

Knowledge Awareness: Bridging between Shared Knowledge and Collaboration in Sharlok

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Abstract: *Sharlok* (SHARing, Linking and lOoking-up Knowledge) has knowledge building and collaborative learning environment through sharing and looking up and linking learners' knowledge. This paper proposes a *knowledge awareness* (KA) for enhancing collaboration opportunities in this situation. KA plays a role of inducing collaboration by giving the learner the information about other learners' activities within a shared knowledge space. For instance, with messages as "someone is looking at the same knowledge that you are looking at.", "someone changed the knowledge which you have inputted." the learner is induced to collaborate with others who are interested in the same knowledge. The spontaneous collaboration which is created by KA, facilitates to refine and evolve both learners' knowledge and shared knowledge.

1. Introduction

Knowledge acquisition type or open structured CAI systems have been proposed. In such environments, the learner can provide his/her own knowledge into the system. This environment improves and keeps learners' motivation for learning [Yamamoto et al 89a]. Recently, researchers in this area attempt to provide technological support for cooperative and collaborative learning advocated by educational theories like, for example, knowledge building tools and collaborative interface tools. However, few researchers attempt to integrate knowledge building tool with collaborative interface.

We propose a knowledge building and collaborative learning environment, called *Sharlok* (SHARing, Linking and lOoking-up Knowledge) which integrates knowledge building and collaborative interface tool. The characteristics of this environment are the following:

- (1) Sharlok allows the learners to share, look up and linking knowledge provided by other learners.
- (2) Learners can explore in shared hypertextual knowledge space according to their interests. Therefore, users can seamlessly learn to cover the multi-domain, which raises and keeps in a high level their motivation.
- (3) Both learners' knowledge and shared knowledge space are refined and evolved through iteration of collaboration about the knowledge.

In this environment, it is necessary to bridge between knowledge building and collaboration toward efficient learning.

Researchers in groupware and computer supported cooperative work (CSCW) are investigating how technology can support effectively the interactions between people. One of the elements for increasing communication opportunities is *awareness* [Dourish et al 92, Bly et al 93, Matsuura et al 95]. In computer supported collaborative learning (CSCL), awareness can be used for enhancing collaborative opportunities. Goldman identified three types of student awareness: social, task, and conceptual [Goldman 92]. These awareness are important for the success of efficient collaboration. Moreover, Gutwin also proposed workspace awareness which is the up-to-the-minute knowledge about other students' interactions within shared workspace [Gutwin et al 95]. However, awareness for the success of collaborative learning in shared knowledge space has not yet been proposed.

We propose *knowledge awareness* (KA) for enhancing effective collaboration in shared knowledge space. KA plays a role of inducing collaboration by giving the learner the information on other learners' activities in shared knowledge space beyond time and space. For instance, with messages as "someone is looking at

the same knowledge that you are looking at.” or “another learner changes the knowledge which you have inputted.” the learner is induced to collaborate with others who are interested in the same knowledge. In addition, the four types of awareness proposed by Goldman and Gutwin are not provided until the user requests. We call these types “passive awareness”. In contrast, we propose “active awareness” in which the system informs awareness to the user automatically.

This paper describes the development of Sharlok and KA in CSCL environment. We first discuss awareness in CSCW and CSCL, and KA in detail in section 3. Section 4 presents an overview of Sharlok, its interface and framework and describes how knowledge awareness can be supported in this environment. Finally, the concluding remarks are given in section 5.

2. Awareness

2.1 Awareness in CSCW

In CSCW, collaboration process is lead from the following processes [Malone et al 94, Kuwana et al 95].

- (1) *Co-presence*: It gives the feeling that the user is in a shared work space with someone else at the same time.
- (2) *Awareness*: It is a process where users recognize each other’s activities on the premise of co-presence.
- (3) *Communication*: The user can exchange messages.
- (4) *Collaboration*: The user collaborates on the specific task with other users and accomplishes the task and common goals.
- (5) *Coordination*: When we do collaborative work, we sometimes conflict the partners. In that case, a coordination process is needed to resolve the conflict towards effective collaboration.

Researchers in CSCW have already proposed the following awareness, that are implemented using multi-media technologies to bond physically distributed environments.

- (1) to give information on the surrounding of the target user, e.g., Portholes [Dourish et al 92];
- (2) to provide common or public space where users can meet, e.g., Media Space [Bly et al 93]; and
- (3) to simulate informal communicative opportunities in real world using computers, e.g., VENUS [Matsuura et al 95].

Table 1: Types of awareness.

