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Group awareness increases student engagement in online collaborative writing

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ABSTRACT

Online Collaborative Writing (OCW) tools such as Google Docs provide an efficient way for students to perform collaborative writing tasks. However, when teachers include OCW in their teaching, they often report fewer positive student engagement. This paper proposes a novel OCW tool called Cooperpad, with a group awareness functionality, which continuously gathers group members' writing behavior, analyzes and visualize their engagement intensity for group members to compare their participation with that of others. Using direct observations, a post-test-only design with an experimental group (N = 72) and a control group (N = 48), we have examined whether access to Cooperpad's group awareness function showed more engagement in a group-writing task than students without access to the tool. Results of direct observation indicate that Cooperpad with the group awareness support increases students' behavioral engagement, compared with a common synchronous OCW tool (without visualization support). In addition, the results show that the quality of writing in the experiment group is significantly greater than that of the control group when performing difficult tasks.

1. Introduction

In recent years, Collaborative Writing (CW) has obtained many educational researchers' interests because of its potential pedagogical benefits. CW, a form of Computer Supported Collaborative Learning (CSCL), requires students to work together to complete writing tasks via planning and collaboration. Recent research shows that CW can assist students to work collaboratively on common goals (Caspi & Blau, 2011), and motivate creativity and critical thinking (Hodges, 2002). Traditional face-to-face CW groups generate more effecient work than single authors for a complex writing task (Allen, Atkinson, Morgan, Moore, & Snow, 1987). However, in traditional face-to-face CW, it is difficult for group members to coordinate their input towards a common goal, and to be aware of what other group members are working on at a different stage of the writing process (Lowry & Nunamaker, 2003).

Early Computer Supported Collaborative Writing (CSCW) tools, such as Aspects® (Ellis, Gibbs, & Rein, 1991) and networked note taking (Posner & Baecker, 1992), were developed to address the coordination issue in collaborative writing processes. Similar to word processors, these collaborative writing tools provided a shared group document for different team members to work concurrently and to be aware of the document's current state. Research investigating how CSCW tools assisted the collaborative writing process has shown that the coordination and group awareness features of CW tools allowed writing groups using CW tools to outperform groups using word processors (Ellis et al., 1991; Posner & Baecker, 1992). However, these tools were platform-dependent and unable to handle large numbers of users.

With the advancement of Internet technologies, Online Collaborative Writing (OCW) tools such as Google Docs, Etherpad (www.etherpad.org) and Wikis have been developed and widely used in education. OCW research has been conducted to explore the impact of OCW tools in collaborative learning (Wheeler, Yeomans, & Wheeler, 2008) and in second language learning (Elola & Oskoz, 2010). Limbu and Markauskaite (2015) further investigate university students' conception of OCW. However, low student engagement has been one of the issues when teachers try to use OCW in their teaching practices (Caspi & Blau, 2011; Cole, 2009).

Group awareness, which has received considerable attention in the field of CSCL, refers to the information where group members acquire about other group members (Gross, Stary, & Totter, 2005), for instance, which task other group members are working on, how much time they spent on the task, or how well they perform on the task. The objective of group awareness research in CSCL is to develop awareness tools that

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group members can use in support of group task. Research shows that the use of group awareness tools positively affect collaborative learning process and group participation (Janssen, Erkens, Kanselaar, & Jaspers, 2007; Janssen, Erkens, & Kirschner, 2011; Jermann & Dillenbourg, 2008). For example, Janssen et al. (2011) propose a group awareness tool called Participation Tool (PT) to provide information about online communication participation to group members. PT constantly analyzes the chatting messages produced by group members and display feedbacks to group members so that they can easily make a comparison between their own pariticiapation and that of other group members. This group awareness tool is designed to improve group performance by motivating students' participation rate. However, a limitation of PT system is that the visualizations used in it are generated from online communication like chatting messages, and it is not suitable for the collaborative writing since students spent most of their time on writing in our case. Moreover, previous studies (Janssen et al., 2007, 2011; Jermann & Dillenbourg, 2008) have tended to focus on measuring student engagement in coordination and regulation of social activities based on the analysis of communication messages in chat programs, but ignored or failed to focus specifically on student engagement for performing the primary writing task. In this study, Cooperpad records through direct observation of the whole process of completing a group-writing task.

This article introduces a novel online collaborative writing tool with group awareness functionality called Cooperpad. The tool analyzes each group member's writing behavior and visualizes his or her behavioral engagement with a writing task. The behavioral engagement measure is derived from the intensity-based engagement measurement algorithm described by Liu, Calvo, Pardo, and Martin (2015). By visualizing other group members' engagement in the writing task and their group engagement ranking in a class, it is expected that *social evaluation and social comparison* motivating factors (Michinov & Primois, 2005; Shepperd, Lynn, Samuelson, Singleton, & Wood, 1993) will lead to increased student participation in group tasks. An empirical study is conducted to examine the effect of group awareness features in a CSCW system on student engagement in a group writing activity. The collaborative writing task is undertaken by a group of undergraduate software engineering students in China, under the instruction of working together to complete a project proposal.

