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PERKAM: Personalized Knowledge Awareness Map for Computer Supported Ubiquitous Learning

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ABSTRACT
This paper introduces a ubiquitous computing environment in order to support the learners while doing tasks; this environment is called *PERKAM* (PERsonalized Knowledge Awareness Map). *PERKAM* allows the learners to share knowledge, interact, collaborate, and exchange individual experiences. It utilizes the RFID ubiquities technology to detect the learner's environmental objects and location, then recommends the best matched educational materials and peer helpers in accordance with the detected objects and the current location. This environment provides the learner with *Knowledge Awareness Map*, which visualizes the space of the environmental objects that surround the learner, the educational materials space, and the peer helpers' space. *PERKAM* system was implemented and an experiment was done in order to evaluate the system performance and the learner's satisfaction. This paper illustrates the design, the implementation and the evaluation of this environment, and it focuses on *Knowledge Awareness Map*, which is personalized according to the learner's current need and location.

Keywords
Ubiquitous Learning, Mobile Learning, Awareness, RFID, Collaboration

Introduction

Ubiquitous computing is a new information and communication technology that utilizes a large number of cooperative small nodes with computing and/or communication capabilities such as handheld terminals, smart mobile phones, sensor network nodes, contact-less smart cards, and RFID (Radio Frequency Identification)…etc (Sakamura & Koshizuka, 2005). The RFID system (Klaus & Rachel, 2000) consists of a tag, which is made up of a microchip with an antenna, and an interrogator or reader with an antenna. The reader sends out electromagnetic waves. The tag antenna is tuned to receive these waves. A passive RFID tag draws power from a field created by the reader and uses it to power the microchip's circuits. The chip then modulates the waves that the tag sends back to the reader and the reader converts the new waves into digital data.

Computing becomes ubiquitous. The knowledge, workers use in computing and communication services, is less limited to solitary moments at an office desk. Instead, it is extended in multifaceted ways to all aspects of the life, both public and private (Yoo & Lyytinen, 2005). The challenge of the future computer systems is therefore not to provide information at anytime and at anywhere but to say the right thing at the right time in the right way to the right person (Fischer, 2001; Fischer & Konomi, 2005). Ubiquitous computing evolution has recently been accelerated by improved wireless telecommunications capabilities, open networks, continuous increasing in computing power, improved battery technology, and the emergence of flexible software architectures. With those technologies, an individual learning environment could be embedded in daily real life (Ogata & Yano, 2004). Day after day, handheld devices became cheaper for a wide rang of people. Meanwhile, mobile devices are now being introduced as learning devices and some researches use them as collaborative tools (Cole and Stanton, 2003). The main characteristics of a Computer Supported Ubiquitous Learning (CSUL) environment are shown as follows (Chen, et al., 2002; Curtis, et al., 2002):

Permanency: Learners never lose their work unless it is purposefully deleted. In addition, all the learning processes are recorded continuously everyday.

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.

Immediacy: Wherever learners are, they can get any information immediately. Thus, learners can solve problems quickly. Otherwise, the learner can record the questions and look for the answers later.

Interactivity: Learners can interact with experts, teachers, or peers in the form of synchronous or asynchronous communication. Hence, the experts are more reachable and the knowledge becomes more available.

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 their natural and authentic forms. This helps learners to notice the features of the problem situations that make particular actions relevant.

Moreover, computer supported ubiquitous learning environment could be Computer Supported Collaborative Learning (CSCL) environment (O'Malley, 1994) that focuses on the socio-cognitive process of social knowledge building and sharing (Yoo & Lyytinen, 2005). The ubiquitous computing environments strongly support collaborative and situated learning approach. The use of ubiquitous computing tools within a situated learning approach, is recommended to facilitate the students' attainment of curricular content, technology skills, and collaboration skills (Lin et al., 2005).

Many teachers and learners believe that *learning by doing* (Schank, 1995) is the best way for learning. In *learning by doing* model, the teachers identify a specific set of skills to teach, embed that skills in a task, activity, or a goal that the student will find it interesting or motivational, then the teachers can evaluate the learner's understanding and skills according to how much the learner successes to reach to the goal. While the learner is practicing to reach to the goal, he/she usually looks for some knowledge. There are two logic ways to get the desired knowledge, one way is to refer to one or more of educational materials that match the learner's needs like books, journals, or video lectures. The other way is to ask for an aid from other learners who have enough knowledge about the learner's request. In last case, the learners can interact and exchange their knowledge in collaborative way. In a ubiquitous learning environment, it is difficult for a learner to know that the other learner has this knowledge even that they are at the same location. In this case, the learner needs to be aware of the other learners' interests that match his request.

The aim of this research is to support the learner with *Knowledge Awareness Map, which* is personalized according to his current need and location. Here, *PERKAMI* and *PERKAMII* models are integrated (El-Bishouty, Ogata & Yano, 2006a; 2006b). This system can recognize the environmental objects that surround the learner those he uses during his practice study. It uses RFID tags to detect the surrounding physical space objects then it generates the learner's digital space where each object in the physical space has its corresponding one in the digital space. The system matches between the educational materials topics and the learner's current task then recommends and visualizes the best matched materials according to how much they match the learner's current task and how near are their physical locations to the learner's current location. The system also matches between the current learner's need and the other learners' interests and locations, recommends the best peer helpers, and visualizes the relative distances between the learner's current need and the peer helpers interests and locations. The learner can refer to some educational materials or contact peer helpers, forward to them his *Environmental Object Map*, interact, and collaborate.

