Context-Aware Support for Computer-Supported Ubiquitous Learning

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Abstract

This paper describes a computer supported ubiquitous learning environment for language learning. This paper proposes two systems. The first is context-aware language-learning support system for Japanese polite expressions learning, which is called JAPELAS (Japanese polite expressions learning assisting system). This system provides learner the appropriate polite expressions deriving the learner's situation and personal information. The second system is called TANGO (Tag Added learNinG Objects) system, which detects the objects around learner using RFID tags, and provides the learner the educational information. This paper describes the preliminary evaluation of those two systems.

1. Introduction

Context-aware computing [1] will help in the organization and mediation of social interactions wherever and whenever these contexts might occur [6]. Its evolution has recently been accelerated by improved wireless telecommunications capabilities, open networks, continuous increase in computing power, improved battery technology, and the emergence of flexible software architectures. With those technologies, an individual learning environment can be embedded in daily real life. The main characteristics of ubiquitous learning are shown as follows [3,4]:

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 answer later.

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 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 notice the features of problem situations that make particular actions relevant.

Moreover, ubiquitous learning can be Computer Supported Collaborative Learning (CSCL) [10] environments that focus on the socio-cognitive process of social knowledge construction and sharing.

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 [5]. A ubiquitous computing environment enables people to learn at any time and any place. Nevertheless, the fundamental issue is how to provide learners with the 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, this paper focuses on learning polite expressions in Japanese as an application domain of CSUL, because Japanese polite expressions are strongly influenced by situations. This paper proposes the context-aware language-learning support system called JAPELAS (Japanese Polite Expressions Learning Assisting System). Users of this system are overseas students of Universities in Japan, who want to learn Japanese Language. They always use PDA (Personal Digital Assistant), and JAPELAS provides the learners the appropriate polite-expressions in the context.

It is very difficult for overseas students to learn Japanese polite expressions because the expressions change in a complicated way according to the context, e.g. hyponymy, social distance, and the formality of conversation scenes. Moreover, the feeling of social distance in Japan often varies from that in the learner's country. This difference may result in misunderstanding for the overseas students. Therefore, it is very important for the learners to understand the social situation in Japan, and how to use polite expressions properly and accordingly. This paper describes the elements that cause the changes of the polite expressions, how the system has been developed, and the initial experimentation of this system.

As for the previous research, Yano and Ochi [12] developed the knowledge base system for Japanese polite expression learning, which is called JEDY (Japanese Expressions Dictionary system). JEDY is an online dictionary for supporting the learning of changes in polite expressions. After the user inputs the information of the conversational partner, the relationship, and the situation, JEDY shows the learner the appropriate examples in that situation. In order to construct an understanding of language, conversation with other people in daily life is very important. In this process, actively pursuing (designing) knowledge rather than passively consuming it is also essential [11]. Therefore, this paper tackles with context-aware support in the conversation in everyday life without any input of the context information.

This paper also proposes TANGO (Tag Added learNinG Objects) System for vocabulary learning. At the beginner’s class of language learning, a label that has 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 system is that 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. The tags bridge authentic objects and their information in the virtual world. TANGO system detects the objects around the learner using RFID tags, and provides the learner with the right information in that context.

Radio frequency identification (RFID) is a simple concept with enormous implications. Put a tag - a microchip with an antenna - on a can of Coke or a car axle, and suddenly a computer can "see" it. Put tags on every can of Coke and every car axle, and suddenly the world changes. No more inventory counts. No more lost or misdirected shipments. No more guessing how much material is in the supply chain - or how much product is on the store shelves. The Auto-ID Center [14] is designing, building, testing and deploying a global infrastructure - a layer on top of the Internet - that will make it possible for computers to identify any object anywhere in the world instantly. This network will not just provide the means to feed reliable, accurate, real-time information into existing business applications; it will usher into a whole new era of innovation and opportunity. On the other hand, the Ubiquitous ID Center [15] aims to establish and spread core technology to automatically recognize "things", and eventually realize a ubiquitous computing environment. This paper presumes objects in the real world have ID tags, and computers can easily identify them.

2. USCL (Computer Supported Ubiquitous Learning)

2.1 What is CSUL?

CSUL (Computer Supported Ubiquitous Learning) is defined as 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 [6]. The CAL (computer assisted learning) systems using desktop computers are not embedded in the real world, and are difficult to move. 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 the learning at anytime and anywhere. In this situation, however, computers are not embedded in the 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 small devices such as sensors, pads, badges, and so on, are embedded and communicate mutually. Pervasive learning environments can be built either by embedding models of a specific environment into dedicated computers, or by building generic capabilities using computers to inquire, detect, explore, and dynamically build models of the environments. However, this makes availability and usefulness of pervasive learning limited and highly localized.

