How Ubiquitous Computing can Support Language Learning

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Abstract

This paper describes a computer supported ubiquitous learning (CSUL), called CLUE, the learners provide their own knowledge about the language learning in their everyday life, share them in the community and discuss about them. This paper focuses on knowledge awareness map and its design, implementation and evaluation. The map visualizes the relationship between the shared knowledge and the current and past interactions of learners. The map plays a very important role of finding peer helpers, and inducing collaboration.

Keywords: ubiquitous learning, computer assisted language learning, collaborative learning, knowledge awareness, authentic learning.

1. Introduction

Ubiquitous computing [1] will help organize and mediate social interactions wherever and whenever these situations might occur [8]. Its evolution has recently been accelerated by improved wireless telecommunications capabilities, open networks, continued increases in computing power, improved battery technology, and the emergence of flexible software architectures. With those technologies, an individual learning environment can be embedded in the real everyday life. The fundamental issue is how the computer software can support appropriately ubiquitous learning.

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 say the right thing at the right time in the right way [6]. A ubiquitous computing environment enables people learning at any time and any place. But the fundamental issue is how to provide learners right information at the right time in the right way. This paper tackles the issues of right time and right place learning (RTRPL) in a ubiquitous computing environment.

Especially, we focus on language learning as an application domain of this research. That is because language is much influenced by situations. The user of this system is an overseas student of a University in Japan, and wants to learn Japanese Language. The other user is a Japanese student who is interested in English as the second language and plays an important role of a helper for an overseas student. The learners with PDA (Personal Digital Assistant) store and share the useful expressions that are linked to any place in everyday life. Then, the system provides each learner the right expressions at the right place. For example, if the learner enters a hospital, then the right expressions at that place are provided at that time for RTRPL. It is very important to encourage not only individual learning but also collaborative learning in order to augment practical communication among learners and accumulation of the expressions.

Knowledge Awareness KA is defined as awareness of the use of knowledge [9,10]. In a distance-learning environment, it is very difficult for the learner to be aware of the use of other learners' knowledge because the learner cannot understand their actions in the remote site beyond Internet. KA messages inform a learner about the other learners' real-time or past-time actions: look-at, change, and discuss, that have something to do with knowledge on which a learner was or is presently engaged. For example, KA messages are "someone is changing the same knowledge that you are looking at", "someone discussed the knowledge which you have inputted." These messages make the learner aware of someone:

(1) who has the same problem or knowledge as the learner;
(2) who has a different view about the problem or knowledge; and
(3) who has potential to assist solving the problem.

Therefore, these messages that are independent of the domain, can enhance collaboration opportunities in a shared knowledge space, and make it possible to shift from solitary learning to collaborative learning in a distributed learning space.

In order to induce collaborative learning, this paper proposes KA map that visualizes KA information for ubiquitous learning environments. The map helps learner to mediate and recognize collaborators in the shared knowledge space. On this map, the system identifies learning-companions who can help solving a problem. The characteristics of the map are:

(1) Visualization of the objects in the map and

expressions as educational materials,
(2) Visualization of the links between expressions and learners to induce collaboration,
(3) Recommendations of appropriate collaborators on KA map to help find suitable partners.

We are developing an open-ended collaborative learning support system, which is called CLUE (Collaborative-Learning support-system with a Ubiquitous Environment). CLUE is a prototype system for KA map, and facilities to share individual knowledge and to learn through collaboration.

2. Computer Supported Ubiquitous Learning

CSUL is defined that a ubiquitous learning environment that is supported by embedded and invisible computers in everyday life. Figure 1 shows the comparison of four learning environments according to [9]. The CAL (computer assisted learning) systems using desktop computers are not embedded in the real world, and difficult to be moved. Therefore those systems hardly support learning at anytime and anywhere.

Compared with desktop computer assisted learning, mobile learning is fundamentally about increasing learners' capability to physically move their own learning environment with them. Mobile learning is implemented with lightweight devices such as PDA, cellular mobile phones, and so on. Those mobile devices can connect to Internet with wireless communication technologies, and enable learning at anytime and anywhere. In this situation, however, computers are not embedded in learner's surrounding environment, and they cannot seamlessly and flexibly obtain information about the context of his/her learning.

In pervasive learning, computers can obtain information about the context of learning from the learning environment where the small devices such as sensors, pads, badges, and so on, are embedded and communicate mutually. Pervasive learning environment can be built either by embedding models of specific environment into dedicated computers, or by building generic capabilities of into computers to inquire, detect, explore, and dynamically build models of their environments. However, this makes availability and usefulness of pervasive learning limited and highly localized.