The outline of this paper is as the following: the main concept of the personalized *Knowledge Awareness Map* is illustrated, the system architecture and implementation are explained, and followed by the system evaluation and discussion. Finally, the conclusion and the future work are presented.

Personalized Knowledge Awareness Map

In order to get help from another learner you have to be aware of his interests and past actions. Therefore it is very difficult to find suitable partners at the beginning of the collaboration. Dourish and Bellotti (1992) defined *Awareness* as the understanding of the activities of others, which provides a context for your own activity. *Knowledge Awareness* (KA) is defined as awareness of the use of the knowledge (Ogata, Matsuura & Yano, 1996). KA has a close relation to the learner's curiosity (Ogata & Yano, 2000). Collaborative awareness is frequently achieved by means of lightweight messaging tools and dynamic information displays that function as notification systems (Carroll, et al., 2003). *Knowledge Awareness Map* graphically displays KA information. It displays the surrounding environmental objects, the matched educational materials, and the recommended peer helpers (El-Bishouty, Ogata & Yano, 2006b). This map plays a very important role in finding peer helpers and inducing collaboration (Ogata, et al., 1999). Hatano and Inagaki (1973) identified two types of curiosity: particular curiosity (PC) and extensive curiosity (EC). EC occurs when there is a desire for learning that makes the learner's stock of knowledge well balanced by widening the learner's interests. PC is generated by the lack of sufficient knowledge, and it is very useful because the learner can acquire detailed knowledge. *Knowledge Awareness Map* excites both types of curiosity.

In *PERKAM*, *Knowledge Awareness Map* is personalized according to the learner's need and the physical location. Personalization can be defined as the way in which information and services can be tailored in a specific way to match the unique and specific needs of an individual user (Renda & Straccia, 2005). Personalized applications lay more emphasis on specific needs, and location of individual learners in designing the learning contents on handheld devices (Cui & Bull, 2005). *PERKAM* satisfies the conditions that Cui and Bull (2005) posited for the personalized learning system:

1. Individualized according to the learner's knowledge.
2. Individualized according to the learner's location and needs in that location.
3. Mobility.

This type of learning systems supports the learners to make their own decisions based on the changed context or sensor information (Mitchell & Race, 2005). Therefore, it encourages *decision-making* and reflection (Song, 2006).

We assume that the knowledge space consists of a number of unique keywords. These keywords define the learners' interests, the environmental objects information and the educational materials contents. The keyword item is very important to recommend the educational materials, and the peer learners that augment the collaboration between them. Therefore, the system model consists of the following items.

Environmental Object

It represents the available real objects that may surround the learner. It may be computers, electronic parts, chemicals…etc. Each object has its own keywords that specify its configuration. One object may share one or more keywords with one or more other objects.

Learner

The learner is the actor in this system. The learner's interest is obtained from his profile and his educational materials folder. In this system, the learner's profile and folder are translated into a number of keywords that determine the user's interest.

Learner Profile

Each learner has his own profile. The learner profile is characterized using the following methods:

1. Learner explicit registration: The learner introduces his personal information and his interesting topics.
2. Learner academic level: The system detects the knowledge that the learner gained from his past academic records.
3. Learner actions: The system records the learners' actions while using it.

Learner Folder

The learner's folder contains the educational materials that the learner is aware of or intending to gain it.

Location

The location of the learners is represented by one dimension in the knowledge space. It is supposed that, everywhere there is a RFID tag to identify the location. The system can detect the learner's physical location using RFID tags. The relative physical distances between the different locations are predefined in the system.

Educational Material

It is the available educational material related to the education process. It includes book, lecture note, video or audio. Each material has its own keywords that specify its contents. One material may share one or more keywords with one or more other materials.

Environmental Objects Map

While a learner is interacting with other learners remotely trying to explain to them his current environment and situation, it may be difficult or at least need long time to describe exactly the available objects that he uses during his practice. The role of *Environmental Objects Map* is to map the physical space into the digital space, where each object in the physical space is detected, recognized and presented graphically by this system. The learner can forward this digital space to the peer helper in order to facilitate easy understanding of his environment, which augments the collaboration between them. For example, consider a learner (learner1 in Figure1) is doing an experiment at a chemistry lab, there are many objects surrounding him, each object is recognized, mapped into the digital space and forwarded to the peer helper. According to the *Environmental Objects Map* information, the peer helper can recognize the learner's situation and can efficiently collaborate with him.