Finally, ubiquitous learning has integrated high mobility with pervasive learning environments. While the 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, both pervasive learning and mobile learning would be in the category of ubiquitous learning. RFID tags are often used to realize pervasive computing.

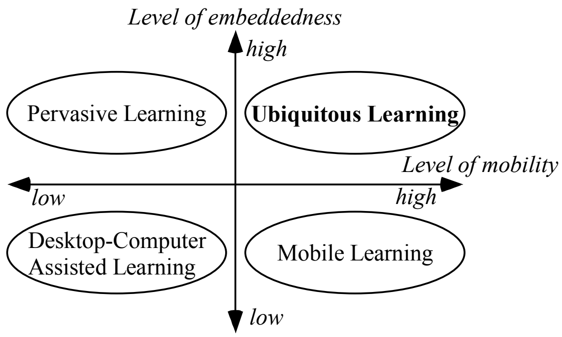


Figure 1. Comparison of learning environments (based on [6]).

2.2 Learning Theories for CSUL

CSUL is advocated by pedagogical theories such as on-demand learning, hands-on or minds-on learning, and authentic learning [8,9]. 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, incidental, and experimental learning [13]. 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 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 similar way 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 to a great discovery. Learners discover something while they are doing something else in the process; therefore, it is considered as surprised by product. Knowledge from incidental learning develops self-confidence and increases self-knowledge in learning.

There are three forms of experimental 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 others, 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. We believe authentic learning in everyday life is very important because learners construct an understanding of Japanese polite expressions.

Miller and Gildea [7] worked on vocabulary teaching, and described how children are taught words from dictionary definitions and a few exemplary sentences. They have compared this method with the way vocabulary is normally learned outside school. People generally learn words in the context of ordinary communication. This process is startlingly fast and successful. Miller and Gildea [7] note that by listening, talking, and reading, the average one year-old learned vocabulary at a rate of a 5,000 words per year (13 per day) for over 16 years. By contrast, learning words from abstract definitions and sentences taken out of the context of normal use, which is how vocabulary has often been taught, is slow and generally unsuccessful. There is barely enough classroom time to teach more than 100 to 200 words per year. Moreover, much of what is taught turns out to be almost useless in practice. Therefore, we believe that it is very important to support vocabulary learning in everyday life with ubiquitous computing technologies.

3. JAPELAS

3.1 Japanese polite expression

Generally, learning the four skills (reading, writing, hearing, and speaking) are main objectives in language learning. It is a main aim of a beginner's class to learn honorific expressions especially for the learner's daily life. However, recently it is important to learn not only vocabulary, pronunciation and grammar of the target language, but also the cultural knowledge in order to have good communication with the native speakers. In Japanese language, learning, polite expressions relate to Japanese culture closely. Using polite expressions, Japanese people usually adapt the manner of speaking to suit the situation. However, it is difficult for the overseas students to use the polite expressions because these expressions change according to the context. If polite expressions are not used properly, they might sound comical and strange. Moreover, it might lead to misunderstanding in conversation. Therefore, it is very important for foreigners to have the solid understanding of the context of conversation.

Table 1: Level of Japanese polite expressions and its example.

Level	Example(tell)
Casual	しゃべる
Basic	言う
Formal	おっしゃる，申す
More formal	お話になる，申し上げる

3.1.1 Level of politeness

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 from the speaker. For example, for the Japanese word "hanasu" that means “tell”, the honorific equivalent is “ossharu," and the modest one is "mousu." The alteration of Japanese polite expressions usually occurs in the verb, noun, adjective, and adverb. Moreover, there are four polite expression level (PEL), which are casual, basic, and formal. Table 1 shows an example of PEL and Japanese sentences. There are two kinds of changing patterns: the first one is irregular change to a different word; the second one is regular change incorporating a prefix and/or postfix word. According to the former, there is no limitation or pattern like an irregular verb. The students usually learn only the basic form in the Japanese language class. This makes Japanese expressions difficult for the overseas learners.

3.1.2 The factors of changes of Japanese polite expression

There are three factors of changes in Japanese polite expressions (Table 2).

Table 2: Factors of changes in Japanese polite expressions.

Factor	*Elements*
Hyponymy	affiliation, age, position (social status)
Social distance	colleague, friends, relatives
Formality	ceremony, party, meeting (scene)

Table 3: Hyponymy rule.

