling is helpful in supporting learner to learn adaptive materials.

Index Terms—m-learning, context-awareness, personalized learning, open learner modeling

I. INTRODUCTION

Because of its portability, mobile technology is a growing trend in a wide range of activities in modern life such as: communication, entertainment, banking and education. Therefore, mobile learning is also emerging as important research in e-learning field. One of the benefits of mobile learning (m-learning) is the ability to provide and access learning materials anytime in anywhere. For two decades, Adaptive Hypermedia (AH) systems have been developed to provide the learners with adaptive learning materials based on their demands through evaluating learner model. Most AHs are designed for the personal computers, so it requires a definite location and time. Having restricted location and time, the learners find it difficult to approach the learning systems whenever they need. Consequently, the most recent generation of mobile learning research focuses on context-aware mobile learning application. With adaptive engine usages, the learners can easily browse the adapted course content as they want.

Our research addresses the context-awareness adaptation in mobile learning that aims to support Vietnamese students to use the mobile devices such as mobile phone, Personal Digital Assistant (PDA) to learn English in order to prepare for TOEFL test. We are interested in the learner modeling as well as the context factors that affect the students. In addition, we take into account open learner modeling to obtain user information as get the learner to talk the system what they need to know. An improved prototype of our model, CAMLES [1] system also described.

The main contribution of our work is personalized learning materials by using open learner modelling to support the learners can edit their model through negotiation with the system. The rest of this paper is structured as follows: First, we review the related researches on context-aware location dependent learning. In the next section, the context factors using in our model to adapt course content for each student is introduced. As for the fourth section, we represent our context-aware mobile learning, the CAMLES system that focuses on representing how to manage editable learner model and content model as well as the system design and architecture. System implementation with our experiments will also be described in section five. Finally, the discussions and conclusions are summarized.

II. LITERATURE REVIEW

Our literature review presents recent context-aware m-learning applications for learning language. Especially, those support students to learn foreign languages. These applications can be classified into two categories: context-aware location-independent learning and context-aware location-dependent learning. Learners can use the form anywhere that is not restricted in any specified locations. The later application, through location-tracking technologies such as GPS or WLAN, which can automatically identify the learner's location as selecting appropriate learning resources for them, is especially basic. Now, we focus on several typical applications:

- CAMCLL [2], context-aware location-independent learning, teaches Chinese to the students whose language levels are not enough to make conversations in Chinese by supporting appropriate sentences to different learners based on contexts. The CAMCLL context includes time, location, activities and learner levels. Adaptive engine of CAMCLL is based on ontology and rule-based matching.

- TenseITS [3] teaches English language to foreign students through meeting their demands. Learner model is designed based on four context factors: location, interruption/distraction, concentration and available time. Appropriate learning materials for different learners are selected based on the information represented in learner model.

- LOCH [4], context-aware location-dependent learning, supports students to learn Japanese while involving in real time situations. By monitoring the positions of the learners, teachers can establish the

communication with the students and guide them. The context factor in LOCH system is location.

- English vocabulary learning [5] recommends vocabulary for different learners based on their location, time for their learning and individual abilities. This system uses WLAN to identify learner's position. In addition, it uses some techniques such as maximizing information strategy, evaluating the score of time characteristics and estimating the amount of learning words to select suitable vocabulary for different learners.

- TANGO [6] supports Japanese students to identify English words with physical objects via the use of mobile devices through RFID tag reader/writer. TANGO includes six modules to select appropriate English words based on learner models.

- MESLL [7] is designed to support Japanese learners to learn Kanji or Chinese as a second language via SMS function or e mail. The learners send an e mail to the system in order to request a test. The system composes a test and feedbacks to them including adaptive English words as well as example sentences.

- PALLAS [8] is designed to support to a mobile language learner by providing personalized and contextualized access to learning resources which is considered as a part of contextualization. Personalization of the system has been defined based on learning style preferences, learner's objectives, and current learner's knowledge.

III. CONTEXT FACTORS TO ADAPT

Context is any information that can be used to characterize the situation of an entity such as a person, place or object that is considered relevant to the interaction between a user and an application [9]. Meanwhile, according to B.Hu, in m-learning, context is the set of suitable environmental states and settings based on situated roles between a learner and a tutor [10].

