Interface Design for a Real-Time Collaborative Editing Tool

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Abstract. The topic Computer Supported Cooperative Work (CSCW) has been introduced since almost three decades now. Many tools have been invented to support different situations in cooperative work. Example of CSCW tools are instant messaging (IM), email, real-time document editor, forum, blog, group decision support system, electronic meeting room, voice chat, video conference and Real-Time Collaborative Editing (RTCE) tools. A study was conducted to investigate the advantages and disadvantages of applying CSCW approach on a class of multicultural undergraduate students as they plan their software project in virtual environment. Analysis of the gathered data was done focusing towards the problems faced during the discussion sessions. Solutions were derived based on the problems identified and an RTCE tool was designed aiming to assist small scale software project planning process in virtual collaborative environment while supporting group awareness for effective teamwork.

Keywords: CSCW, RTCE, Group Awareness.

1 Introduction

In 1984, the term Computer Supported Cooperative Work (CSCW) was first coined by Irene Greif and Paul Cashman [1]. The term came up to describe their research interest in the workshop they organized in Massachusetts, which was focusing on supporting work activities using computer systems.

There are many benefits provided by using the CSCW approach. Teams that are spatially dispersed but working on projects where communication is essential need a medium to connect their group members. With the use of CSCW tools, the team members can attend the discussion sessions at their own space. This reduces or eliminates the commute time and cost, as well as leasing or buying cost for a physical discussion area. Document storage space and maintenance costs and document searching time can also be reduced significantly [2].

Despite the advantages that CSCW can offer, the effectiveness of virtual teamwork highly depends on the CSCW tool used and the team members' individual behaviours that differ mostly affected by their cultures. In a virtual team, it is crucial to have good shared understanding among the team members through language [3]. In addition, "as team members communicate, they tend to filter information through

their cultural 'lenses', thereby giving rise to a potentially broad range of misinterpretations or distortions" [4]. Miscommunications can be reduced with the use of CSCW tools [2, 5].

Real-time collaborative editing (RTCE), also known as real-time distributed collaborative writing systems (RDCWS) or synchronous collaborative authoring (SCA) is an example of a CSCW tool. It is a groupware that allows multiple users to access, view, and edit the same computer file synchronously using globally dispersed computers.

Awareness in the CSCW context is defined as "an understanding of the activities of others which provides a context of your own activity" [6]. Group awareness refers to the knowledge of each other's state and activity in a collaborative work. Mendoza-Chapa et. al [7] defined group awareness as "a mental state of the users generated by their mutual interactions and by their interactions within the workspace".

Group awareness is crucial for effective virtual collaborative work. It has been proven that group awareness helps to simplify communication, improve coordination and assist convention in a shared workspace [6, 8-11]. Group awareness ensures understanding among group members in their discussion when using the tool [7, 11-13]. An extensive review on awareness support in distributed software development research papers was recently done by Steinmacher et. al [14].

2   Research Methodology

A study was carried out to investigate some of the RTCE tools' weaknesses using a chosen RTCE tool. The participants of the study were 25 undergraduate students majoring in Software Engineering. The study was done while they were working on their Project Management course assignment that took 30 percent of their final grade for the course. The students were given a task to plan a software project virtually and submit their project plans as their course assignment. All the study sessions were done during their course's laboratory sessions. The students came from different cultures and there were even minorities of different nationalities. Data were collected during the study using several data collection methods: recording, observation, surveys, document analysis and interviewing.

The 25 students were divided into five teams of five. They were grouped in the best way to achieve equal teams with the highest diversity degree as possible. Each team consisted students of both genders, two or more cultures, and with each team members' CGPA average equals to 2.90 ± 0.02. The list below provides the individual attributes of the students and the values they take:

- **Gender**: female, male
- **Education level**: second year Computer Science undergraduate students
- **Study major**: Software Engineering
- **CGPA**: from 0.00 to 4.00
- **Race**: China Chinese, Malaysian Chinese, Malaysian Indian, Malaysian Malay, Palestinian Arab
- **First language**: Arabic, Cantonese, English, Malay, Mandarin

During the laboratory sessions, the students' seats were pre-arranged. They were instructed to sit far from their own team members to disallow face to face communication among any team members and to set the virtual project team mood. However, there was a high possibility for them to meet face to face at any time other than the discussion sessions. This might have ruined the 'virtual' settings but the best that could be done to control the off-record discussions was by informing them that their marks would depend on their contribution seen in their conversation history.

