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Knowledge Augmentation for Experiential Learning in Fieldwork

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Abstract: The main issue addressed in this paper is how to augment knowledge to be learned through experiences in fieldwork. Our approach to this issue is to provide learners with awareness (Unknown Awareness UA for short) of information after their learning, which has not been obtained during the fieldwork and which is unknown to them, and to help them augment their experiential knowledge with the UA information. This paper demonstrates a knowledge augmentation system, which automatically generates a Web album with the map showing the fieldwork route followed and locating the photos/memos taken during the fieldwork from the experience log made with GPS and digital camera. The system appropriately extracts UA information related to the experience log from the Web to present it on learners' demand in the user interface. The results of the case study suggest that UA information tends to promote augmentation of experiential knowledge.

Keywords: Knowledge augmentation, experiential learning, unknown awareness, fieldwork, Web

Introduction

Learning from experience could often strengthen knowledge to be learned [2]. In fieldwork investigating historical spots, for example, learners visit and interact with environments around the spots to gain experiences of looking at, touching, and feeling the real spots. Such experiences would allow them to strengthen knowledge learned about the spots compared with learning from books/textbooks describing the spots. We call such learning from experiences experiential learning. Knowledge obtained from experiences is also called experiential knowledge.

This paper addresses an issue of how to facilitate experiential learning process in fieldwork. Current work on supporting experiential learning provides several learning technologies (LT) that can be classified into three: LT for pre-experience, LT for experience, and LT for post-experience. LT for pre-experience aims at presenting useful information before getting experiences, which helps learners plan their fieldwork. LT for experience aims at presenting instructive information in real time during fieldwork with mobile or ubiquitous devices. LT for post-experience aims at helping learners reflect on their experiential learning process by means of fieldwork log.

On the other hand, experiences are not often gained as planned due to some accidents, time constraints, etc. During fieldwork, learners often fail to notice knowledge that could be obtained from useful and instructive information to be given by LT for pre-experience/experience. They would accordingly finish their experiential learning with insufficient knowledge. Without careful consideration of the fieldwork contexts, in addition, experiential knowledge obtained would be dispersed.

Towards resolving these problems, this paper proposes a LT for post-experience that provides learners with awareness of information after their fieldwork, which has not been obtained during the fieldwork and which is unknown to them, to augment their experiential knowledge with the information. Such awareness is called unknown awareness UA for short [3], and the information bringing about UA is called UA information. Although related work on LT for post-experience focuses on facilitating reflection on experiential learning process or on sharing experiences [4,5], this paper aims at scaffolding such knowledge augmentation in reflecting on experiential knowledge obtained in the fieldwork. This is the novel point in the proposed learning technology.

In this paper, we also demonstrate a knowledge augmentation system called ReTrip. Retrip automatically generates a Web album with the map showing the fieldwork route a learner followed and locating the photos/memos (representing experiential knowledge) he/she took during his/her fieldwork, which are obtained from the log made with GPS logger and digital camera. In addition, ReTrip extracts UA information related to the log from the Web to present it on his/her demand in the user interface. The learner can select and put it into the map to augment his/her experiential knowledge. From a case study with ReTrip, we have ascertained the possibility that UA information promoted augmentation of experiential knowledge.

1. Knowledge Augmentation

1.1 Experiential Knowledge

In general, knowledge obtained from experiences is retained better rather than knowledge obtained from books/textbooks [1]. It is also retained with the contextual information related to the experiences such as time, place, weather, and so on, which could function as indexes for recollecting the experiential knowledge.

If learners are provided with the UA information after experiential learning, they could assimilate it into their experiential knowledge. Such knowledge assimilation would be promoted according to the closeness between the UA information and their experiential knowledge [6].

The UA information is also expected to bring about effects of assimilation into experiential knowledge on knowledge augmentation and recollection. The knowledge augmentation effects are classified into the following three:

(1) experiential knowledge could be deepened if the UA information complements it (**knowledge deepening effect**),
(2) experiential knowledge could be widened if the UA information includes the one about the neighborhood of it (**knowledge widening effect**), and
(3) experiential knowledge could be strongly connected if the UA information includes the relationships among pieces of it (**knowledge restructuring effect**).