a) Physical space b) Detection, recommendation and collaboration

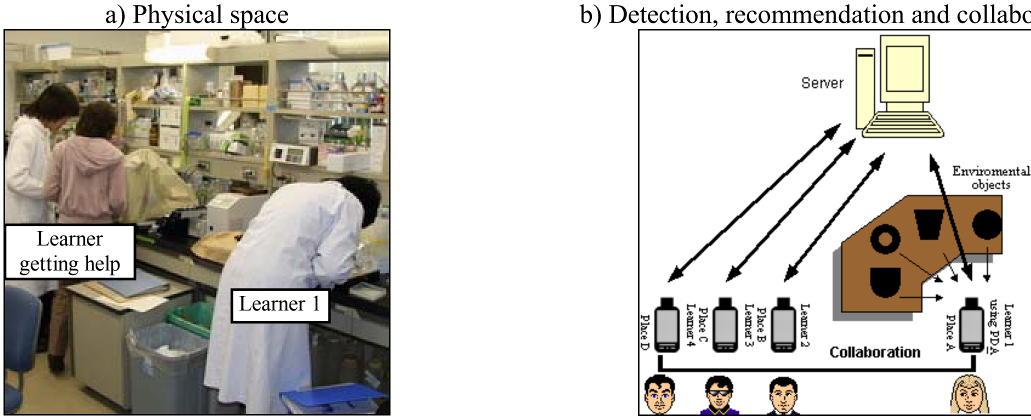

Figure 1. Environmental objects

Peer Helpers Map

This map displays a two dimensions knowledge space of the recommended learners who are using the system and have enough knowledge about the learner's request. This map represents the level of recommendation of each learner based on his interests. Consider that L is a certain learner, n is the number of keywords that a learner's request consists of, and n_L is the number of the matched keywords with a certain learner's interests. In *PERKAM*, it is assumed that the Level Of Interest *(LOI)* is calculated as follows:

$$LOI = \left(\frac{n - n_L}{n} \right), \text{ where } 0 \leq LOI \leq 1$$

In case of *LOI* value is equal or close to zero, then *L* is recommended as a peer helper and will be close to the learner's request in the horizontal (x) dimension. The vertical dimension represents the relative physical distance (*RPD*) between the learner's location and the recommended peer helper's location, where $0 \le RPD \le 1$. The closer the recommended helper to the learner's request in the vertical (y) dimension, the nearer his physical location to the learner. In case that many peer helpers are matched, the system recommends the best three peer helpers according to the following helper recommendation score (*HRS*) formula:

$$HRS = 1 - \frac{LOI + RPD}{2}, \text{ Where } 0 \le HRS \le 1$$

Educational Materials Map

This map displays a two dimensions knowledge space of the suggested materials. It represents the strength of the relation between the suggested materials and the learner's request in one dimension, and how far their physical locations are from the learner's location in the other dimension. Therefore the learner can get information about the appropriate material that satisfies his need. Consider that *m* is a certain material, *n* is the number of keywords that the learner's request consists of, and n_m is the number of the matched keywords with *m* keywords. In *PERKAM***,** it is assumed that the strength of the relationship *(STR)* between *m* and the learner's request is calculated as follows:

$$STR = \left(\frac{n - n_m}{n} \right), \text{ where } 0 \le STR \le 1$$

In case of *STR* value is equal or close to zero then *m* is recommended to the learner as a matched material and it will be close to the learner's request in the horizontal (x) dimension. The vertical dimension represents the relative physical distance (*RPD)* between the learner's location and the recommended materials locations where $0 \le RPD \le 1$. The closer the material to the learner's request in the vertical (y) dimension, the nearer the material to the learner's physical location. In case that many educational materials are matched, the system recommends the best three of them according to the following material recommendation score (*MRS*) formula:

$$MRS = 1 - \frac{STR + RPD}{2}, \text{ Where } 0 \le MRS \le 1$$

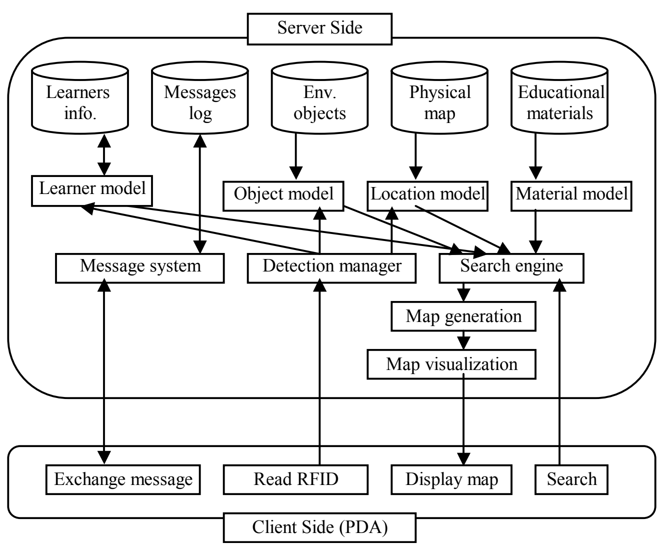

Figure 2. System architecture

System Implementation

In *PERKAM*, it is supposed that each learner has a PDA (Personal Digital Assistant) handheld device connected to the Internet through wireless connection, each device is equipped with a RF (Radio Frequency) reader, and for each object there is RFID (OMRON I.Code) tag attached to identify it. The learner can access the system anywhere and anytime, and face his PDA to all objects that surround him, then the system will recommend the related educational materials and the appropriate helpers who are aware of the requested knowledge. According to the level of recommendation, the learner can refer to an educational material or select the helper whom will interact with, forward his *Environmental Objects Map* to and exchange knowledge with him.