The major highlights of our work can be described as follows:

1) Introduces a novel group awareness tool to support online collaborative writing;
2) Adapts a well-known observational instrument, Behavioral Observation of Students in School (BOSS) (Shapiro & Keller, 2006), to measure student behavioral engagement in a group writing project;
3) Evaluates the effect of using Cooperpad and a common OCW tool on student engagement.

The remainder of this paper is organized as follows: Section 2 describes the relevant work in the areas of collaborative writing, student engagement and group awareness. Section 3 presents the system used in the study. Section 4 describes the research scenario and experimental study used to validate the proposed approach. The paper concludes in Sections 5 and 6 with a discussion of the overall approach as well as lines for future exploration.

2. Background

2.1. Improving participation in CSCL environment

High levels of participation and equal participation of group members are very important in CSCL. However, some studies report that individual and group characteristics can impair CSCL, for example, the tendency for some group members to dominate the group writing process (Savicki, Kelley, & Ammon, 2002), low participation rates by all group members (Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003) including "social loafing" where group members make less effort to achieve a goal when they work in a group than individually, and unequal participation of students or the 'free rider effect' where some members do little or no work. Various approaches have been proposed to encourage participation, such as Positive Interdependence (PI) in group work (Johnson & Johnson, 2010). PI, for instance, occurs when the group members who share common goals work together for both individual and group benefits. These strategies motivate students to commit and enhance group cohesion, and thus may be used to solve the problems like free rider.

Group awareness is another approach suggested to enhance student participation in a group task (Janssen et al., 2007, 2011; Jarvela, Veermans, & Leinonen, 2008). Such visualization tools display the contribution of each member to the group task, such as online discussion (Janssen et al., 2007). Janssen et al. (2007) claim that group awareness influences participation due to two important factors, motivational and feedback factors. The awareness of group participation can stimulate group members to commit more due to the social evaluation and social comparison factor (Shepperd et al., 1993). In addition, the awareness of group participation can be treated as a form of feedbacks, provided to group members to reflect on how well they are working together and how the group process may be enhanced (Butler & Winne, 1995). Motivational components of visualization have been considered critical, as visualized contributions from each member are available for individual identification and group evaluation (Jermann, 2004), and such social evaluation in turn would motivate and increase student participation (Shepperd et al., 1993). These findings suggest that awareness is important in facilitating CSCL (Kirschner, Strijbos, Kreijns, & Beers, 2004). They help us to develop better visualization, which in turn can be used to better motivate students to engage in collaborative writing. In fact, social evaluation and comparison strategies have been implemented in the visualization features of the system described in the current study (Cooperpad). Group members can observe their own group and other groups' engagement with the task.

2.2. Student engagement

Researchers have considered student engagement as involvement in a learning activity (Christenson, Reschly, & Wylie, 2012). Most researchers (Appleton, Christenson, Kim, & Reschly, 2006; Fredricks, Blumenfeld, & Paris, 2004) view student engagement from three aspects: behavioral, cognitive and emotional engagement. Behavioral engagement relates to involvement in learning or academic activities, which can be directly observed by humans or recorded by the system, whereas cognitive engagement concerns willingness to make an endeavor to learn, which may not always be externally visible. Emotional engagement refers to positive or negative feelings that learners have about their learning experience, peers, school environment and etc. Based on Fredricks et al. (2004), Henrie, Halverson, and Graham (2015) inspect existing methods for engagement measurement and classify a range of indicators used to measure engagement in an e-learning environment. Behavioral engagement can be measured by both system-recorded indicators like the number of times when students login and the time that they spent on watching online video, and human observations such as Behavioral Observation of Students in School (BOSS) (Shapiro & Keller, 2006). For the cognitive engagement, some qualitative measures try to evaluate cognitive processes, such as the quality of the tasks completed in a student-submitted work (Hew, Huang, Chu, & Chiu, 2016). Emotional engagement may be measured by the self-report (Hew et al., 2016) or visible expressions of emotion (Bebell & Kay, 2010) that contains emotional feelings towards study experience.