The reflection effect is as follows. Once the UA information is assimilated, it functions as new indexes for recollecting the experiential knowledge, which would make the recollection process more easily because the indexes increase [1].

On the other hand, the assimilation process does not always occur. Even if useful UA information is presented to learners, it could not be assimilated without recollecting the corresponding experiential knowledge. In addition, it does not occur when the relationship between the UA information and the experiential knowledge is unclear to the learners.

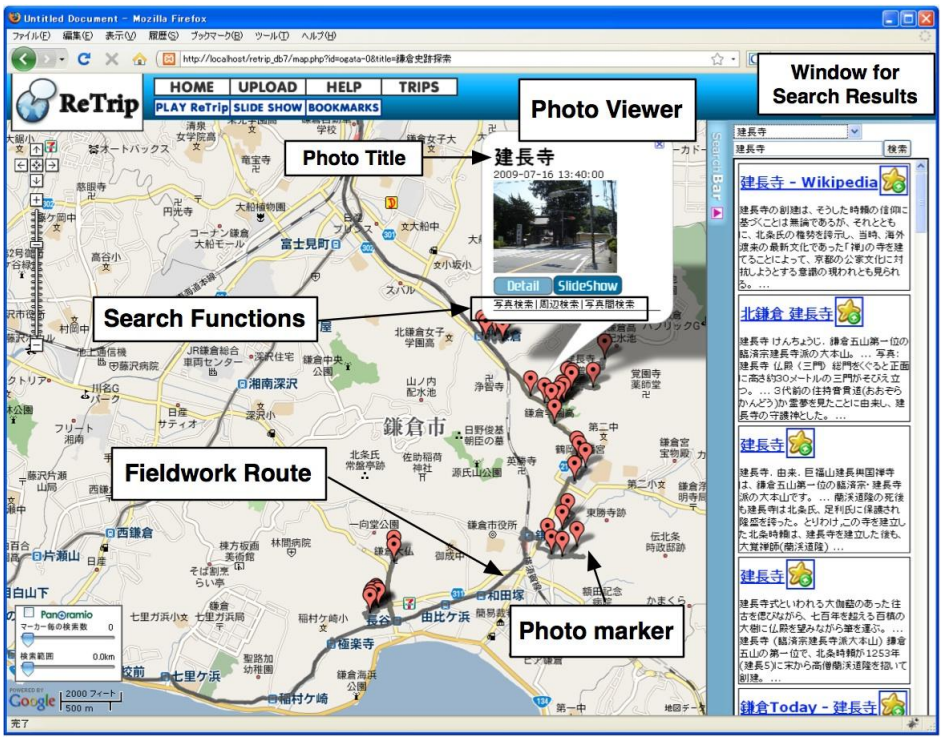

Figure 1. User Interface of Retrip.

1.2 Model

In order to promote the assimilation process, it is necessary to encourage leaners to recollect their experiential knowledge. It is also necessary to make it clear to them that the UA information is closely related to their experiential knowledge.

In this paper, we have accordingly built a model of knowledge augmentation with UA information. In this model, learners are first expected to recollect their experiential knowledge with the contextual information presented. In the recollection process, the UA information closely related to the experiential knowledge is presented. The learners are also expected to notice the relationship between the presented UA information and their recollected knowledge to increase UA, which could motivate them to assimilate the UA information into the recollected knowledge. The UA information would bring about its own knowledge augmentation effect.

2. Retrip

2.1 Framework

Following the knowledge augmentation model, we have developed Retrip. Retrip aims to augment experiential learning process executed in fieldwork investigating historical spots. Such fieldwork generally involves making a route of visiting a number of historical spots and investigating background and history of each spot to integrate knowledge learned from it into experiential knowledge. In order to log the fieldwork process, Retrip requires a learner to carry a GPS logger, digital camera during the fieldwork to take photos for learning the spots. He/she is also required to take a memo for supplementing each photo, and to include the title of the photo in the memo. The fieldwork route is logged by the GPS logger. In Retrip, the photos and corresponding memos taken are viewed as representation of his/her experiential knowledge obtained from the fieldwork.