Affiliation	*Position*	*Age*	**Hyponymy**
Same (group, department, or organization)	Upper	Any	Upper
	Same	Upper	Upper
	Same	Same or lower	Same
	Lower	Any	Lower
Different	Upper	Any	Upper
	Same	Same or lower	Same
	Lower	Any	Lower

Table 4: Social distance rule.

Affiliation	*Social relation*	*Social distance*
Same	Any	Inside
Different	Relatives, friend	Inside
	Others	Outside

Table 5:JAPER rule

Formality	*Hyponymy*	*Social distance*	**Level of Polite expressions**
Formal	Any	Any	More formal
Informal	Any	Outside	Formal
	Upper	Inside	Formal
	Same	Inside	Basic
	Lower	Inside	Casual

(i) Hyponymy: Generally, people 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 a 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).

3.1.3 Rules for changes of Japanese polite expression

The learner must understand not only vocabulary but also the situations to use the right polite expression. This paper proposes JAPER (Japanese polite expression rule) to provide an appropriate level of expressions (formal, basic, or casual) according to the situation (see Table 5). This system has social distance rule, hyponymy rule, and JAPER (Japanese Polite Expressions rule). The hyponymy-rule derives the social relation of the standing speaker and the listener focusing on their affiliation, position, and age. The social distance rule derives a degree of intimacy focusing on their affiliation and friendship. In the JAPER, the formality is divided into "formal" and "informal". Finally, the JAPER derives the level of polite expressions: formal, basic, and casual.

3.2 Implementation

We have developed the prototype system of JAPELAS on a PDA (Toshiba Genio-e) with Pocket PC 2002, infrared data communication port, RFID (Radio Frequency Identification) tag reader/writer, GPS, and wireless LAN (IEEE 802.11b). The program has been implemented with Embedded Visual C++ 3.0. As shown in figure 2, JAPELAS has the following modules:

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 this system, each learner enters those data. In addition to the explicit method like this, JAPELAS detects learner's comprehensions during the system use. Moreover, this system records the information of the other learners whom the leaner have met. The learner can use this information for individual learning. By selecting someone as a conversational partner, the learner can learn polite expressions alone through the simulation.

Environmental model: This module has the data of rooms in a certain area. The room is detected in the location manager using RFID tag and GPS. The location is used to determine the formality. For example, meeting rooms are included informal situations. If the learner enters a meeting room, more formal expressions are provided there without reference to hyponymy and social distance.

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

IR communication: IR requires no fixed infrastructure and no configuration. In addition, IR simplifies the designation of communication targets. Instead of entering target names, users can point to the person.

Location manager: With RFID tags and GPS, this module detects the learner's location, e.g. store, private room, home, etc. RFID tags are used indoors, while GPS is for outdoors. RFID tags are attached in the entrance doors in the room, and identity the rooms.

Polite expression recommender: Based on polite expression rules, this module provides the appropriate expression at the situation.

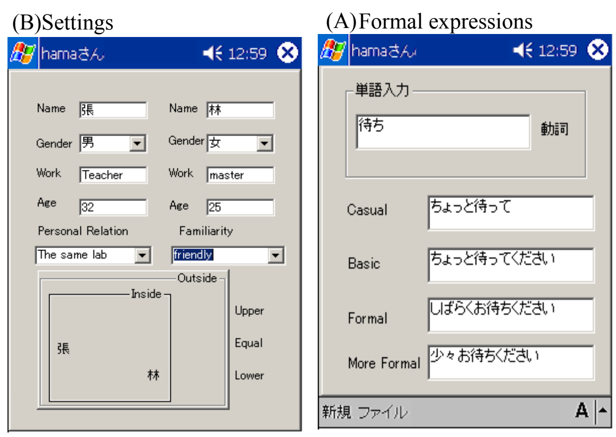


Figure 2: User Interface of JAPELAS

3.3 User Interface

As shown in figure 2, the users input their individual personal data, e.g., name, gender, work, age, relationship etc. When the user talks to a conversational partner, the system gets the information of the person via the infrared data communication of PDA as shown in (B) settings window, and then it suggests the suitable polite expressions for the user as shown in (A) expression window. In this case, the system recommends the user to use formal or more formal expressions. The data of the partners is stored into the database in order to facilitate personal learning. The user can select one person from the database, and s/he can simulate the conversation.

Figure 3 shows a scene of learning polite expressions with JAPELAS. 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. That is because Mr. X is older than Mr. Z. On the other hand, when Mr. X turns to Mr. Y in order to talk, the system tells Mr. X a formal expression. That is because the year of Mr. X is lower than the year of Mr. Y.