Architecture

PERKAM system consists of the following modules (as shown in Figure 2):

- Learner model: It contains the learner's information such as personal data, past actions, interests, folder…etc.
- Object model: It contains information about the physical educational objects that may be used by the learner.
- Location model: It contains information about the places (buildings and rooms) and the distances between them.
- Material model: It contains information about the education material as its title, author, type and keywords.
- Message system: It provides the learner with an easy tool to exchange messages with the other learners.
- Detection manager: It detects the location and the objects that surround the learner.
- Search engine: It matches between the learner's request, the available education materials and the peer learners.
- Map generator: It represents the surrounding environmental objects, the educational materials, and the recommended peer helpers' information according to the learner's need.
- Map visualization: It prepares the enough information to graphically visualize the KA maps.

Software Prototype

During the implementation of *PERKAM* prototype, the limited CPU speed and memory capacity of PDA devices is put in consideration. In order to get high performance software, most of the computing processes are done on the server side. Therefore, the PDA is mainly used to submit and receive data. Database schema is designed and implemented using MS-SQL2000 server in order to store all learners' profiles, actions, messages, and the environmental objects that surround the learner. The software consists of the following applications:

1. Detect-Tag: It is a client-server application, the client side application is developed using embedded C++ language. The target of this application is to read the stored data in the RFID tag (which represents the objects and the locations information) and send it to the server. The server side application is developed using visual C++ language. The function of this application is to listen on the network to the incoming client packets, receive client data (a particular learner's location or environmental object) and to connect to the database server in order to store the learner's current situation.
2. Search-Collaborate: This is the core of our system. It is a web based client-server application developed using ASP.Net and C# languages, where the learner can use anywhere using an Internet browser. A learner can login the system using his ID and password, browse his own folder, search about some knowledge, view *Knowledge Awareness Maps*, and exchange messages. This application contains a *Map generation module*, which generates the required information to build *Knowledge Awareness Map*. It passes this information to the *KA map visualization* module to display it graphically.
3. Visualize-KA-Map: It is an embedded flash object. Here, *Knowledge Awareness Map* is dynamically designed and displayed. The application is developed using Macromedia Flash ActionScript.

System Interface

After logging-in successfully, the system will redirect to *User Page* (Figure 3-a), where the learner can check the incoming messages. *New Messages Alert* list provides the learner with the new unread message. He can click on any message to read it then the read message will move to *Message History* list. The message takes the sign *(R)* after its title when the learner replies to this message.

Also, the learner can click on an educational material item in his own folder to get more information about it (such as its type, keywords, location). *User Page* is refreshed automatically every 30 seconds but the learner can refresh it any time by pressing *Refresh* button.

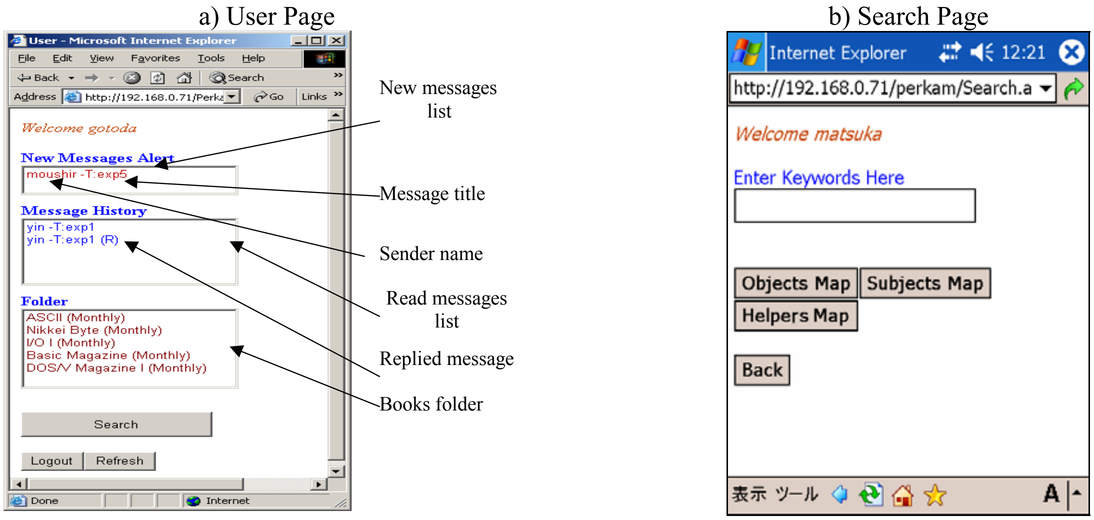

Figure 3. System Interface

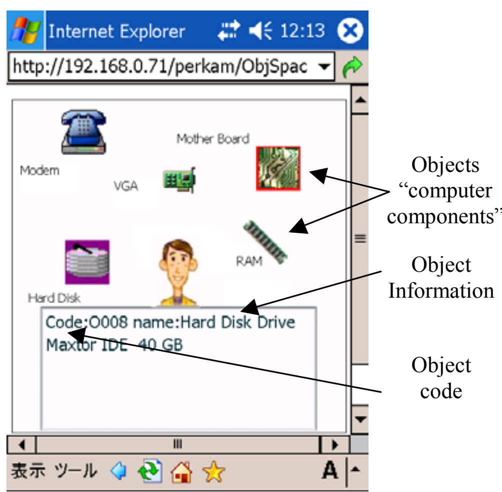

Figure 4. Environmental objects map

When the learner needs help, he can press *Search* button where the system will redirect to *Search* page (Figure3-b). In *Search Page*, the learner can enter some keywords that identify his request but he does not have to do that because the system can detect the environmental objects that he is using and translate it into a number of keywords that represent his query. In case of entering some keywords, these keywords will be combined with the detected environmental objects keywords to perform the learner's query.