In our personalized m-learning model, it is suggested that context is the information that has impact on learners in learning activities. We assume that there are several factors having influence on adapting course materials in each learner. Location, time, manner, and learner's knowledge are context factors taken into account in our model. Firstly, location allows information and services to localize. In our model, location allows adaptation system to situated place where learners participate in the course. As S.Cui proposed in TenseITS [3], location is a special place where students use mobile devices to learn such as home, bus terminal, hotel, etc. Secondly, time refers to the instantaneous time of the day. Specially, the interval that the learner interacts with the system is important for an amount of course materials requiring the learners to learn. Thirdly, the manner of learning is considered as a factor of context using for adaptation. It mentions learner's attitudes such as concentration, interest level when they take part in the course. Finally, learner's knowledge is regarded as an oriental factor to determine what course content should be learned in the next stage.

Context-awareness describes a process in which context factors are used to target the provision of adaptive learning materials for the learner in interactive systems based on location, learner's preferences as well as learner's knowledge. This process includes two principal functions: 1) context interpretation and 2) context implementation

[11]. The former collects the learner's input data. Following context processing, the later issues the output that is personalized according to the information reflecting learner modeling.

Reichenbacher [12] noted that there are four different levels of adaptation: information level, technology level, user interface level and presentation level. Focusing on information level, our model aims to adapt learning materials according to context factors mentioned above. In the next section, we will present our personalized mobile learning framework in deeply.

IV. CONTEXT AWARE MOBILE LEARNING ARCHITECTURE

In order to select personalized mobile learning materials based on the context as well as learner's preferences, we propose architecture with their layers described in Figure 1.

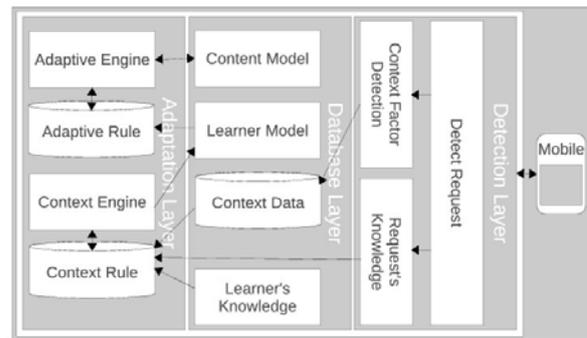


Figure 1. Context-Aware mobile learning architecture

A. Detection Layer

The function of the detection layer is to define the requirements of learners, including the normal academic requirements or requests to change the assessment system for learners. Requirements normal learning behaviour of learners choose topics, the context in which the system offers, then the system will generate learning content compatible with the choices available to the learners. For the normal academic requirements, the request will be determined through the identification of contextual factors that the user input options, such as location, time and learning topics. These factors made the user interface to the learner can choose. The elements are selected according to the person standing position and the time he or she can learn. This requirement is applicable to learners, when they choose new topic or in the new context. Besides, requests to change the assessment system for learners are required to change indicator of the level of understanding of the learner after the implementation of the normal academic requirements of learner completed. That is, it was only made when learners complete their learning content through the test questions. For this requirement, students must pay through an examination and assessment of the learning process in the system. Request is the response of learners to assess learning outcomes after the end of learning content that the system made based on normal academic requirements above. This requirement is a change in the knowledge of the topics that the learners who participate. Therefore, when learners make this request means that the learner wants to change the level of knowledge in the database to

achieve a high level of knowledge than reality. In addition to giving context and get her feedback from learners, detection layer includes a test for evaluation of the first learn to participate in the system.

1) *Detect Request*

This component is responsible for classifying requests that learners interact with the system. The system is divided into two types of entry requirements:

- Firstly, the requirements in terms of context, when the learner needs in terms of learning content, the request will be passed to the component Context Factor Detection for processing.

- Secondly, the requirements in terms of changes in the level of knowledge of learners for each topic, which the system was rated after the y complete learning content. Learning content is delivered by systems through data collection requirements on the context in which learners choose.

In addition, the data request is processing the request on a proficiency test, like tests of assessments of the candidates qualifications.

2) *Context Factor Detection*

For a system of learning English in context, the determination of the input context elements is a first step in the processing system. Context Factor Detection is part of the Detection Layer, its function is to identify the contextual factors which the user provides the system to start their learning process. In this context is defined, including the location of the user, the time that they can be used to complete the required course content and its concentration in the learning process. Each person can learn at the same location or different. Similarly, they can have time to learn the same or different. The concentrations are separate. In general, we can say that each individual has a separate context, most of them are different. Therefore, the composition Context Detection Factor was born with the specific task of determining the value of the components that the context user supplied. These values are input to the system's data layer. This component works only when there is interaction in terms of context between users and systems. That is, in the process of learning, learner does not have any changes in terms of location, duration and concentration, the components will not make it to redefine these elements. Then, the default factors provided the context for the system is the contextual factors that considered as users' first choice in the process of using the system. In other words, the component Context Detection Factor referred to as user requirements change in terms of location, time or concentration.