It is important to understand the concept of student engagement from these three perspectives (Fredricks et al., 2004; Guthrie & Wigfield, 2000). However, most e-learning studies tend to measure only

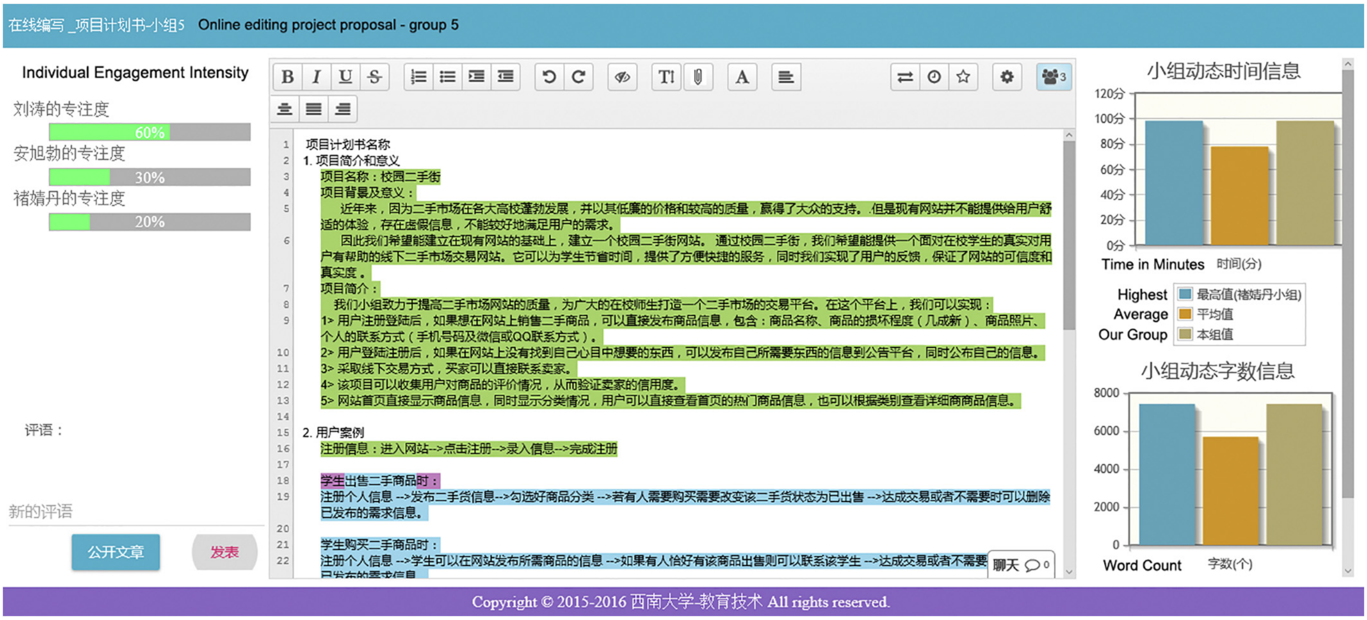

Fig. 1. A screenshot of collaborative writing on a project proposal in the Cooperpad. The text editor is located in the middle of the screen and its content is collaboratively written by group members (the text color indicates which member wrote this text). The engagement intensity bars shown are on the left while the group engagement-ranking chart on the right.

one or two engagement categories (Henrie et al., 2015). This essay focuses on behavioral, cognitive and emotional engagement, since these three engagement components are considered as some of the most critical indicators of student involvement and achievement in an e-learning environment.

3. System description

Cooperpad is a web-based system that provides a collaborative writing environment. It is comprised of a collection of tools and functionalities enabling assignment management (Calvo, O'Rourke, Jones, Yacef, & Reimann, 2011), engagement measurement and visualization (Liu et al., 2015), online chat and collaborative document creation within the same environment. The aim of the system is to stimulate the collaborative writing process with visualization of participant engagement as well as enabling instructors to facilitate collaborative assignments more easily. Furthermore, because the whole writing and interaction history is logged, data is available for dynamic analysis of individual writing behavior patterns. A screenshot of the Cooperpad is shown in Fig. 1.

The writing area of Cooperpad is powered by Etherpad, a real-time collaborative text editor. Student's edits are collected and stored about 60 times per minute. Etherpad stores the change-sets in its database, associated with a timestamp, user, and pad-id. The system then extracts relevant details (author, assignment, group, time of change, change-type (addition, deletion, copy/paste)) for further analysis, such as behavioral engagement in writing (Liu et al., 2015).

The visualization tool shows how much each group member engaged in the group writing in a real time and is shown on the left side of Fig. 1. While students are writing in the online environment, the visualization is continually updated, allowing students to compare their engagement to others in their group. This visualization is called *individual engagement intensity*. The engagement score is derived from an intensity-based engagement measurement algorithm described previously (Liu et al., 2015). This algorithm sums weighted time intervals between two adjacent revisions, where the weight refers to the engagement intensity. If the time interval is smaller, the weight is bigger, which indicates that the engagement intensity is high. In addition, the visualization enables students to examine the engagement of students from other groups in a class by providing their group ranking. Currently, the visualization tool shows the group with the highest engagement intensity and word count, and the average engagement intensity and word count across groups in a class (on the right hand side of the screen in Fig. 1). The visualization tool is used to enhance group awareness of group member's behavioral engagement so that students are motivated to work on the group-writing task through *social evaluation and social comparison*.