If the learner presses on *Objects Map* button, he will see his *Environmental Objects Map* (Figure 4) where each object in the physical space is detected, recognized and presented graphically as an icon. The learner can recognize the object type from its icon shape. When the learner moves the pointer over any of these objects, the object information will appear in the text box located at the bottom of the map. The person's character represents the current learner who is doing a task and it indicates the learner's request.

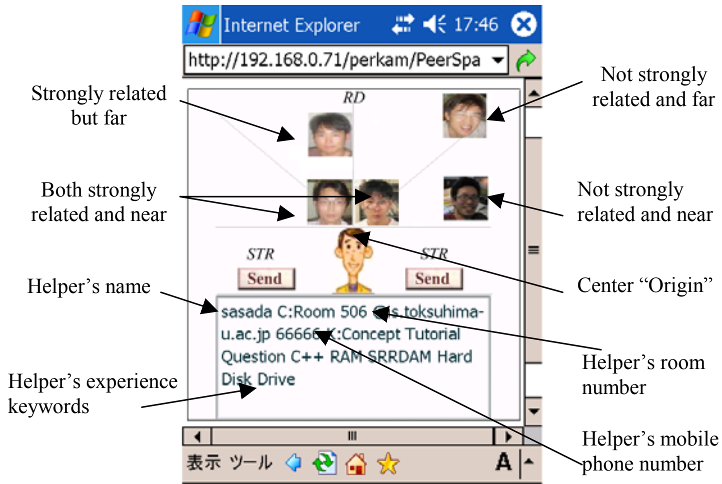

Figure 5. Peer helpers map

Returning to *Search Page*, if the learner presses *Helpers Map* button, the recommended *Peer Helpers Map* will be displayed (Figure 5), where each face represents one of the recommended peer helpers. The learner's name, information, and his matched interest keywords are displayed in the text box at the bottom of the map when the learner moves the cursor over his photo. The map shows how strong is the relation (*STR*) between the helper's knowledge and the learner's request in the horizontal dimension and how near his physical location is to the learner's location in the vertical dimension. Both left and right sides of the map have the same meaning. The best matched and nearest peer helper is the closest to learner's head (origin). The learner may select a suitable helper and press *Send* button then the system will redirect to *Mail Page* where he can send a message to this helper, attach his *Environmental Objects Map*, and ask the helper to reply to his question or to come to help him.

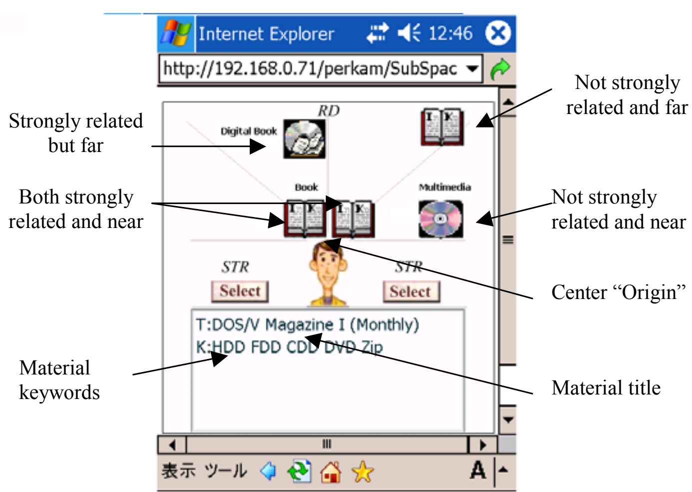

Figure 6. Educational materials map

Returning again to *Search Page*, if the learner presses on *Subjects Map* button, then *Educational Materials Map* will be displayed (Figure 6). He can click over any material icon to get its information in the text box under the map like, its title, keywords, and location. The learner can recognize the material type from its icon shape. The map shows how strong the relation (*STR*) is between the material content and his task in the horizontal dimension and how near its physical location is to his location in the vertical dimension. Both left and right sides of the map have the same meaning. The best matched and nearest peer material is the closest to learner's head (origin). The learner may select a suitable educational material, then the system will redirect to *Material Page* to get more information about it. It may be very close to his current location, so he can refer to it and complete his task.

System Evaluation

An experiment was done in order to evaluate the system usage, how much it can improve the learners' skills, and the learners' satisfactions. The proposed experiment is based on *learn by doing model*, where the teachers identify a specific set of skills to teach, embed that skill learning in a task, activity, or goal that the student will find interesting or motivational. Finally the teacher can evaluate the learner's understanding and skill according to the how much the learner successes to reach to the goal.

In this experiment, a teacher of computer hardware course is asking students to do tasks regarding personal computer assembling "examples of these tasks are illustrated in Table 1". Each student is given many hardware components. The teacher defines a fixed time to complete the task and to reach the final goal that the computer is working probably. The teacher supplies each learner with PDA connected to the wireless LAN and equipped with RF reader. While the learner tries to assemble the PC, he often has lack in some knowledge, for example, how to adjust a certain Hard Disk Drive (*HDD*) jumper to slave mode. In this case, he picks his PDA, and direct it to the location tag and all hardware components, then the *PERKAM* system detects his location and all environmental objects that surround him, and builds *Environmental Objects Map* (Figure 7). *Environmental Objects Map* represents each object by a small photo of the same object type in order to let it is easy for the learner to understand and recognize the physical objects. After building *Environmental Objects Map*, the learner can ask the system to recommend a number of related educational materials to refer, and peer learners who their interests and experiences are matching the information collected from the detected objects in order to collaborate and complete the task.