Finally, ubiquitous learning is integrated high mobility with pervasive learning environment. While learner is moving with his/her mobile device, the system dynamically supports his/her learning by communicating with embedded computers in the environment. As for the broad definition of ubiquitous learning, however, both pervasive learning and mobile learning would be in the category of ubiquitous learning.

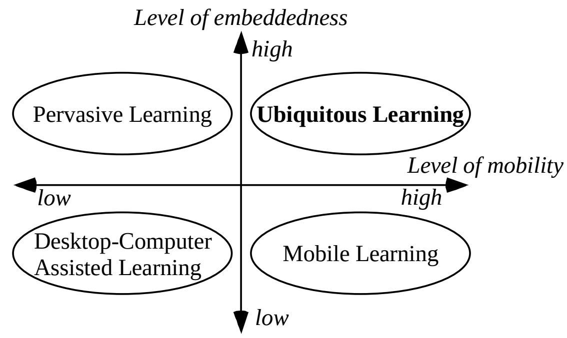

Figure 1: Comparison of learning environments (based on [9]).

2.1 Learning Theories for CSUL

CSUL is advocated by pedagogical theories such as on-demand learning, hands-on or minds-on learning, and authentic learning. CSUL system provides learners on-demand information such as advices from teachers or experts at the spot at the precise moment they want to know something. Brown, Collins, and Duguid [2] define authentic learning as coherent, meaningful, and purposeful activities. When the classroom activities are related to the real world, students receive great academic delights. There are four types of learning to ensure authentic learning: action, situated and incidental learning [7]. Action learning is a practical process where students learn by doing, by observing and imitating the expert, and by getting feedback from teachers and their fellow-pupils. Usually, learning is promoted by connecting knowledge with workplace activities.

Situated learning is similar to action learning because trainees are sent to school-like settings to learn and understand new concepts and theories to be applied later on in practice. Knowledge is developed through the authentic activities and important social interactions. Cognitive apprenticeship methods try to enculturate students into authentic practices through activity and social interaction in a way similar to that evident in craft apprenticeship" ([2], p.37).

Incidental learning includes unintentional and unexamined learning from mistakes, unexpected incidents, etc. For example, a child can acquire an unexpected result in the science lab by the mistake of dropping some other liquid to the given experiment that may lead a great discovery. Learners discover something while they are doing something else in the process; therefore, it is considered as a surprised by-product. Knowledge from incidental learning develops self-confidence and increases self-knowledge in learning.

There are three forms of experiential learning: action learning, future search, and outdoor education. Action learning is a social process of solving the difficulties, by involving that learners are doing things and thinking about what they are doing. In the classroom, action learning is a problem-solving process by developing knowledge and understanding at the appropriate time. The future search process is to develop thinking and understanding and is not about problem solving, but rather an exercise in developing insights, understanding, learning from one another, and reducing misunderstandings. Outdoor education is an outdoor program of team members to apply their new learning during an outdoor experience upon returning to the job in order to gain more insights through challenge activities. Learners integrate thoughts and actions with reflection from the outdoor experiences.

2.2 Characteristics of CSUL

The main characteristics of ubiquitous learning are shown as follows [3,4]:

(1) Permanency: Learners can never lose their work unless it is purposefully deleted. In addition, all the learning processes are recorded continuously in everyday.
(2) Accessibility: Learners have access to their documents, data, or videos from anywhere. That information is provided based on their requests. Therefore, the learning involved is self-directed.
(3) Immediacy: Wherever learners are, they can get any information immediately. Therefore learners can solve problems quickly. Otherwise, the learner may record the questions and look for the answer later.
(4) Interactivity: Learners can interact with experts, teachers, or peers in the form of synchronies or asynchronous communication. Hence, the experts are more reachable and the knowledge is more available.
(5) Situating of instructional activities: The learning could be embedded in our daily life. The problems encountered as well as the knowledge required are all presented in the nature and authentic forms. It helps learners notice the features of problem situations that make particular actions relevant.