3) *Request's Knowledge*

After each learning content, learners must complete a test. The system will assess understanding of content learned through the course of the test results. Results of evaluation of the system can not satisfy learners. The learner might think that their level of understanding of that field as well, while the system is rated at normal levels. Therefore, they will not agree with this assessment, they want to change this assessment, they want their system to assess the level of understanding of content. Then, they asked to change their level of understanding about that field. When learners have this requirement, the Data Request to transfer the request to the Request Knowledge.

This component is responsible for processing the request to change the understanding of a topic in which the learner has participated. This component is required to receive input from learners on updating the assessment of their knowledge about the topic just to participate. The update is a change in their data in the database system. It involves elements corresponding to the context that they are topics to change levels of understanding. Hence, it will be combined with contextual elements that learners initially are available to the system. This combination will be held in Adaptation Layer. Thus, the composition Request's Knowledge update request to change data on the level of understanding of the learner to provide treatment system. When learners participate in the system and make learning content, the composition Request's Knowledge can be used several times, repeated until the learner to accept the assessment of the system on the level of knowledge of person for each subject participated.

B. *Database layer*

Database layer is a component of the system where data is stored and provided to the system. This layer consists of four subcomponents: context data, learner's knowledge, learner model and content model. The components are closely linked together. Firstly, the context is separated into two components, including data about the context (location and time) and data about the learner's knowledge before. The separation into two components will support the processing system to update the knowledge required from the user feedback better. The system will only have to update the knowledge level of users without having to change the context of their previous selections. Learner's knowledge, which stores information about the assessment system for learners. This is the level of knowledge learned at the end of his studies. Secondly, the learner model and content model are two ingredients which are based on rules adapted from that extract the relevant content, stored in a database, users and interactive learning.

1) *Context data*

Context information is the information obtained from the learner's request such as location, interval of time to learn and concentration. These factors require the learners to fill in before they participate in the course. In this model, we define location as a place where the learners use mobile devices to take part in the course. It is not a specific common place such as home, bus terminal, hotel, etc. Each location is described by a corresponding discrete value in Table 1. This represents the factors that impact on learning activities such as concentration level, the frequency interruption as well as available time to learn. The lower value indicates that the location affecting context factors is higher, whereas the higher value indicates that impact is lower.

TABLE I. THE VALUE OF LOCATION FACTOR

No	Location	Value
1	Bus terminal	1
2	Restaurant	2
3	Outing	3
4	Campus	4
5	Home	5

Interval of time is available time that the learner will spend on learning. In terms of time limit in using mobile device, we use four options of interval of time for choosing the time to learn. These are 15, 30, 45, and 60 minutes. Similarly, we use discrete values to identify the level of concentration. The learner can choose one of parameters before participating in the course. Those values are only used to assume the concentration of learner because selection cannot guarantee for that the learners will concentrate as they do.

The concentration parameter is designed to determine the learner's requirements of concentration on learning while student uses mobile device to browse the course. Three concentration levels are low, medium and high. Each of them also is described by discrete value that is 1, 2 and 3 respectively.

2) *Learner's Knowledge*

Learner's Knowledge is the user's knowledge of the topics given in the system. This knowledge is the result obtained by two methods:

- Firstly, it is the result of the learning process. This result is determined by: after each lesson content, the system will give a certain number of questions. Then the user will complete the questions. The system is based on the amount of questions that users complete right to make the rate of assessment for each topic that the learner has chosen. This rate will be reported to the learner. If the learner does not accept the rate of assessment, or it is the knowledge that the system offers, the user may change that assessment in accordance with their capabilities. The system will rely on feedback data and the previous context, generates a set of questions for users to complete. The system will re-evaluate and inform students. Notification process - feedback loop is done, only when the learner accepts the level of knowledge that the system evaluated.

- Secondly, the initial test of their knowledge of learners without their contents must complete a course before. A set of questions will be generated automatically and randomly covers the most basic themes that initially the user needs to achieve. The completion of these questions and received feedback is determined similarly to the above method.