Awareness		Examples
Social	↑ Goldman (92) ↓	What should I expect from other members of this group? How will I interact with this group? What role will I take in this group? What roles will the other members of the group assume?
Task		What do I know about this topic and the structure of the task? What do others know about this topic and task? What tools are needed to complete task? How much time is required? How much time is available?
Concept		How does this task fit into what I already know about concept? What else do I need to find out about this topic? Do I need to revise any of my current ideas in light of this new informaion? Can I create a hypothesis from my current knowledge to predict the task outcome?
Workspace	↑ Gutwin (95) ↓	What are the other members of the group doing to complete the task? Where are they? What are they doing? What have they already done?
Knowledge	↑ Ogata (95) ↓	Who is discussing looking at the same knowledge that I am looking at now? Who has changed the knowledge since I have last looked at it? What knowledge are they discussing now? What knowledge of my input did they change?

Based on Gutwin, Calgary (in CSCL '95)

2.2 Awareness in CSCL

Awareness is important for effective collaborative learning and it plays a part on how the learning environment creates collaboration opportunities naturally and efficiently. Social awareness provides information on social relationships within the group to carry out the task, e.g., the role in the group. Task awareness shows how the learners accomplish the task. Concept awareness is the awareness of how a particular activity or knowledge fits into the learner's existing knowledge or completes the task. Workspace awareness is the up-to-the-minute knowledge about other learners' interactions within shared knowledge space. In contrast to the four awareness, KA is the information about other learners' activities in shared knowledge space (see Table 1).

3. Knowledge Awareness

We divide their activities into (1) "look up", (2) "change", and (3) "discuss". Sharlok monitors and memories of these 3 activities. "Look up" activity means looking up and refer shared knowledge. This awareness provides episodically collaborative chances where the user talks to another learner. "Change" includes creating, updating and deleting knowledge or links. For instance, by watching this action, Sharlok informs the learner that someone has updated the knowledge her/she offered. If the learner is aware of someone who is discussing about the same knowledge, he/she may join the discussion. By discussing on the changed knowledge, shared knowledge is refined and feedback to the environment.

3.1 Time and Knowledge Proximity

We consider two dimensions of messages for KA: time separation and knowledge separation (see Table 2). Same time type KA informs that other learners are doing something at the same time that the learner who is using the system. This awareness easily mediates the collaboration in real time. Different time type KA provides the encounters beyond time using learners' past actions. Same knowledge type KA is a message on other learners' activities which have relevant to the knowledge that the learner is looking at, discussing on, or changing. This message leads the learner to collaborate with others who are interested in the same knowledge. Different knowledge type KA is an awareness that informs other learners' actions which have no relation with the knowledge that the learner is using. Through this awareness, the learner may be cognizant of unknown but important knowledge.

Table 2: Message types of knowledge awareness.

	Same knowledge	Different knowledge
Same time	Who is discussing the knowledge ?	What knowledge are they discussing ?
	Who is looking at the knowledge ?	What knowledge are they looking at ?
	Who is changing the knowledge ?	What knowledge are they changing ?
Different time	Who discussed the knowledge ?	What knowledge did they discuss ?
	Who looked at the knowledge ?	What knowledge did they look at ?
	What has been changed since I last looked at the knowledge ?	What knowledge did they change ?

3.2 Passive and Active Knowledge Awareness

From the point of view of providing awareness, we divide KA in "passive awareness" and "active awareness". While, in a passive one, the system does not show awareness information until the learner requests it, in the active awareness, the learner is autonomously informed during his/her interaction with system. Sharlok induces spontaneous collaboration between learners using active awareness. For instance, a learner (Mr. A) can starts to discuss with another learner (Mr. B) using information that Mr. B has updated from the knowledge that Mr. A had provided. Then Mr. A learns from Mr. B. Currently, The default rules of active KA are only same time and same knowledge type. A learner can modify them for his/her own learning style.

4. Sharlok

Sharlok includes shared knowledge space, awareness, and collaboration modules. We developed them using Tcl/Tk, Tcl-DP in a UNIX workstation. The system consists of several clients and a server connected via Internet. Sharlok uses Holmes (Hypertext and semi-Object oriented Learners' MEmory System) as a shared knowledge space. The collaboration is supported by GroupKit [Roseman et al 92].

4.1 Holmes: Shared Knowledge Space

Holmes integrates hypertext and semi-object-oriented database technology. Holmes handles shared knowledge using TRIAS [Yamamoto et al 89b] which allows users to add, delete or change attributes or values at any time during its use. TRIAS represents data with triplets by a small grain size as (object, attribute, value), and it automatically links triplets which have the same element. As in figure 1, search button in the main window opens the browsing window in which the learner can start looking up knowledge. Class button opens the type window in which the learner inputs knowledge. Question button allows the learner to create discussion.