2.3 Information Model

Based on [1], CSUL deals with 5W1H information as follows:

Who: Current systems focus their interaction on the identity of one particular user, rarely incorporating identity information about other people in the environment. As human beings, we tailor our activities and recall events from the past based on the presence of other people. CSUL identifies not only the current user but also other users surrounding the user. CSUL provides the right information after interpreting the user-models of them. Especially, other people influence Japanese language. For example, we, Japanese people use different level of polite expressions according to the ages of other people

What: The interaction in current systems either assumes what the user is doing or leaves the question open. Perceiving and interpreting human activity is a difficult problem. Nevertheless, interaction with continuously worn, context-driven devices will likely need to incorporate interpretations of human activity to be able to provide useful information.

When: With the exception of using time as an index into a captured record or summarizing how long a person has been at a particular location, most context-driven applications are unaware of the passage of time. For example, the learner might get the right expressions at the certain time, e.g, morning.

Where: In many ways, the “where” component of context has been explored more than the others. Of particular interest is coupling notions of “where” with other contextual information, such as “when.

Why: Even more challenging than perceiving “what” a person is doing understands “why” that person is doing it. Using “why” information, the right information could be provided to the learner.

How: CSUL has to provide right information at the right form in the right way. For example, if learner has a PDA with small memory, the system has to provide the light information such as texts or pictures. But if there is a desktop computer near the learner, the system can provide video clip data.

3. Systems of Computer Supported Ubiquitous Language-Learning Environment

We have developed the system called CLUE that consists of the three subsystems for supporting ubiquitous language learning: sentences, polite expressions, and vocabularies.

3.1 Learning Sentences

Learners, overseas students, store useful expressions into the database of CLUE, or ask questions with CLUE when they have some problem in everyday life. Japanese students refine the expressions or answer their questions. When learner is walking around, CLUE provides the adequate expressions and/or questions at RTRP. At the initial state, some fundamental sentences were stored in the database referring [5]. The order is determined based on the following conditions:

(1) The expression is frequently used at the learner’s location.

(2) The learner has never learned the expression.
(3) Most of other learners have already learned the expression.
(4) The level of expression that is given by a teacher is appropriate for the learner's level.

Condition (1), (2) and (3) is derived from the learner's information. Condition (4) is also derived from learning materials and the learner's level that is detected by the right answer rate of the learner at that moment. The more conditions an expression meets, the higher the order of the expression will be. In this way, CLUE presents the right expression at the specific place.

Interface of the collaborative learning environment of CLUE is shown in Figure 2. The map window (A) shows the current location of each learner. The face icon on the map means the learning status of each learner. For example, if a learner has a problem or question, the face turns into a fad one. By clicking the face icon, the learner can send a message to the learner corresponding to the icon. In addition, a rectangle icon on the map shows a landmark where a teacher or a learner gives some expressions, or where they communicate with each other. If a learner enters an expression at the place for the first time, then a new landmark is created in the map. By cling the rectangle icon, the user can see the web page of the place (e.g., the hospital), the expressions that are used in the place, or the communication logs about the expressions or the place. Users can also register their positions at any time if GPS does not work. For example, it might come out when big buildings surround them, or when they are in a building.

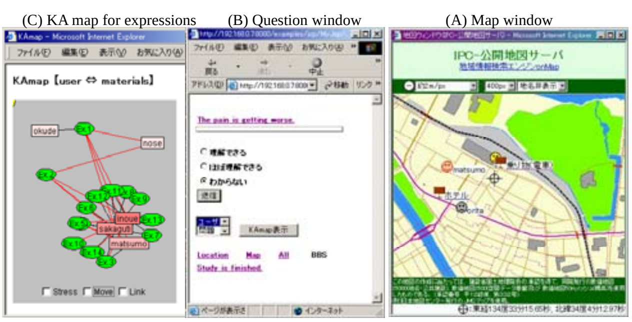

Figure 2: Interface of CLUE.

If the learner approaches the certain place, the window (B) appears, which shows a useful expression at the place in English. If the current user has already learned all the expressions at the place, the expressions are not appeared. If the learner can correctly answer the Japanese expression corresponding to the English expression, the next expression will appear. Otherwise, the learner will be given the same expression in coming the place at the next time.

If the learner has a question about the expression, the window (C) shows the relation between expressions and other learners. The color of an oval icon shows the level of difficulty of the expression. A teacher gives the level. Moreover, the color of a rectangle icon shows the level of proficiency of the learner. The higher the level is, the more correct-answers the learner gives. From this KA map, the learner can find the suitable person to ask the question.