Knowledge of the learner after the unification and was saved in the database will be divided into five basic levels: poor, average, good, very good, excellent. Each level also is described by discrete value as showed in Table 2.

TABLE II. LEVEL KNOWLEDGE LEVEL

No	Learner knowledge level	Value
1	Poor	1
2	Average	2
3	Good	3
4	Very good	4
5	Excellent	5

3) *Content Modelling*

We describe the course content as the tree structure with hierarchical nodes that describe topics. They consist of several child nodes. The leaf is a node without child nodes. These contain topic content in detail. Each node includes some attributes to distinguish and they are the basis for adaptation processing. The learner model decides whether node is chosen for different learner or not. It not

only decides the numbers of nodes needed to learn but also decides the depth of the tree content that learners are suggested to travel. There are some reasons why the course content is represented as tree structure instead of knowledge graph that modelled in our recent study, ACGs model [13, 14]. Those are: (1) The content of our scenario, the learning topic test support is hierarchical structure, (2) The content adaptation for different learner is to select suitable topics from the course so that it examines the tree processing to select nodes required to learn.

We denoted T (Topic) is the subject study, in which T_i ($i = 1...n$) is the subject of the T. Similarly, T_{ij} ($j = 1...m$) is the child of T_i . The topics are arranged under a tree from top to bottom according to the content of the topic. Each topic is a node of the tree. The topics above (as in the general topic) have content that covers the content of the child (a subject in the details.) The child node will inherit the content of the topic at parent level. But it is only reflected in the general level, not goes into detail on each issue reflected in the topic. It focused on the content corresponding to its position. This raises the problem of how that can be determined in accordance with the contents of that topic. Because threads are arranged according to each topic, tree should have different altitudes. Depending on such topics as wide or narrow, there are many issues of concern which branches child was born. The principal topics with content relevant to general users have average knowledge on that topic. Learners can choose which topics to be able to absorb knowledge in accordance with their capabilities. At the higher topics the content more detail and depth. To be able to learn the content in these topics, the system requires students to understand well the content of lower-level topics. This requirement is entirely accurate, because the topics at high levels are inherited from the subject at a low level, learner may want to learn and understand the need to have certain knowledge of the problem. This knowledge was assessed through the learning process of users in low-level topics.

4) *Learner modelling*

One of the most important information in this layer is learner model that is basic to select adaptive course content for different learner. It is designed from context factors as well as learner's knowledge. Because all context factors are represented by discrete values, the learner model also is described by them. In this model, we assume that learner model depends on context factors and learner knowledge. With context factors, we designed learner model whose value is calculated by value of location, concentration and time to learn as showed in Table 3. At this stage of the model, we assume that the value of learner model is aggregation of all of context factors. Therefore, there are ten models of learners with values from 3 to 12 respectively.

TABLE III. THE VALUE REPRESENTS LEARNER MODEL BASED ON CONTEXT FACTORS: LOCATION, CONCENTRATION AND TIME

Low(1)				Medium (2)				High (3)			
15	30	45	60	15	30	45	60	15	30	45	60
1	2	3	4	1	2	3	4	1	2	3	4
3	4	5	6	4	5	6	7	5	6	7	8
4	5	6	7	5	6	7	8	6	7	8	9
5	6	7	8	6	7	8	9	7	8	9	10
6	7	8	9	7	8	9	10	8	9	10	11
7	8	9	10	8	9	10	11	9	10	11	12

Five rows in Table 3 represent the value for location factor, the first row denotes location at Bus terminal which has minimum value and fifth row denotes location at Home which has maximum value. For instance, for the learner who is at home with low concentration level and time to learn is 45 minutes, the learner model value represented in Table 3 is value 9 (row 5th and column 4th).

As mentioned above, based on learner's knowledge factor, we define learner model as the aggregation of learner model that is based on context and knowledge as shown in Table 4.

TABLE IV. LEARNER MODEL IS COMBINED CONTEXT FACTORS AND LEARNER'S KNOWLEDGE

Learner Model	Learner's knowledge				
	1	2	3	4	5
1	2	3	4	5	6
2	3	4	5	6	7
3	4	5	6	7	8
4	5	6	7	8	9
5	6	7	8	9	10
6	7	8	9	10	11
7	8	9	10	11	12
8	9	10	11	12	13
9	10	11	12	13	14
10	11	12	13	14	15

There are fourteen models of learner based on learner's knowledge level and context factors. These models are the basis for adaptation layer to select adaptive course content for different learners. For example, if the learner who can be at Home, concentration level is Medium, time to learn is 30 minutes and knowledge level is Good (This value is evaluated through the test question when learner participates the course), the learner model value is 11.