After the fieldwork, Retrip requires the learner to input the fieldwork log. It then generates a Web album automatically with the map showing the fieldwork route and locating the photos/memos. Figure 1 shows the user interface of Retrip. Such map-based album enables the learner to recollect the contexts of fieldwork and experiential knowledge obtained in the fieldwork route.

Presenting the map-based Web album, Retrip extracts UA information related to the fieldwork log from the Web, which includes the photo titles, keywords in the memos, and the coordinates specified by the GPS logger where the photos were taken. Currently we restrict Web resources for extracting UA information to the ones that are more reliable and that officially describe the historical spots visited in the fieldwork.

Such extracted UA information is selected on the learner's demand in the map-based Web album, which makes it easier for him/her to notice the relationship between the UA information and his/her experiential knowledge. He/she is also expected to assimilate it into the album, which contributes to augmenting his/her experiential knowledge. The assimilated UA information is displayed in a distinctive form on the album.

In the following, let us explain functions for knowledge augmentation.

2.2 Recollection

The map-based Web album is generated from the fieldwork log via Google Maps API [7]. As shown in Figure 1, the fieldwork route is displayed in grey line, and the photos are represented as red markers that are put in the points where they were taken. When a learner mouse-clicks any marker on the map, he/she can have a photo viewer including the corresponding photo, photo title, and link (represented as *Detail* button) to the memo contents. This viewer also has another button called *SlideShow*, which allows him/her to in sequence browse the photos taken before or after taking the current photo.

Such map-based Web album could visualize the contextual information in the fieldwork, which includes the time sequence of the fieldwork, the geographical relationships among the locations where he/she learned about the historical spots, and the locations where he/she visited/learned but did not take photos.

2.3 UA Information Extraction

The UA information is classified into three types, which are UA information related to the photo title and [illegible] lation about the neighborhood of [illegible] mation about the relationship betw[illegible] otos. These types of UA informat[illegible] edge Deepening, Knowledge Wide[illegible] gly call these UA information type[illegible] rovides a learner with search funct[illegible] hich are provided as buttons in the [illegible]

When the le[illegible] extracts the photo title in the photo[illegible] of the memo by means of API for [illegible] loper network [8], whose API score[illegible] rip then makes a keyword list inclu[illegible] three keywords.

Selecting o[illegible] arch between the title and the keyw[illegible] . He/she can also

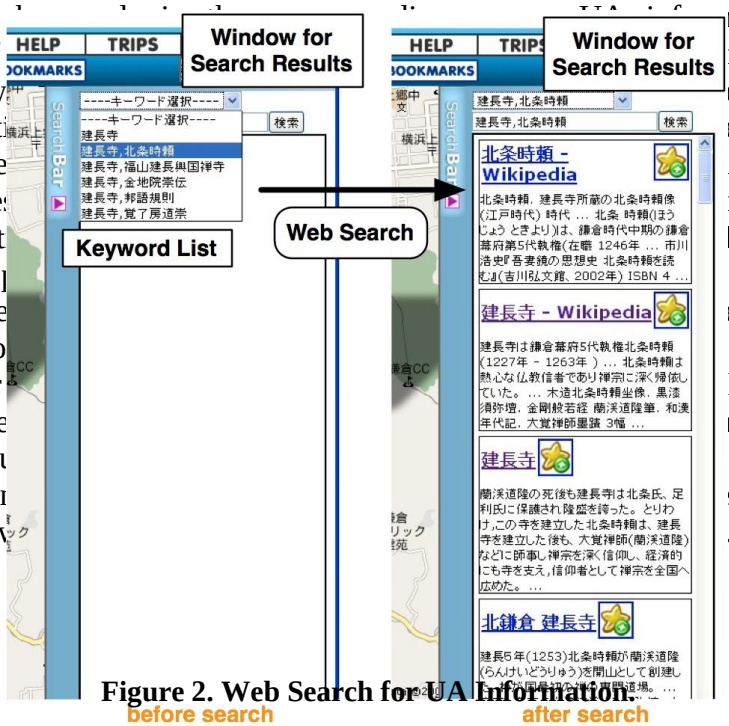

Figure 2. Web Search for UA Information.