3.2 Learning Polite Expressions

Japanese polite expressions are divided into two types that are honorific words and modest words. The former is used to express a speaker's respect for a conversational companion. The latter is used to express a humble attitude of a speaker. For example, in a word of "hanasu", its honorific word is “ossharu," and its modest one is "mousu." The alteration of Japanese polite expressions usually occurs in the verb, noun, adjective, and adverb. Moreover, there are three levels of polite expressions (LPE): casual, basic, and formal. There are two kinds of changing patterns: the first one is irregular change to a different word; the second one is regular change incorporating with a prefix and/or postfix word. According to the former, there is no limitation and pattern like an irregular verb. This makes Japanese expressions difficult for the overseas learners. Therefore, we have developed the subsystem of CLUE, the main aim of which is to provide the learner the appropriate polite-expression in the specific context.

Figure 3 shows a scene of learning polite expressions with CLUE. Every user has a PDA and inputs his information into the database, e.g., name, grade, age etc. When Mr. X talks to Mr. Z, the system tells Mr. X a casual expression. On the other hand, when Mr. X turns to Mr. Y in order to talk, the system tells Mr. X a formal expression.

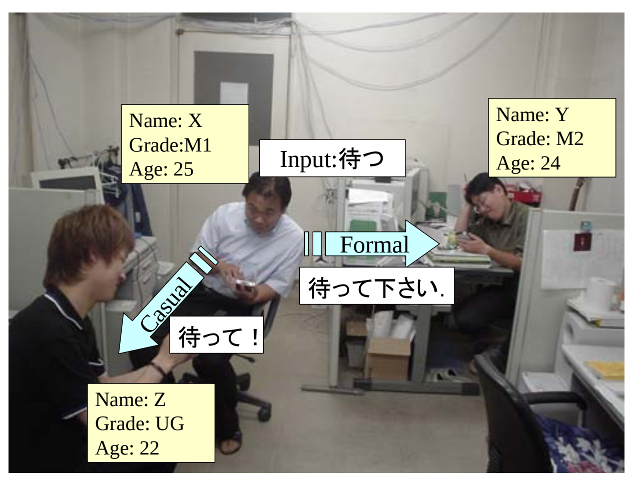

Figure 3: Scene of polite expressions learning.

The factors of changes of Japanese polite expression

There are three factors of changes in Japanese polite expressions.
(i) Hyponymy: Generally, people usually use a term of respect to elder or superior people. Social status depends on affiliations, the length of career, age and so on.
(ii) Social distance: Japanese polite expressions are often expressed in the familiar sense. However, the familiar sense is often different from country to country. For example, the Japanese familiar sense is narrower than the American one. The Japanese familiar sense depends on social relationships, which are classified into an inside group and an outside group. If the relation is family or colleague, then they consider being inside a group and using a casual level of polite expressions. If the relation is not so close, people use formal expressions.
(iii) Formality: The situation of a conversation influences polite expressions. For example, Japanese people often use more formal expressions in the formal situation (giving a talk at ceremony, writing a letter, and so on). According the above factors, the rules for making appropriate polite expressions are built in CLUE.

As shown in figure 4, the users input their individual personal data, e.g., name, gender, work, age, relationship etc. When the user talks to another user, the CLUE gets the information of the other via the infrared data communication of PDA, and then it suggests the suitable polite expressions for the user.

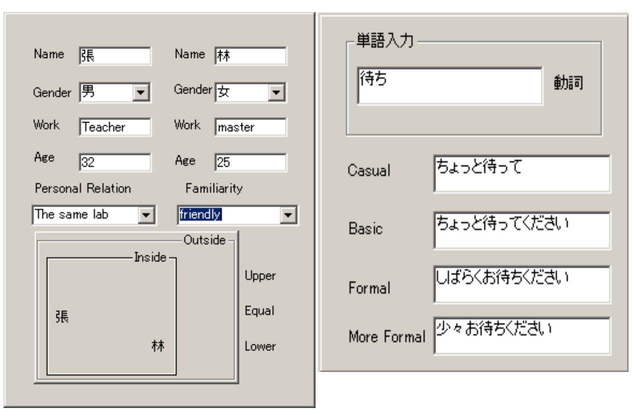

Figure 4: Interface for polite expressions learning.

3.3 Learning Vocabularies

At the beginner's class of language learning, a label that is written the name of the object is stuck on the corresponding object in a room in order to remind learners the word. The idea of this subsystem is the learner sticks RFID (Radio Frequency Identification) tags on real objects instead of sticky labels, annotate them, e.g., questions and answers, and share them among others (see figure 5). The tags bridge authentic objects and their information in the virtual world.