C. Adaptation layer

Adaptation layer includes some functions designed to adapt learning materials for each learner. Based on the results of test as well as learner's background, Learner's Knowledge evaluating component used to identify how learner's knowledge level is. Learner modeling component is constructed to determine all of the context factors such as location, time to learn, and learner's knowledge of different learners affecting to adaptation. The heart of this layer, learning resource selection component, is used to select appropriate adaptive learning content for each learners according to their learner modeling. We designed several rules to choose learning resources from content model as travelling of tree nodes. The child node describes detailed information about parent node. Therefore, if learner travels the tree deeply, the content obtained is more detailed.

Learning material is adapted to different learners in two ways. The first way is that when learner selects one topic from suggested list, the content belonging to this topic is adapted based on learner model of different learners. The second way occurs when the learners finish a test, the system recommends one or more topics that students need to learn.

We classify student into fourteen categories in order to adapt the course content.

The excerpt we used to select learning resources in this model is if - then rules. The rules as described in the Table 5.

Defended on learner model, the adaptive rules include three elements such as height of tree, number of topic and number of test question.

TABLE V. TABLE 5. ADAPTIVE RULES ACCORDING TO LEARNER MODEL

No	Learner model	Rules		
		Height of tree	Number of topic	Number of test question
1	LM1	1	1	5
2	LM2	1	2	5
3	LM3	1	2	5
4	LM4	2	3	5
5	LM5	2	3	5
6	LM6	3	3	10
7	LM7	3	4	10
8	LM8	3	4	10
9	LM9	4	4	10
10	LM10	4	4	12
11	LM11	4	5	12
12	LM12	5	5	12
13	LM13	5	5	12
14	LM14	5	5	12

The height of tree informs that how information is in details. The number of topics denotes the number of child nodes or sub topics of determined topics. Having several sub topics, the number of topics will decide how many topics are supplied to different learners. Similarly, the number of test questions denotes how many test questions will be required to take after different learners browsing the definite topics.

Adaptation Layer is composed of four main components: Adaptive Engine, Adaptive Rule, Context Engine and Context Rule.

1) Context Rule

This component is a set of rules for handling data and the context in which the Database Layer and Knowledge's Request components provide. The use of rules for the context will depend on the requirements of the learner provides. If the request is to provide learning content or assessment tests, the composition will receive data from the two components Knowledge's User and Context Data from the Database Layer provides. Correspondingly, if the request is to change the level of knowledge, the composition will receive data from the Context Data from Database Layer and Knowledge's Request from Detection Layer. After receiving the corresponding data from the components, data and the rules which were built before, is executed in the Context Engine component.

2) Context Engine

Context Engine is the execution of laws on the data context associated with it. The result of this process is to model learning to the learner. The calculation is done as in Table 4.

3) Adaptive Rule and Adaptive Engine

Adaptive Rule of rule is adapting to each learner model, which is provided by the Database Layer. If the learner model is formed from the required content and knowledge which learners already saved previously, then the law will be applied and processed by the Adaptive Engine

components as in Table 5. On the other hand, if the learner model is based on a request to change the assessment of knowledge on the subject studied, the content model will be developed based on the corresponding learner model and the number of random course questions. The number of random questions given corresponds to the model of learning and topics that learners want to change the level of assessment. Then, the content model will not include the learning content and height of tree. To determine the degree of difficulty of questions, with it, the determination of the number and level of difficulty of the questions will be based on previous context models and the level should change. Specifically, the context model will prescribe the number of questions that the system will require the learners to answer; specified levels should change the level of difficulty of questions. The number of questions will be determined by the system default. Meanwhile, the level of difficulty of questions is determined by the ratio between the number of wrong answers the question and the number of respondents answered the question.

$$L = \frac{n1}{n2} * 100\%$$

In which:

- L: Level of difficulty of a question
- n1: Number of wrong answers that question
- n2: Number of people answered that question

For example: With a question has:

n1 = 200; n2 = 500; Then, L = (200/500)*100% = 40%.