select and browse a candidate of the UAinfo-KD from the window of search results to increase the UA. Each candidate in the window has a star-shaped bookmark icon as shown in Figure 2. The learner can mouse-click a bookmark icon to assimilate the bookmark into the photo viewer. In this way, he/she is expected to deepen his/her experiential knowledge represented in the photo/memo with the Web page contents indicated by the bookmark.

Search for UAinfo-KW is divided into landmark and Panoramio search. In the landmark search, Retrip extracts the names of landmarks near the location where a photo was taken by means of the local search API presented by Yahoo! developer network [8]. In the same way as search for UAinfo-KD, Reptrip then makes a keyword list from the names to provide the learner with the AND search for extracting the UAinfo-KW about the landmarks.

In the Panoramio search, Retrip uses the Panoramio photo-sharing service presented by Google [9] to search photos submitted to the Panoramio, which were taken around the photo location in the Web album, to locate them as distinctive Panoramio markers. When the learner mouse-clicks any Panoramio marker, he/she can have a viewer for the Panoramio photo, which is similar to the photo viewer. In selecting the *Keep It* button in the viewer, he/she can assimilate it into the album. Such UAinfo-KW expects the learner to widen his/her experiential knowledge by assimilating it into the Web album.

In the same way as search for UAinfo-KD, Retrip makes a keyword list including the combination of the keywords obtained from two photos the learner selects in the Web album. He/she can conduct the AND search for extracting UA information related to the two photos. Such UAinfo-KR expects the learner to reconnect experiential knowledge obtained from the historical spot related to each photo, which would contribute to restructuring and strengthening his/her experiential knowledge.

Figure 3. Assimilation of UA Information.

2.4 Knowledge Assimilation

Figure 3 shows the Web album with assimilated UA information. In the window of the search results presenting UA information candidates, the learner can mouse-click any bookmark button to assimilate it into the photo viewer he/she drives. As for the landmarks assimilated, Retrip also puts the landmark markers in the corresponding location. In the

Panoramio search, the Panoramio photo mouse-selected are put as new markers in the corresponding location.

3. Case Study

3.1 Purposes and Procedure

In order to ascertain how the UA information provided by Retrip could be assimilated, and whether the assimilated UA information could bring about effects of the assimilation on knowledge augmentation and recollection of experiential knowledge, we have conducted a case study as follows.

We prepared three sessions that were fieldwork, Retrip, and post-test sessions. Participants were five graduate and undergraduate students in science and technology. All participants had an experience of using Retrip in another preliminary fieldwork.

In the fieldwork session, we required each participant to visit the city of Kamakura, which is one of the most historical cities in Japan, to investigate and learn about background and history of the historical spots and sights for five hours with GPS logger, digital camera, and memo. The starting and terminal points of the fieldwork route were fixed in JR (Japan Railways) Kamakura station. The participant made his/her own route for visiting the spots and sights. After fieldwork, the participant was required to input the fieldwork log into Retrip, which was obtained from the GPS logger, digital camera, and memos he/she took.

In the next day, we conducted the Retrip session. In this session, the participant was required to use Retrip to look all over the fieldwork route and drive the photo viewer to review and recollect his/her experiential knowledge learned in the fieldwork. The participant was also required to search and browse the UA information to be extracted from the prepared six Web resources including Wikipedia and reliable resources about Kamakura, and to assimilate useful UA information on his/her demand into his/her Web album. The time limit given was two hours.