Table 1. Examples of the tasks

Name	Task
Task1	Plug a Hard Disk drive 40 GB as a Master device and a CD ROM as a Slave drive using one IDE cable.
Task2	Plug a Hard Disk drive 30.7 GB as a Master device and a CD ROM as a Master drive.
Task3	Plug an AGP VGA card 32 MB and 2x128 MB RAM.
Task4	Plug an AGP VGA card 16 MB and 1x256 MB RAM.

The Experimental Procedure

The main target of this experiment was to evaluate the learners' skills in PC assembling before and after using the system, and to measure how much they have learnt during using the system. This experiment consisted of five phases where16 students were involved. In its first phase the teacher asked each student to fill a questionnaire to evaluate his knowledge and experience about PC assembling, it included:

1. Learner's theoretical knowledge.
2. Learner's practical experiences.
3. Learner's references and his own educational materials.

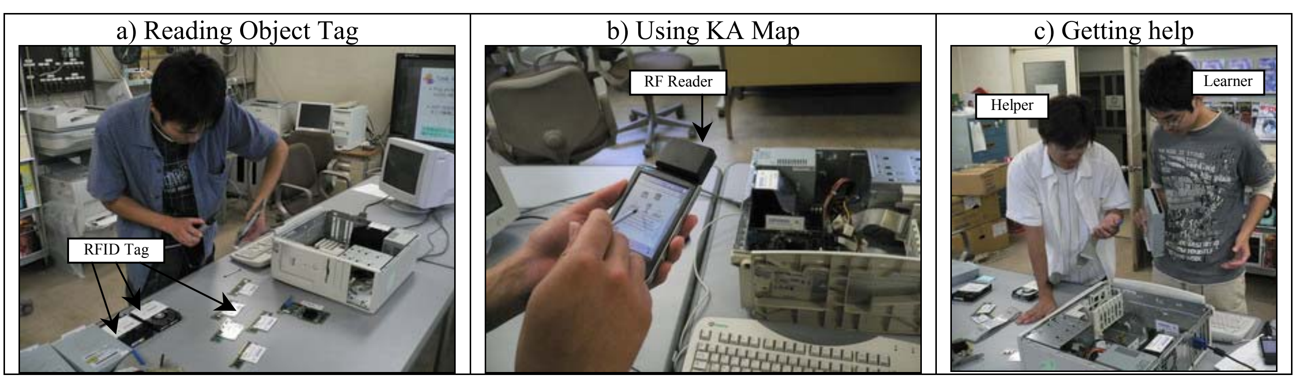

Figure 7. Using *PERKAM* system during the experiment

Depending on that questionnaire, the students were divided into two groups:
1. Experts group: 6 students who were experts and had a strong knowledge about PC assembling.
2. Learners group: 10 students who were beginners.

In the second phase, the teacher asked the experts group to do some tasks individually to be sure about their strong experiences in PC assembling. In the third phase, 5 students from the learners group were asked to do some tasks individually without using the developed system, and they were allowed to use an Internet connection to search for an appropriate material that may help them to complete the task in the fixed time (30 minutes). In the fourth phase, 9 students from the learning group (three of them were involved in the third phase and failed to do their tasks) were asked to do the tasks using *PERKAM* system, get recommendations and collaborate with the peer helpers to complete the tasks during the defined time, while the 6 expert students were asked to be online using *PERKAM* at different locations in the campus during their normal daily work, and to be ready to receive any message from the other learners. After completing the task, all students from both groups (experts and learners) were asked to fill in a questionnaire in order to measure the learner's satisfaction.

In the fifth phase after two months, all students who used the system in the fourth phase and successfully completed their task were asked to do their asks without getting any help to measure how much they have learnt while using the system.

Table 2. Sample of message dialog

Student	Message
A	I cannot understand. What does it mean Primary?
B	"Primary" is a plugging setting. What is the capacity of your task HDD?
A	The HDD capacity is 40GB.
B	Connect it to the motherboard in a place where "pri" small is written, and use one cable to connect both CDD and HDD.
B	Use the correct HDD; check its specification from the *Environmental Objects Map.*
A	I have plugged the two devices, what shall I do then?
B	After plugging in, you can find a teeny part called a "Jumper" adjust it as a Primary for the HDD and Slave for the CDD.
A	I cannot understand, could you please come now and show me how to do it?
B	Ok…

Results and Discussion

In the third phase of the experiment, 40% of the involved students (2 out of 5) hardly completed the task just in time (30 minutes) while getting help from related websites. They used search engines like *Google, Yahoo and AltaVista.* They entered some keywords to identify their requests such as, Primary, Slave, or SDDR RAM. Sometimes they entered wrong keywords, and other times the search results returned as unrelated websites.