To obtain enough data for analysis, three laboratory sessions were conducted with two hours allocated for each session. The students were assisted and monitored by a tutor. After each laboratory session, a set of questionnaires was distributed with the requirement that the questionnaires be completed and returned before they leave. The students' conversation history and project planning documents were accessed to understand their work flow and team management. A presentation session was also held after the submission of their completed assignment to clarify certain ambiguities regarding the students' opinions and behaviours during the laboratory sessions and the results seen in their final deliverables.

3   RTCE Tool Selection

There are many RTCE freeware that provide basic features and require payments for pro versions with more added features. However, some of the pro versions are overrated. The features they provide are not much compared to the free versions yet they are costly. Some tools provide many extra features but lack in quality and performance. A virtual team needs to find the most suitable tool that can assist their work best. Different tools are targeted for different types of work and some tools are still new and unstable.

During this research, the most suitable RTCE tool for students' software project planning was searched. All found tools were personally tested to choose the one that is the most suitable for laboratory assignment use. Table 1 shows the summary of RTCE tools that were tested.

During the tool search, there was no existing RTCE tool found that is perfect for undergraduate students project planning. However, a set of Google[1] applications seemed to be the most suitable for the study use. It supports the creation and edit of various file types which are useful for project planning documentations as well as the text chat feature.

The students could use GMail[2] to share files to team members. In this application too, the chat history is retrievable and the links to the teams' shared documents are given in emails. Google Docs[3] was chosen for the students to do their project planning documentation as its interface is simple and the functions are adequate.

There were concerns that led to the choosing of Google applications over the others for the study use. Requirements and constraints include the following:

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[1] `http://www.google.com`
[2] `http://mail.google.com`
[3] `http://docs.google.com`

Table 1. Summary of existing RTCE tools review

Application name	File type support	Platform	Free version features	Text chat support
Amy Editor	text, source codes	web-based	full	no
Cacoo	diagrams, drawings	web-based	limited or pro for academic plan	yes
CoCKEditor	text	web-based	full	yes
Collabedit	text, source codes	web-based	full	yes
Conceptboard	text, drawings	web-based	limited or pro for 30 days trial	no
Dabbleboard	text, diagrams, drawings	web-based	limited or pro for 30 days trial	yes
FlockDraw	drawings	web-based	full	yes
Gobby	text, source codes	desktop application	full	no
Google Docs	word document, presentation, spreadsheet, form, diagrams	web-based	full	yes
LucidChart	diagrams	web-based	limited or pro for 14 days trial	yes
MeetingWords	text	web-based	full	yes
MoonEdit	text, source codes	desktop application	full	no
PiratePad	text	web-based	full	yes
PrimaryPad	text	web-based	limited or pro for 3 months trial	yes
ShowDocument	text, drawings	web-based	limited or pro for 30 days trial	yes
Squad	text, source codes	web-based	limited or pro for 10 days trial	yes
SubEthaEdit	text, source codes	desktop application	full for 30 days trial	no
Sync.in	text	web-based and desktop application	limited or pro for 30 days trial	yes
TitanPad	text	web-based	full	yes
Twiddla	text, drawings	web-based	limited or pro for 30 days trial	yes
ZohoWriter	text	web-based	limited or pro for 15 days trial	yes

- **Drawing diagrams and tables feature:** A project planning documenting tool requires a simple diagram or table drawing feature. It should be able to at least support the drawing of the simplest diagrams such as the activity chart and also tables to represent project schedule or milestones. Google Docs supports various file types such as the word document, presentation, form and spreadsheet, as well as diagram drawings.
- **Limited learning time:** It was easier to conduct the study using Google applications as most of the students were already familiar with them. Only a few

minutes were needed to brief the students on the applications at the beginning of their first laboratory session. The sessions needed to start off immediately as only four weeks were given by the course lecturer to conduct this research with the course's students.