We then conducted the post-test session two days later from the Retrip session. In this session, the participant was given two problems that were reproduction problem and recollection problem. The purpose of the reproduction problem was to ascertain whether his/her experiential knowledge was augmented with the assimilated UA information. The purpose of the recollection problem was also to ascertain whether the assimilated UA information functioned as indexes for recollecting his/her experiential knowledge.

In order to make a reproduction problem for each participant, we selected four photos from his/her Web album, which were not adjacent each other on the fieldwork route. We also selected two UA items (bookmark or Panoramio photo) of UAinfo-KD/KW assimilated for each selected photo. In addition, we selected other five items assimilated, which were unrelated to the four photos, as misleading items. In the reproduction problem, the participant was required to rearrange the four photos in time sequence in his/her fieldwork, to attach the photo title to the corresponding photo, to relate the UA items to the corresponding photos, and to remove the misleading items. Resolving such problem suggests the possibility that the knowledge augmentation effect is obtained.

The recollection problem consisted of three sub problems each of which asked the participant to recollect the photo title by means of the corresponding UA items assimilated respectively from UAinfo-KD, UAinfo-KW, and UAinfo-KR. In order to make three sub problems for each participant, we selected two photos with the titles from his/her album, each of which were linked to more than two UA items assimilated from UAinfo-KD and UAinfo-KW respectively. We also selected one pair of two photos having the UA item

assimilated from UAinfo-KR. Resolving such recollection sub problems suggests the possibility that the recollection effect is obtained.

3.2 Results

Table 1 shows the numbers of bookmarks and Panoramio photos (UA items) assimilated in the Web albums from each of UA information. As shown in this table, the assimilation from UAinfo-KD accounted for 61%. The assimilation from UAinfo-KR was less. The assimilation from landmark search also accounted only for 9%.

Table 2 also shows the post-test scores of reproduction problems. The results suggest that the participant except Participant-A could reproduce their experiential knowledge with UA information. However, more detailed analysis of incorrect parts reproduced also suggests that the UA items assimilated from landmark search were not reproduced at all. From this, we need to discuss how to bring about the knowledge widening effect in future.

Table 3 shows the post-test scores of recollection problems. The sub problems with UAinfo-KR for Participant-C/E could not be made. The participants except Participant-E seem to have no problem of recollecting the photo titles. From these results, we can say that the UA information could function as indexes for recollecting experiential knowledge.

4. Conclusion

Table 1. Results of UA Information Assimilated.

Participants	Number of photos taken	Number of bookmarks assimilated from UAinfo-KD	Number of UA items assimilated from UAinfo-KW		Number of bookmarks assimilated from UAinfo-KR	Total number of UA items assimilated
			Bookmarks assimilated from landmark search	Photos assimilated from Panoramio search		
Participant-A	45	42	11	22	4	79
Participant-B	56	71	15	38	3	127
Participant-C	38	25	1	8	0	34
Participant-D	34	25	1	11	1	38
Participant-E	39	22	1	2	0	25
Total	212	185	29	81	8	303
The ratio of the number of UA items assimilated to the total number (303)		61%	9%	27%	3%	

This paper presents a model for augmenting experiential knowledge obtained from fieldwork with UA information extracted from the Web. Following the model, this paper also demonstrates Retrip, which generates a Web album including experiential knowledge a learner obtained from fieldwork, and which extracts UA information from the Web suitable to his/her experiential knowledge. Such UA information allows him/her to augment his/her experiential knowledge.

In future, we will refine Retrip according to the results from the case study, and will

Table 2. Post-Test Scores for Reproduction Problems.

Participants	The percentage of correct answers
Participant-A	53%
Participant-B	68%
Participant-C	80%
Participant-D	95%
Participant-E	79%

Table 3. Post-Test Scores for Recollection Problems.

Subjects	Score: Problem with UAinfo-KD	Score: Problem with UAinfo-KW	Score: Problem with UAinfo-KR	Percentage of correct answers
Participant-A	2	1	2	83%
Participant-B	1	2	1	67%
Participant-C	1	2		75%
Participant-D	2	2	2	100%
Participant-E	0	2		50%

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