As shown in the left window in figure 5, the system provides the right words to the learner by scanning the RFID tags around the learner. For example, when the learner enters a meeting room, the system asks him/her a question where an "entaku" is, which is a round table in Japanese. The leaner can hear the question again if s/he wants. If the leaner scans the tag labeled on the table, the answer is correct, and the system will not ask the same question next time. Otherwise, the system tells a hint.

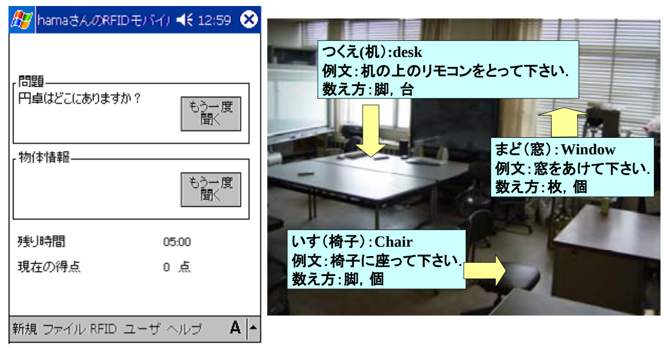

Figure 5: Scene of vocabulary learning.

3.4 System Configuration

We have developed the prototype system of CLUE, which consists of a server and clients. Each learner's client of CLUE is Toshiba Genio-e that is a PDA with Pocket PC 2002, Personal Java, GPS (Global Positioning System), and wireless LAN (IEEE 802.11b). Especially, we selected this device to use GPS and wireless LAN at the same time. The server program has been implemented with a java servlet via Tomcat. CLUE has the following modules (see figure 6):

Learner model: This module has the learner's profile such as name, age, gender, occupation, interests, etc, and the comprehensive level of each expression. Before using CLUE, the learner enters those data. In addition to the explicit method like this, CLUE implicitly detects learner's interests according to the history of the visiting. Moreover, this system records whether the learner understands expressions.

Environmental model: This module has the data of objects, rooms and buildings in the map, and the link between objects and expressions. For example, (Post office, location (x, y), "I'd like to buy a stamp.") means the post office is located at (x, y) on the map and the expression is often used.

Educational model: This module manages expressions as learning materials and dictionaries. Teacher enters the basic expression for each place. Both learners and the teacher then can add or modify expressions during the system use.

Communication support: This server manages a BBS (bulletin board system) and a chat tool like an instant messenger, and stores these logs into a database.

Location manager: This module stores the each learner’s location into the database.

Adaptation engine: This module recommends the learner the suitable expression and KA map.

Communication client: This is a client of BBS and chat.

Location sensor: This module sends the learner’s location from GPS to the server automatically.

Information visualization: This module shows KA map to the learner.

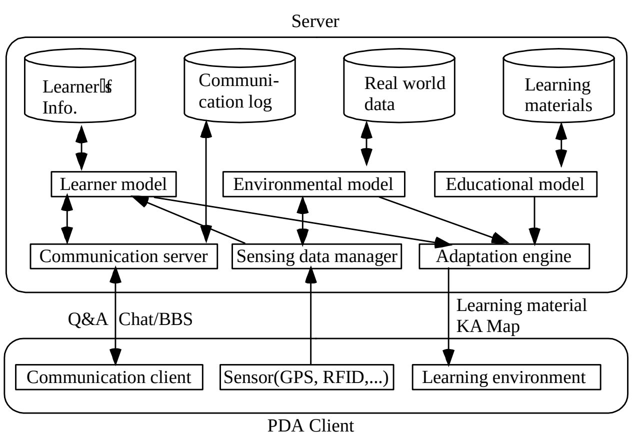

Figure 6: System configuration of CLUE.

4. Conclusion

This paper describes a computer supported collaborative learning (CSCL) [11,12] in ubiquitous computing environment. In the environment called CLUE, the learners provide and share individual knowledge and other knowledge on the WWW and discuss about them. This paper focuses on *knowledge awareness map* and its design, implementation and evaluation. The map visualizes the relationship between the shared knowledge and the current and past interactions of learners. The map plays a very important role of finding peer helpers, and inducing collaboration. In the future, we will try to evaluate CLUE.

Acknowledgement

This work was partly supported by the Grant-in-Aid for Scientific Research No.15700516 from the Ministry of Education, Science, Sports and Culture in Japan. Mr. Ushida, Mr.

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