- (1) *Sharing knowledge*: Type window shows the class definition and its hierarchy among subjects by tree structured knowledge layer. In this window, a learner can add, delete, or rename attribute or subclass. Using "All Object" button, the system shows all the objects of the selected class into the object list window. By selecting the "New Object" button, a learner can create a new knowledge as an object. The data of Holmes can be not only text but also figure or image.
- (2) *Looking up knowledge*: In the Browsing window a learner can look up the knowledge by selecting "object", "attribute" and "value" in turn as in a search condition. Then the system gives the results into the Objects list window and shows the knowledge (object) in the object window such as "physics object" in figure 1. The question button in the object window is used for starting collaboration.
- (3) *Linking knowledge*: By selecting add explicit link menu in the object window, the learner can link the knowledge (object) as an explicit link. In other hand, TRIAS generates automatically implicit links between triplets. Learners obtain relevant knowledge by "Explicitly linked to/from" and "Implicitly linked to/from" in the window.

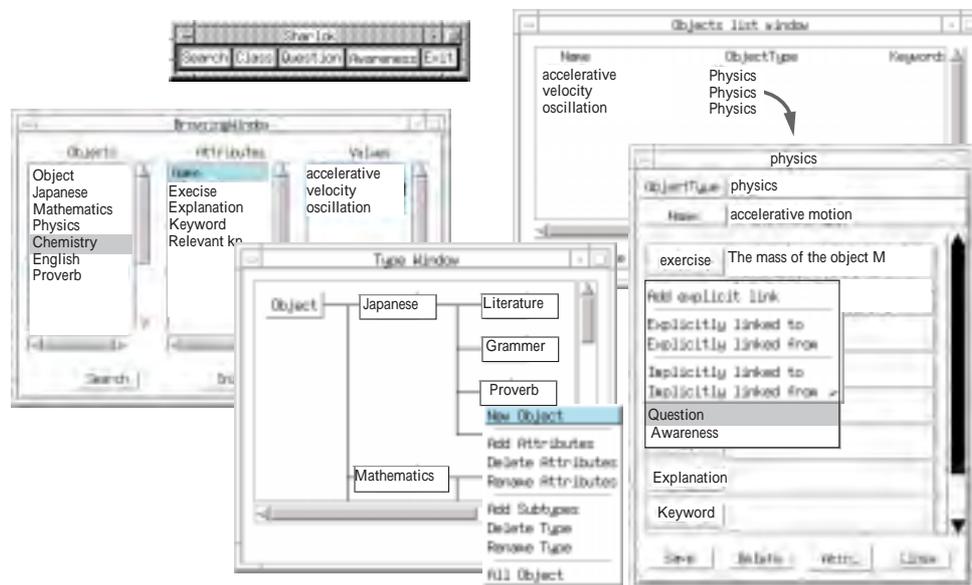


Figure 1: Example screen of Holmes.

4.2 Knowledge Awareness

Using learners' history, KA facilitates encountering other learners not only in real time but also in past time. Sharlok monitors the learners' activities in the shared knowledge space and stores them as learners'

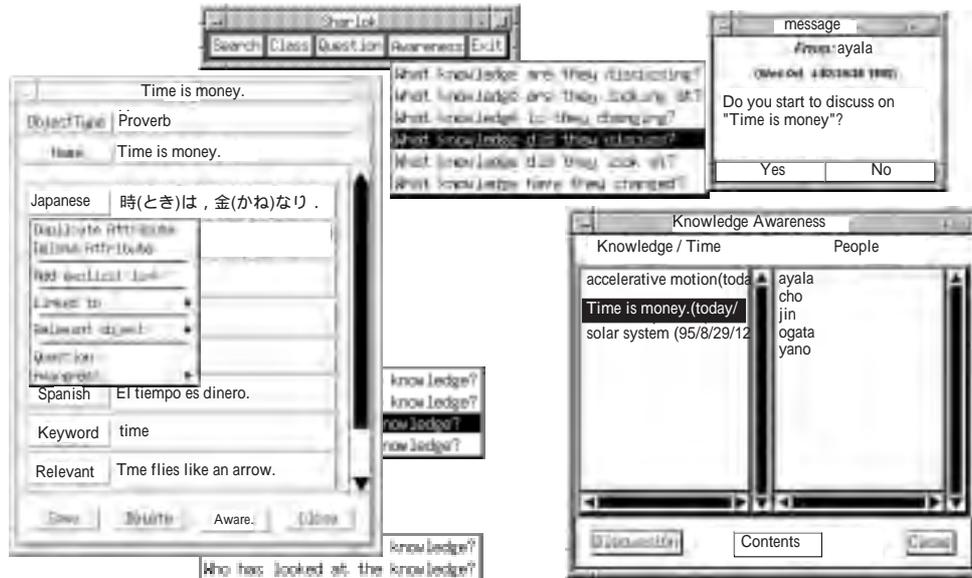


Figure 2: Example screen of knowledge awareness.