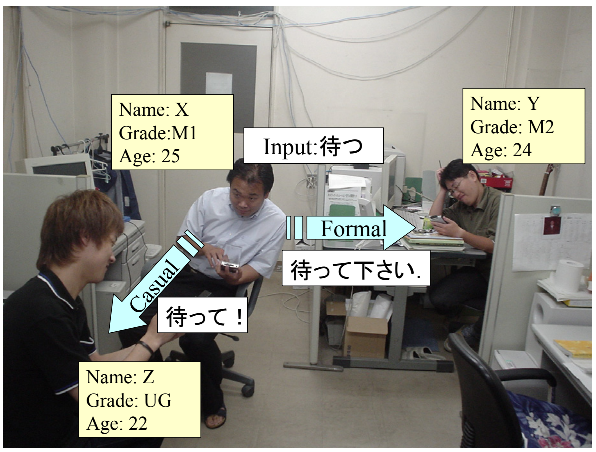


Figure 3: Usage Scene of JAPELAS.

3.4 Experimentation

We arranged 18 users to evaluate JAPELAS with questionnaire. The average of the users' age was 16.9. The users were high school students, 16 boys, and 2 girls that did not have a PDA. However, 56 percent of the users had their own computers. The user played a role, e.g. teacher, elder brother, father, guest, etc who were given by us. The user played one role of them, walked in the room, and randomly made a pair for the conversation (see figure 4). When the user begun the conversation, JAPELAS helped him/her use the right polite expressions. The user could sometimes change the role, and totally used JAPELAS for 30 minutes. After the experimentation, they gave a number between one and five to each of nine questions, with one being the lowest, and five being the highest. The average of the points was 3.78. Table 6 shows the results of the questionnaire. According to Question (1), the system provided the appropriate information for the users. Question (2) didn't obtain a good point. That is because this experiment was the first time for all the users to use PDA. We should have carefully explained them how to use it.

In terms of language learning, question (3) shows this system was quite useful for it. A learner gave a comment that this system was easy to understand the appropriate level of politeness by changing roles and situations. From the results of question (4), we should make the response of the system a little faster. Question (5) and (6) show the users were very interested in this system, and liked to keep using it. Some learners commented that they could learn how to use polite expressions using this system. In Japan, there is a social problem that some of young people cannot use appropriate polite expressions. Therefore, we found this system is very useful even for Japanese people.

Figure 4: Scene of experimentation with JAPELAS.

Table 6: The results of questionnaires.

No.	Questionnaire	Ave.	S.D.
Q1	Did this system provide appropriate polite expressions?	4.06	0.80
Q2	Do you think this system easy to use?	3.06	0.94
Q3	Do you think this system useful for language learning?	4.06	0.54
Q4	Is the response of this system is adequate to use?	3.28	1.27
Q5	Do you think this system very interesting?	4.11	0.68
Q6	Do you want to keep using this system?	4.11	0.58

4. TANGO

4.1 Implementation

We have developed the prototype system of TANGO, which works on a Toshiba Genio-e PDA with Pocket PC 2002, RFID tag reader/writer (OMRON V720S-HMF01), and wireless LAN (IEEE 802.11b). RFID tag reader/writer is attached on a CF (Compact Flash) card slot of PDA as shown in Figure 2. The tag unit can read / write RFID tags within 5 cm distance, and it works with a wireless LAN at the same time. The TANGO program has been implemented with Embedded Visual Basic 3.0.

TANGO has the following modules:

Learner model: This module has the learner's profile such as name, age, gender, occupation, interests, etc, and the comprehensive level of each word or each expression about an object. Before using TANGO, the learner does the examination, and enters the comprehensive level. In addition to this explicit method, TANGO detects learner's comprehension during the system use.

Environmental model: This module has the data of objects, rooms and buildings, and the link between objects and expressions in the learning materials database.

Educational model: This module manages words and expressions as learning materials. The teacher enters the fundamental expressions for each object. Then, both learners and teacher can add or modify them during system use.

Communication tool: This tool provides the users with a BBS (bulletin board system) and a chat tool, and stores their logs into a database.

Tag reader/writer: This module reads the ID from a RFID tag attached to an object. Referring to the ID in the object database, the system obtains the name of the object.

User interface: This module provides learner questions and answers.