- **Price:** Google applications are free for public usage. Therefore, all the recorded data in Google servers can be accessed at any time after the laboratory session for data collection or revision. Most of the other good applications' pro versions require payment per user per month and the maximum period offered for trial is only 30-days. 30 days is not sufficient to do the study and data collection from all 25 participating students' accounts.
- **Email feature:** Emails enable the students to send offline messages to their team members while allowing them to attach files and links. Team members who were absent during a discussion session would not have the access to the missed session's chat conversation, but would not be missed out if the shared messages are sent via emails to both present and absent members. It would also be more convenient for the students to be able to share ideas, articles or links and have them saved in a separate storage with proper message subjects instead of having to search in the conversation history. GMail can be opened from Google Docs and to use all the Google applications require only one username per person.

It would be best if the RTCE tool supports IM so that the students can discuss and document their work together at the same time in just one page. There were three ways to use IM by Google, one is a chat application and the other two are chat features integrated in other applications. These were Google Docs text chat, Google Talk application and GMail text chat.

The most important feature that was needed in this study is the ability to support group chatting and the ability to save and retrieve chat conversation history. The conversation history was needed to identify the active and passive students, to see the relevance of the students' discussion, and also to check if the flow of the students' planning process was done the correct way.

Table 2. IM mediums by Google

	Google Docs Chat	Google Talk	GMail Chat
Group chat	√		√
Chat history		√	√
Email notification		√	√
No additional setup required	√		√
No need to start any extra application aside from the email and real-time document editing applications	√		√
Provides adequate chatting features to assist the project planning discussion	√	√	√

Table 2 summarizes the three IM mediums. The chat feature integrated in Google Docs might be very convenient for the students to use while they write and edit their documents (as it is located on the right panel of the same page) but it does not support

chat conversation history archiving. Using it is still possible, but the users would need to copy and paste their chat conversations onto a document and save them manually. Chat windows other than Google Docs' can also be placed on the right panel of the same page as they can be moved around. Google Talk application does not support group chat. Therefore, GMail chat was the best option and was eventually chosen for the study.

4   Results

The advantages of using RTCE tools identified from the study are listed as below:

- From the compiled completed questionnaires, 92 percent of the students said that they really enjoyed doing their assignment virtually. This result supports other researches stating that students enjoy online chat to face to face chat [15-17]. Some of the students also mentioned that virtual discussions are more exciting than face to face discussions. The minorities who did not enjoy the virtual discussion sessions gave their reason that they do not prefer to stare at the monitor screen for too long.
- None of the students agreed that cultural issues strongly affected their group communication during the assignment discussion sessions. As long as the members are using the same language well and have the right level of knowledge for the project, the project should be able to run smoothly.
- To most of the students, virtual discussions enabled them to complete their project faster. This might be because the students needed to attend and be punctual for the discussion sessions as the laboratory sessions are a part of their Project Management course's requirements, thus require less effort to get the team together. Even for students who had problems to be present at the laboratory, they could still join the discussion sessions if they had internet connection elsewhere.

Complaints from the students and detected problems were also collected and analyzed. Some of the problems reported were:

- Google **account creation errors** and **internet disconnections** during discussion during the first laboratory session. The errors came from Google for some students when they were creating their account probably because there is a limit to a number of accounts that can be created per IP address at one moment.
- They were constantly **editing the same part of the document**.
- **Difficulties to draw diagrams** in Google Docs. Some of the students had to draw the diagrams elsewhere and then paste them onto the document.
- **Deadbeats**. There were some participants who were present during the discussion sessions but did not contribute much due to lack of knowledge, uncomfortable with the written language used, laziness or shyness. Weak language skills could be the cause for students' shyness and anxiety about making errors [18-19].
- A lot of time needed to re-explain and update the team's progress to an **absentee** of the previous laboratory session. Chat conversation history will only be accessible by a user if the user attended the session. Users who were supposed to join the

discussion but were not present at slotted sessions had difficulties catching up with the team's progress.

CSCW tools' users are of different cultures and from different regions with different mind settings. CSCW tools should incorporate awareness mechanisms to improve team communication thus strengthen the team relationship and understanding. During this research, it was found that most CSCW tools do not have good group awareness support. This would cause ineffective teamwork and produce bad quality deliverables. The CSCW tool development team must consider this issue seriously as this globally dispersed and multicultural group of people will be having limited options in developing good team communication in virtual space compared to face to face meetings.