In the fourth phase (while using *PERKAM* system), when the learners stopped doing their tasks because of shortage of some knowledge, they used the *Environmental Objects Map* to recognize the computer parts and tried to complete their tasks. If they still could not understand how to finish their tasks, they used *Peer Helpers Map* to get the system recommendation of the peer helpers. About 33% (3 out 9) of the learners depended on the *Environmental Objects Map*, while 67% (6 out 9) of the students asked for help from the recommended helpers in order to complete their tasks, where 66% (4 out 6) of them asked the peer helpers to come and interact face-to-face. They did not refer to any educational material and preferred to collaborate with the peer helpers other than to refer to the recommended education materials. They started to send messages using *PERKAM* message system, ask the peer helpers to recognize the computer components that they were using from their *Environmental Objects Map,* propose some questions, and try to use the helpers' answers to finish their tasks. Finally in case of failing to finish the tasks, they invited the helpers to come, interact face-to-face and to show them how to do that task. An example of message dialog between learner "A" who was doing Task1, and helper "B" is shown in Table 2.

In the fifth phase, 89% of the students (8 out of 9) completed their tasks during the allowed time. They did not get any kind of help. They depended only on what they have learnt while using *PERKAM* system before. It implies that there is obvious improvement of the students' knowledge and skills after and before using the system, and they have learnt and gained new experiences during using the system.

Table 3 illustrates the questionnaire results, from the answers of questions 1 and 2, it is clear that, all students agree that the system is easy to use and its performance is fast. From questions 3 to 6, the students indicate excellent understanding and a very effective use of *Knowledge Awareness Maps.* Questions 7 and 8 declare that most students prefer to collaborate with other learners to complete their tasks rather than to refer to related educational materials. From questions 9 and 10, it is clear that how efficient the system can recommend the peer helpers. Question 11 refers to the importance of the location dimension to recommend the peer helpers, where 50% of the students prefer to ask the helper to come and help them face-to-face, while the others prefer to communicate using the system email or the mobile phone. Questions 12 and 13 reflect the efficacy of using the system as a learning tool.

After completing the fifth phase, the learners were asked to score their skills improvement in the PC assembling. The average score was 91%. It indicates strong satisfaction of the learners for using the system as a learning tool. Also the peer helpers were asked about the main reason of offering their help and supporting the learners' requests with their experiences; 50% of them said that "they are looking forward to getting help from the learners in the future" while the others defined the main reason as, "they like to help any one". Both reasons guarantee keeping the collaboration between the students. Finally, some comments are given by the students to improve the system interface. The learners suggest allowing them taking photos and transferring them to the helpers, while the helpers recommend getting sound alerts when receiving new messages.

Table 3. The questionnaire results

Question	For (Learner/ Helper)	Agree Percentage	Disagree Percentage
1-Can you easily use the system?	Both	100%	0%
2-Is the system response time fast?	Both	100%	0%
3-Can you easily use *Knowledge Awareness Maps*?	Both	100%	0%
4-Can you easily get information about the computer components from the *Environmental Objects Map*?	Learner	100%	0%
5-Can you easily get information about the learner's surrounding computer components from the *Environmental Objects Map?*	Helper	100%	0%
6-Do you think that the *Environmental Objects Map* is useful to recognize the learner's problem?	Helper	100%	0%
7-Did you use only the *Environmental Objects Map* to complete your task?	Learner	33%	67%
8-Did you collaborate with a recommended peer helper to complete your task?	Learner	67%	33%
9-From whom have got peer helper recommendation, Can you get the suitable helpers related to your task from the *Peer Helpers Map*?	Learner	100%	0%
10-Do you think that the incoming message questions are suitable for your experiences?	Helper	100%	0%
11-Do you prefer to collaborate with the other learners face-to-face, or using the system email?	Both	50%	50%
12-Do you think that it is useful to use this system for learning?	Both	100%	0%
13-Have you learnt and got new experience while using the system?	Learner	100%	0%

Conclusion and Future Work

While a learner is doing a task to practice what he has learnt, he usually needs some help and instructions because of lack of some knowledge, but the problem is the difficulty for the learner to find the effective knowledge in time even if the source of this knowledge is very near to his physical location. In order to solve this problem a ubiquitous computing environment is presented to support the learner while doing a task, this environment is called *PERKAM.* It allows the learners to share knowledge, interact, collaborate, and exchange individual experiences. This environment provides the learners with *Knowledge Awareness Maps* that visualize the environmental objects space that surround the learner, the educational materials and the peer helpers' space. *PERKAM* recommends the educational materials according to how much their topics match with the learner's current task and how near their physical locations are to the learner's current location. On the other hand, it recommends the peer helpers according to how much their interests match with the learner's current task and how near are their locations to the learner's current location.

The experiment was done in order to evaluate the system usage, efficacy and the learner's satisfaction. The proposed experiment is based on *learn by doing model.* The experiment and the questionnaire results indicated that *Knowledge Awareness Map* is useful to understand the learner's situation and efficiently recommends the suitable peer helpers. Also, the results showed that it is useful to use the system in the collaborative learning and to improve the learners' knowledge and skills.

The proposed future work is to design more experiments to evaluate the system in different learning fields, add new features such as recommending video clips as learning materials, and to improve the peer helpers recommendation algorithm depending on the sameness between the learner's current situation and the peer helper's pervious situations.

References

Carroll, J., Neale, D., Isenhour, P., Rosson, M., & McCrickard, D. (2003). Notification and awareness: synchronizing task-oriented collaborative activity. *Journal of Human-Computer Studies, 58*(5), 605-632.