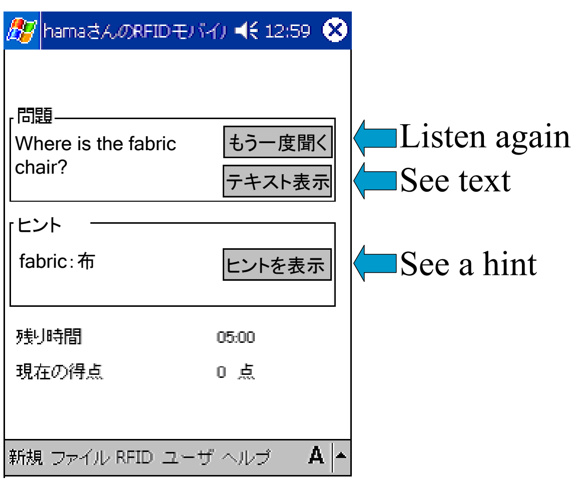
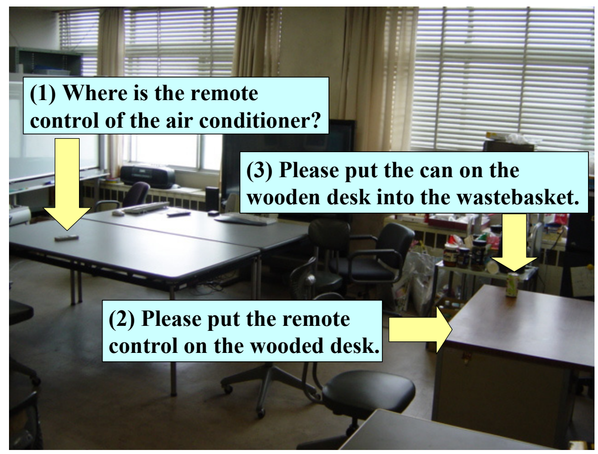


Figure 5. Screen snapshot of TANGO.

4.2 Interface of CLUE

The interface of the learning environment TANGO is shown in Figure 5. Figure 6 shows an example of a room where RFID tags were attached to some objects for this system. TANGO system asks a question 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 the question "Where the remote control of the air conditioner is?". The leaner can hear the question again if s/he wants. Moreover, the learner can see the text and hints. If the leaner scans the tag labeled on the remote control, the answer is correct. Then the system will ask to put it on the wooden desk. This way, the interaction between the learner and the system goes on.

Figure 6: Inquiries from TANGO in a room.



4.3 Experimentation

We arranged six high school students to evaluate TANGO with a questionnaire. The average of the users' age was 16. The users had no PDA, and 50 percent of them had their own computers. We explained them how to use the PDA, before they used TANGO. Each user looked for objects in the room according to the questions read aloud by the PDA. For example, if the question was where the fabric chair was in the room, and the user scans the RFID tag of the chair, the user gets the point. Otherwise, the user loses the point. Users competed against each other for getting the points. After the experiment, they gave a score between one and five to each of nine questions, with one being the lowest, and five being the highest. The average score was 3.78. Table 7 shows the results of the questionnaire. According to question (1), some of the users felt that the questions were difficult. Question (2) shows that TANGO system is not so easy to use. That is because this experiment was the first time for all the users to use a PDA. However, the user interface should be improved for the novice user who does not have her/his own PDA.

In terms of language learning, question (3) shows that TANGO was quite useful for it. One of the learners commented that with this system, it was easy to understand the terms by their correspondence with authentic objects. From the results of question (4), we should make the response of the system a little faster. The questions (5) and (6) show the users were very interested in this system, and that they would like to keep using it. Some learners commented that they had a feeling of achievement.

Table 7: The results of questionnaires.

No.	Questionnaire	Ave.	S.D.
Q1	Were the questions provided by this system difficult?	3.33	0.52
Q2	Do you think this system easy to use?	3.33	1.03
Q3	Do you think this system useful for language learning?	4.17	0.41
Q4	Is the response of this system is adequate to use?	3.67	0.52
Q5	Do you think this system very interesting?	4.33	0.52
Q6	Do you want to keep using this system?	3.83	0.75

5. Conclusions

This paper described a context-aware language-learning support system for Japanese polite expressions learning, which is called JAPELAS. JAPELAS provides the right polite-expression that is derived from hyponymy, social distance, and situation through the identification of the target user and the place. The experiment showed JAPELAS was very useful to learn Japanese polite expressions. Moreover, this paper described TANGO system, which detects the objects around the learner using RFID tags, and provides the learner with the educational information. In the experiment, the learner played the game of TANGO, and was very interested in this system.

As for the future work, this system requires the user to input the verb s/he wants to speak. Therefore, we will try to adapt natural language interface to detect the verb in the future research without any input from the user. In addition, software agent will be introduced as conversational partners. The agent will enable collaborative learning when learner is alone. Moreover, formality should be detected from not only location but also the time schedule. For example, meeting rooms are not always in conference.

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