From these findings, possible solutions to the problems were derived, while considering group awareness support. The solutions are expected to reduce the communication problems and improve the teamwork effectiveness, thus produce better quality deliverables. Considering conversational, workspace and contextual awareness, a few RTCE tool features were suggested and an RTCE tool interface was designed. Details are provided in the next section.

5   The RTCE Interface Design

Based on the discussion in the previous section, an RTCE tool for undergraduate students was designed. The tool would consist of three main components:

- **Real time document editor**: Allowing users to create documents (text, drawings and spreadsheets), have them shared with multiple users and edit in real time environment.
- **IM**: Allowing multiple users to chat and discuss via simple text messaging as they are working on the same document.
- **Email or private messaging**: Allowing users to send offline messages and include attachments to the intended users including those who are not able to attend the slotted virtual discussion sessions.

The RTCE tool should also support these added features that are not well supported or have yet to be supported by the RTCE tools that were used in this study:

1. **Telepointers** [20-24]: When a user moves his pointer, the other users should be able to see the movement to know the user's current activity. Each should be assigned with different colour to represent the identity of the pointers' owners. It is suggested that, telepointers that have been idle for at least 15 seconds should disappear from the other users' view to avoid confusion and mess. This feature supports awareness of presence and action in workspace awareness.
2. **Work modification alert** [25-26]: As another user is modifying a part of a document, the original author of the document part should be notified. A simple text notification would do, with a clickable link that would direct the original author straight to the paragraph that is being modified. This feature supports awareness of action in workspace awareness.

3. **Relaxed-WYSIWIS (What You See Is What I See) view sharing** [8, 11, 27-29]: The users will be able to see which part of the document the other users are currently viewing. Being able to view all online users' viewports at a fixed panel might take a lot of space and is not necessary. It is enough for a temporary viewport to only appear as a user mouse over a username. This feature supports awareness of presence in workspace awareness.

4. **User profile info** [30]: The users who are working on the same document should be able to see at least a brief profile of each other by clicking at the user's colour code in the list of users. This would help the team to distribute the work in a more efficient way by maximizing each user's expertise on the relevant sections of the document. This feature supports awareness of identity in workspace awareness.

5. **Paragraph freeze**: This feature is to avoid multiple users editing the same part of the document at the same time. Once a user has started typing in a paragraph, the tool should not allow any second user to disturb the typing process until the first user has finished typing the paragraph. Other users however can still continue editing the other parts of the document. This supports awareness of turn-taking in workspace awareness and might reduce the problem mentioned by some of the students in the compiled questionnaires that they kept modifying each other's work that were still being typed in.

6. **Recorded chat conversation** [31-33]: All chat conversations done in Google Docs are not recorded. Only those conversations that happened in the GMail text chat feature can be retrieved from GMail. It would be useful if all the chat conversations in the RTCE tool will be automatically saved and they are retrievable for later revisions. As we learned from the laboratory session results, it took a lot of time for the other team members to explain everything to the member who has missed the previous session. It would make the work smoother if they could just retrieve their previous session's chat conversation, select relevant conversation using checkboxes and forward them to the absent user in an offline message so the absent user could study and be prepared to join the next session. This feature supports contextual awareness and also awareness of conversational context in conversational awareness.

7. **Wake idle or inactive users**: To solve the problem of deadbeats, the tool might be able to encourage the students to contribute by incorporating a new feature which sends a notification to the idle user via a pop-up with a ping to let the user know that he has been idle for too long and should start taking part in the discussion. In this case, the tool should keep track of each user's idle time and check if it has exceed the maximum idle time limit set by the team leader or the document creator. The team leader or other members should be notified too so that they will try to help bring the passive member into the discussion. This feature supports awareness of presence and conversational context in conversational awareness.