Because the level of need to change covers only the value: Poor (1), Average (2), Good (3), Very Good (4), Excellent (5), we will determine the level of difficulty corresponding to the ratio between the Poor [0%, 20%), Average [20%, 40%), Good [40%, 60%), Very Good [60%, 80%), Excellent [80%, 100%]. Specifically, we have the following Table 6:

TABLE VI. CONTENT MODEL AS A CHANGE OF LEARNER

Learner Model	Number of test question	Knowledge's Request				
		1	2	3	4	5
1	10	[0%,20%)	[20%,40%)	[40%,60%)	[60%,80%)	[80%,100%)
2	10					
3	10					
4	10					
5	10					
6	10					
7	10					
8	10					
9	10					
10	10					

The questions will be taken randomly in the ratio range them. For example: Originally, the user selects the context values: Location (home), time (30 minute), concentration

(medium) and Topic is Noun. Then, the user completed and evaluated: level of knowledge is Average. The user wants to change this rating to Good. Meanwhile, the number of questions the system offers is 10 and the difficulty of the questions are in the interval [40% -60%).

V. SYSTEM PROTOTYPE IMPLEMENTATION

We implemented CAMLES prototype based on J2ME technology. Therefore, mobile phone needs to support java program as well as GPRS or 3G. In order to use CAMLES, the learners need to download and install application themselves in their mobile phone. At this stage, we develop content model which consists of five main topics: Noun, Verb, Adjectives, Adverbs and Prepositions. Those are considered as parent topics for the entire contents of the system. Under each topic, there will be a corresponding child topic, for example, the child of Adjectives topic has eight children: Manner, Place, Time, Frequency, Sentence, Degree, Interrogative and Relative.

The learner inputs context parameters via mobile interface. The topic content was adapted him. Finishing this topic, the system suggests some question test to evaluate learner's knowledge of the topic and shows the test results as well as recommendations in next screen.

For example, first, students will choose the context, including Time (10 minute), Location (Home) and Concentration (High). Then they will select Topic (Noun). Based on the context and topic, the system will give back to learning content, respectively, as Figure 2.

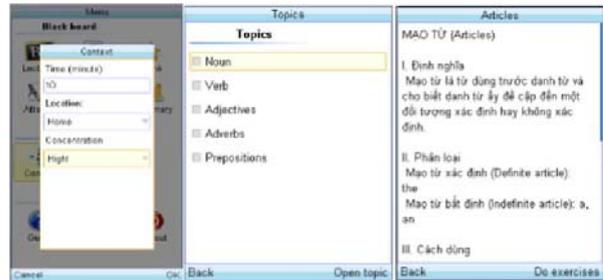


Figure 2. Learner inputs context parameters and adaptive content showed

After that, learners were unsure about their knowledge of course content that the system offers, learners will have to complete the questions that the system provides, as Figure 3.

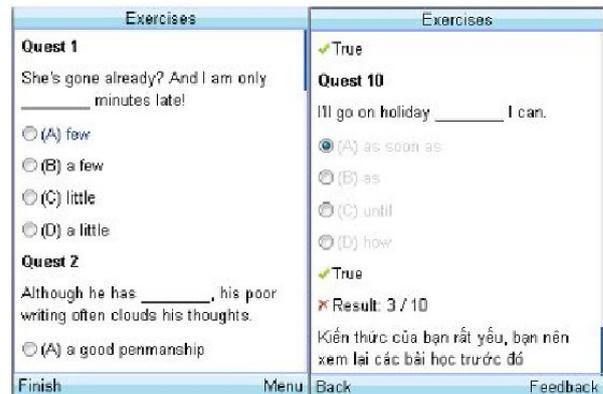


Figure 3. Test questions for evaluating learner's knowledge

End of test questions evaluating the system requires learners to perform, the system will evaluate and respond

to learners. The study could change the evaluation of the system on their own knowledge, as in Figure 4.

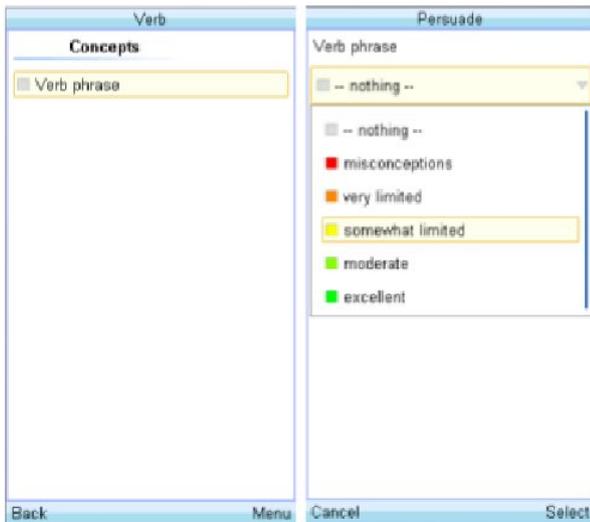


Figure 4. The learner evaluated changes in the knowledge that the system was evaluated