history. Passive KA are displayed through fetching the learners' history when the learner requests it. In contract, active KA are generated according to the rules or conditions. The rules are triggers for the display of messages. As in figure 2, the same time and different knowledge type KA are autonomously displayed in the message window. The learner can start or join the discussion by selecting "Yes" button. When the learner requests KA by selecting the menu, Sharlok tells him/her the information in "Knowledge Awareness" window. Since KA window shows conference names, their schedules and their participants respectively, the learner can start or join the discussion by selecting a conference name, and see the contents of the discussion using "Content" button.

4.3 Collaboration

Figure 3 shows an example of collaboration in Sharlok. The system displays the conference window when a conference starts. This window shows up-to-minute conference names and their respective participants. By selecting conference name, a learner can join the discussion. The question button in the main window and the object window are used to start collaboration. After a learner selected the button and wrote his/her question, Sharlok calls other learners for the collaboration using their respective message window. If the learner pushes "Yes" button in the window, Sharlok starts up a text tool, a drawing tool and the knowledge (object) for discussion. In the text tool, the only one learner who has the speaking right can write his/her idea. If another learner requests the right to speak his/her opinion and the current writer gives the right, the requesting learner becomes the next writer. In figure 3 a writer is ogata and the next one will be mat. Moreover, participants can use a drawing tool for a discussion. This tool shows their mouse pointers and allows them to draw figures at the same time.

5. Conclusion

In this paper, we described Sharlok which has knowledge building and collaborative learning environment through sharing and looking up and linking learners' knowledge. Through this environment, the learners cover the lack of mutual knowledge each other by sharing their knowledge and they can confirm or correct the knowledge by collaboration. We proposed knowledge awareness (KA) for enhancing collaboration opportunities. That is, KA plays a role of inducing collaboration by giving the learner the information about other learners' activities in shared knowledge space. We believe that KA can bridge between a shared knowledge space and a collaboration well toward efficient collaboration.

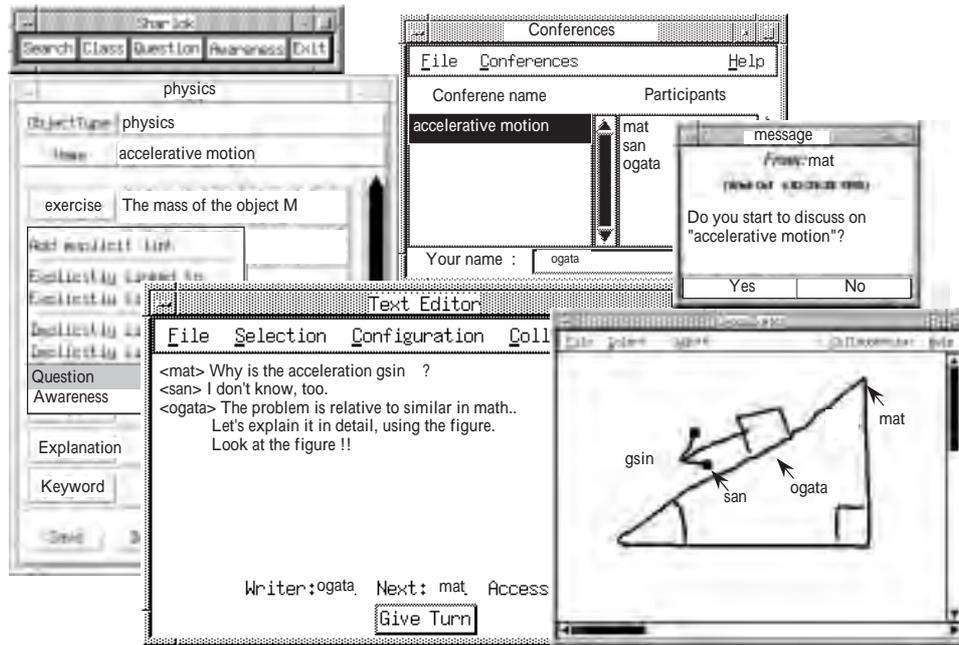


Figure 3: Collaboration screen of Sharlok.

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