8. **Instant translation** [34-35]: Another known cause for idle users is unfamiliarity with the language used in the discussion. Students who were having problems understanding or typing the language used in the discussion could not really contribute their ideas as they found it difficult to explain their opinions. One of the 25 students was known to be very weak in English by looking at his writing
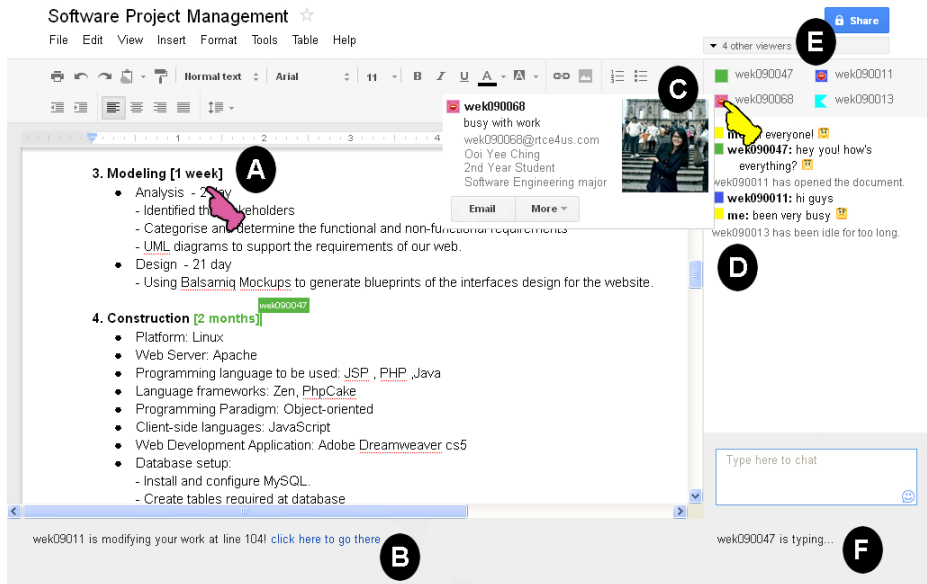
Fig. 1. The RTCE tool design: (A) telepointer; (B) modification alert to original author; (C) user profile info; (D) idle user notification; (E) user availability status; (F) typing cue

skills in the questionnaire answers he submitted and his team's conversation history. It can be seen in the conversation history that he was not actively sharing ideas during the discussion. An extra feature to help this type of users work better is to have an automatic translation feature. The user whom is already aware of his own weakness in the written language used in the discussion could pre-set his preferred language and later during the virtual discussion, he could just mouse over a word to see its meaning in the selected language. This feature supports contextual awareness.

9. **'Who is typing' cue** [11, 36-37]: In most IM tools including Google Talk and GMail chat, users are notified at the chat window if there is another user typing in the group conversation. This notification allows more organized conversation and avoids clash of words at the same time. This feature supports awareness of turn-taking in conversational awareness.

10. **One conversation at a time**: Since the online users are all discussing on the same document, one chat conversation is enough. The chat tool however should allow username tagging as a user types his message in the chat conversation. This feature is yet to be seen on any of the reviewed RTCE tools. This username tagging would allow the users to create attention to specific online member while everyone else could also see the discussion, be aware of any issues arose and join the discussion if needed. This feature supports awareness of multiple concurrent conversations in conversational awareness.

11. **Availability status display** [38-42]: All users who are accessing the document will automatically appear on the chat list and once they go offline, their

usernames will disappear from the list. If a user has been idle for a certain period of time (no detected movement on telepointers or cursors on both the document and chat tool), a different shape or symbol should be used to indicate that the user is away from the discussion. The colour of the symbols should remain the same as the colour will only represent the identity of the user. This feature supports awareness of presence in conversational awareness.

A real time document conferencing tool's interface was designed based on the discussion above. Fig. 1 shows the designed tool's interface.

6   Conclusion

There was no existing RTCE tool found that is perfect for undergraduate students software project planning. A combination of Google applications was identified to be the most suitable, but not perfect. Several advantages and disadvantages of applying the RTCE tool for the students' software project planning were analysed.

An RTCE tool embedded with new relevant features and awareness mechanisms is expected to reduce the communication problems and improve the teamwork effectiveness, thus produce better quality deliverables in small scale software project planning. However, the presented RTCE tool interface design is yet to be tested. Future work includes the development of a working RTCE tool based on the ideas and design presented in this research.

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