After the learner has changed the knowledge level assessment system that has been evaluated, the system will provide the learner some questions to confirm that the change of the course is true. Therefore, students will have to complete all the questions. If learners complete the right amount of questions in the rate that the system can accept, then students will be accepted that the knowledge itself has changed. Conversely, if learners do not complete the questions, the system will re-evaluate the level of knowledge of the learning results that learners have achieved. The change in the evaluation and testing will stop when they have accepted the assessment of knowledge that the system offers, such as in Figure 5.

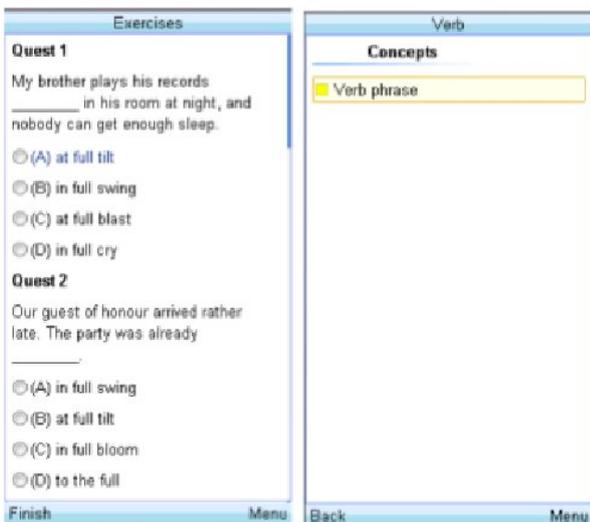


Figure 5. Questions that learners should complete the questions and assessing knowledge levels were changed after completing the questions

To examine our experimentation, we designed a questionnaire which includes six questions in order to survey 35 students who used CAMLES system with their mobile phones which support GPRS or 3G to connect to Internet. In order to evaluate our system, students check to one of from 1 to 5 values that 1 was the lowest and 5 was the highest. We classify students into three categories:

group one includes students who have never taken the TOEFL test before, group two contain students who have taken TOEFL test and have got below 450 score (paper test), and group three are students have received above 500 score. Table 7 shows average results of the questionnaire for each group.

TABLE VII. RESULTS OF QUESTIONNAIRE

No	Question	G1	G2	G3
1	Do you think the system was easy to use?	3.5	4.0	4.0
2	Would you like to use the system again?	4.5	4.0	3.5
3	Do you think the test question is appropriate for you?	3.0	4.5	4.0
4	The topic that system selects is appropriate for you?	4.5	4.0	3.5
5	Did you choose context factors as you in?	3.0	4.5	5.0

According to Question 1 and Question 2, the students were satisfied with system and would like to use the system again. Results of Question 3 showed that the students who have never taken TOEFL test before did not satisfy because the test questions, which we used in prototype, are not easy. The results of this question also denote that the students, who have had high test scores before, satisfied with system. Average score of Question 4 is 3.5 denoting that the topic selected for such students is not good enough because our content model does not have more topic as well as topic content is not in details to support them. Question 5 surveys learners who choose the context whether true as they in or not. For instance, the learners can choose their location at home while they are at Bunterminal. Problem of how to locate learner's location will be resolved in the next stage through location base services. As you see, in Group 1 result, students who have never take the TOEFL test before are interested in our system. However, Average score of Question 5 is 3.0 showing that they often choose the context which is not true as they in. For example, they choose Restaurant location while they are in class.

VI. DISCUSSIONS

Our target users are graduate students who intend to take TOEFL test. However, this approach can be applied to general learners to study English as a foreign language. Our model, context-aware location-dependent learning, adapts learning content according to context as well as learner's knowledge background. To find interests in our system, we compare it with early systems.

In TenseITS [3], learner's knowledge parameter is only calculated at current stage, so if the learner, from second time, backs to the system with the same context factors as he/she inputted previously, the adaptive contents are similar. In our model, learner's knowledge background is stored and is evaluated after the students finish the topic. The results are basic for recalculating value of learner model for next time when learners use system.