Chen, Y. S., Kao, T. C., Sheu, J. P., & Chiang, C. Y. (2002). A Mobile Scaffolding-Aid-Based Bird -Watching Learning System. *Proceeding of International Workshop on Wireless and Mobile Technologies in Education*, Los Alamitos: IEEE Computer Society, 15-22.

Cole, H., & Stanton, D. (2003). Designing mobile technologies to support co-present collaboration. *Personal and Ubiquitous Computing, 7*(6), 365–371.

Cui, Y., & Bull, S. (2005). Context and learner modeling for the mobile foreign language learner. *SYSTEM, 33*(2), 353-367.

Curtis, M., Luchini, K., Bobrowsky, W., Quintana, C., & Soloway, E. (2002). Handheld Use in K-12: A Descriptive Account. *Proceeding of the International Workshop on Wireless and Mobile Technologies in Education*, Los Alamitos: IEEE Computer Society, 32-30.

Dourish, P., & Bellotti, V. (1992). Awareness and coordination in shared workspaces. *Proceedings of Computer Supported Cooperative Work '92*, New York: ACM Press, 107-114.

El-Bishouty, M., Ogata, H., & Yano, Y. (2006a). Personalized Knowledge Awareness Map in Computer Supported Ubiquitous Learning. *Proceeding of the 6th International Conference on Advanced Learning Technologies*, Los Alamitos: IEEE Computer Society, 817-821.

El-Bishouty, M., Ogata, H., & Yano, Y. (2006b). Learner-Space Knowledge Awareness Map in Computer Supported Ubiquitous Learning. *Proceeding of the fourth IEEE International Workshop on Wireless, Mobile and Ubiquitous Technology in Education,* Los Alamitos: IEEE Computer Society, 116-120.

Fischer, G. (2001). User Modeling in Human-Computer Interaction. *Journal of User Modeling and User-Adapted Interaction, 11*(1/2), 65-86.

Fischer, G., & Konomi, S. (2005). Innovative Media in Support of Distributed Intelligence and Lifelong Learning. *Proceeding of the International Workshop on Wireless and Mobile Technologies in Education*, Los Alamitos: IEEE Computer Society, 3-10.

Hatano, G., & Inagaki, K. (1973*). Intellectual curiosity*, Chuo Koronsya Press.

Klaus, F., & Rachel, W. (2000). *RFID Handbook: Radio-Frequency Identification Fundamentals and Applications*, John Wiley & Sons.

Mitchell, K., & Race, N. J. P. (2005). uLearn: Facilitating ubiquitous learning through camera equipped mobile phones. *Proceedings of the Third IEEE International Workshop on Wireless and Mobile Technologies in Education 2005,* Los Alamitos: IEEE Computer Society, 274-281.

Ogata, H., Imai, K., Matsuura, K., & Yano, Y. (1999). Knowledge Awareness Map for Open-ended and Collaborative Learning on World Wide Web. *Proceeding of the International Conference on Computers in Education ICCE99*, 319-326.

Ogata, H., Matsuura, K., & Yano, Y. (1996). Knowledge awareness: Bridging between shared knowledge space and collaboration in Sharlok. *Proceeding of Educational Telecommunications 96*, 232-237, Retrieved June 7, 2007, from http://www-yano.is.tokushima-u.ac.jp/ogata/pdf/ed-media96.pdf.

Ogata, H., & Yano, Y. (2000). Combining Knowledge Awareness and Information Filtering in an Open-ended Collaborative Learning Environment. *The International Journal of Artificial Intelligence in Education, 11*, 33-46.

Ogata, H., & Yano, Y. (2004). Knowledge Awareness Map for Computer-Supported Ubiquitous Language-Learning. *Proceeding of the International Workshop on Wireless and Mobile Technologies in Education*, Los Alamitos: IEEE Computer Society, 19-26.

O'Malley, C. (1994). *Computer supported collaborative learning,* NATO ASI Series*,* Computer and Systems Sciences, 128.

Renda, M., & Straccia, U. (2005). A personalized collaborative Digital Library environment: a model and an application. *Journal of Information Processing and Management, 41*(1), 5-21.

Sakamura, K., & Koshizuka, N. (2005). Ubiquitous Computing Technologies for Ubiquitous Learning. *Proceeding of the International Workshop on Wireless and Mobile Technologies in Education*, Los Alamitos: IEEE Computer Society, 11-18.

Schank, C. (1995). What We Learn When We Learn by Doing. *Technical Report No. 60*, Northwestern University, Institute for Learning Sciences.

Song Y. (2006). What consequences have handheld educational uses brought about. *Proceeding of the International workshop on Mobile and Ubiquitous Learning Environments MULE in conjunction with ICCE2006*, Beijing, China, 1-7.

Lin Y., Swan K., & Kratcoski, A. (2005). Situated Learning in a Ubiquitous Computing Classroom, *Journal of the Research Center for Educational Technology,* Fall, Retrieved June 7, 2007, from http://www.rcetj.org/?type=art&id=3530&.

Yoo, Y., & Lyytinen, K. (2005). Social Impacts of Ubiquitous Computing: Exploring Critical Interactions Between Mobility, Context and Technology. *Journal of Information and Organization, 15*(2), 91-94.