The CAMLL [2] is also based on learner level to adapt suitable sentences, however, how the learner's level updating learning progress has not been specified.

At this stage, our learner model is still not distinct for all context cases. Therefore, there are several different contexts having the same value in learner's model. In the

future work, we will consider refining the content model as well as adaptive engine in order to match the learner's requests. One notable problem of how to fragment content to display in accordance with the size of the mobile phone is also considered. In addition, we will improve user interface to meet demands of new users. We intend to deploy a web application version of this model because of the disadvantages of the stand-alone application. The web application easily supports different models of mobile phones.

VII. CONCLUSIONS

This work represented a personalized context-aware mobile learning architecture. By using open learner modeling technique, this model allows learners to interact with the system in order to get accurate actual learner's demands. In order to do that, we also proposed an adaptation mechanism based on evaluating learner's knowledge to select adaptive learning materials meet the learners. Besides, prototype of use was presented to illustrate the potential of applicability of our system.

VIII. REFERENCES

- [1] N. V. Anh, P. V. Cong, and H. S. Dam. A Context-Aware Mobile Learning Adaptive System for Supporting Foreigner Learning English. In Proceedings of IEEE-RIVF 2010 International Conference on Computing and Telecommunication Technologies, 2010.
- [2] K. Al-Mekhlafi, X. Hu, and Z. Zheng. An approach to context-aware mobile chinese language learning for foreign students. In Proceedings of the 2009 Eighth International Conference on Mobile Business, pages 340–346, Washington, DC, USA, 2009. IEEE Computer Society. <http://dx.doi.org/10.1109/ICMB.2009.65>
- [3] Y. Cui and S. Bull. Context and learner modelling for the mobile foreign language learner. volume 33, pages 353 – 367, 2005.
- [4] R. G. J. Paredes, H. Ogata, A. Nobuji, Y. Oishi, and T. Ueda. Loch: Supporting informal language learning outside the classroom with handhelds. In WMTE'05, pages 182–186, 2005.
- [5] C.-M. Chen, Y.-L. Li, and M.-C. Chen. Personalized context-aware ubiquitous learning system for supporting effectively english vocabulary learning. In ICALT'07, pages 628–630, 2007.
- [6] H. Ogata and Y. Yano. Context-aware support for computer-supported ubiquitous learning. In WMTE'04, pages 27–34, 2004.
- [7] [6] M. LI, H. OGATA, S. HA SHIMOTO, and Y. YANO. Adaptive kanji learning using mobile-based email. pages 520–526, 2009.
- [8] S. A. Petersen, J.-K. Markiewicz, and S. S. Bjørnebekk. Personalized and contextualized language learning: Choose when, where and what. Research and Practice in Technology Enhanced Learning, pages 33–60, 2009.
- [9] A. K. Dey. Providing architectural support for building context-aware applications. Atlanta, GA, USA, 2000. Georgia Institute of Technology.
- [10] B. Hu and P. Moore. "smart context": An ontology based context model for cooperative mobile learning. In CSCWD (Selected Papers)'06, pages 717–726, 2006.
- [11] G. D. Abowd, A. K. Dey, P. J. Brown, N. Davies, M. Smith, and P. Steggles. Towards a better understanding of context and context-awareness. In HUC'99, pages 304–307, 1999.
- [12] T. Reichenbacher. Adaptive methods for mobile cartography. ICC 2003, (August):10–16, 2003.
- [13] N. V. Anh and H. S. Dam. Acgs: Adaptive course generation system - an efficient approach to build e-learning course. In Proceedings of the IEEE S ixth International Conference on Computers and Information Technology, pages 259–265, 2006.
- [14] N. V. Anh, N. V. Ha, and H. S. Dam. Developing adaptive hypermedia system based on learning design level b with rules for adaptive learning activities. Journal of Natural Science, Vietnam Nation University, 25(1):1–12, 2009.

AUTHORS

Viet Anh NGUYEN is with the University of Engineering and Technology, VNU, E3, 144 XuanThuy, CauGiay, Hanoi, Vietnam (email: vietanh@vnu.edu.vn).

Van Cong PHAM is with the University of Engineering and Technology, VNU, E3, 144 XuanThuy, CauGiay, Hanoi, Vietnam (email: vcong.pham@gmail.com).

This work has been supported by the research project No QG.11.33 of Vietnam National University. Received 15 August 2011. Published as resubmitted by the authors 27 September 2011.