4. Study

The purpose of this study is to examine the impact of the group awareness on student engagement during online collaborative writing. The following research questions were used to guide this study:

1. Do students who have access to the group awareness tool participate more during online collaborative writing than students who do not have access to the tool (behavioral engagement)?
2. Do students who have access to the group awareness tool provide higher quality of the writing than groups who do not have access to the tool (cognitive engagement)?
3. Do students who have access to the group awareness tool feel positive emotion towards using the tool (emotional engagement)?

4.1. Participants and settings

Participants were third year undergraduate engineering students taking *Java 2 Platform Enterprise Edition (J2EE) Development* course in a key university in southwest of China. The total sample consisted of 120 students (62 males, 58 females), aging from 19 to 22 years old with an average of 21.34 Mean age of the students was 21.34 years (SD = 0.59).

All the 120 students coming from two parallel classes (one class has 57 students while another has 63 students) were randomly assigned into 40 groups with three students in each group. In order to understand the student perception of the group awareness better, we randomly assigned more students in the experiment setting. 24 groups (including 72 students) were randomly assigned to the experimental setting, in which they used the Cooperpad with visualization support described in section 3; and 16 groups (including 48 students) were

Table 1
Observation code adapted from BOSS (Shapiro & Keller, 2006).

		Definition	Examples
On-task behavior	Active engagement	The student is actively attending to the assigned task.	Writing the document. Searching for relevant learning materials. Participating in online discussion about the assignment. Talking to the teacher about the assignment.
	Passive engagement	Student is passively attending to the assigned task.	Listening to the teacher's instruction. Reading group online discussion. Reading a peer's writing.
Off-task behavior	Off-task motor	Any instance of motor activity that is not directly associated with an assigned task	Playing computer games. Playing mobile phone. Resting
	Off-task verbal	Any audible verbalizations that are not permitted and/or are not related to an assigned task	Chatting to peers about issues unrelated to the writing task. Making any audible sound, such as whistling, humming, forced burping.
	Off-task passive	A student is passively not attending to an assigned activity for a period of at least 3 consecutive seconds within an interval	Looking around the room. Starring out the window. Passively reading group online discussion about issues unrelated to the assignment.

randomly assigned to the control setting, where students used the Cooperpad without visualization support as a common online collaborative writing tool.

4.2. Group writing task

Students were asked to collaboratively write a project proposal with an instruction. The project proposal included three parts: (a) aim of project, (b) key use cases, and (c) application framework description. The first and second part of the task required students to discuss what system they will build using the web technologies and what are the distinct features of the system, while the third part of the task required students to describe different application frameworks, such as Spring and Hibernate, that they would use in their project. Students had unrestricted access to the Internet or their textbooks for information to complete all parts of the project proposal. Regarding the difficulty level of each subtask, the third part was considered the easiest component since the description of different application frameworks can be easily found online and in textbooks. The subtask of key use case descriptions was considered the most difficult task among three subtasks since it requires students not only to point out the functionalities provided by the system, but also to describe in detail the whole interaction process between human and system. Finally, group members had to collaboratively write an essay of at least 1000 words. This group task was complex and group members had to share and divide the task. Students collaborated on the writing task in a two-hour lab session and submitted it at the end of the lab session. Before class, students spent time on thinking about what project they are going to build, so the writing task is manageable in a two-hour time frame based on our experience.

4.3. Procedure

Each time only one class of students took the 2-hour lab session and the class has both control and treatment groups. Students in a group was sitting near each other so that they can effectively discuss the project topic and allocate the group work in the beginning of the session, and then use the computer to work on their individual work. Before the start of the session, all students were instructed about the collaborative writing and the writing strategies. During this introduction (30 min), the writing task and online collaborative writing environment were explained to the students, including the visualization for the experimental groups.

During the session (90 min), teachers answered task-related questions, while seven postgraduate students from the educational technology department from the same university observed and recorded student engagement. In order to obtain a representative sample of students' behavior over the session, observations were rotated across groups so that each group of students was observed continuously for only 1 min at a time. All groups were supposed to be observed for the same amount of time, around 30 min. But, if a group made an early submission, this group would generate less observation points. After the lab session, the students were required to hand in their final versions of the group task. Their teachers graded these final versions. In addition, students in the experimental groups responded to an online survey about their perceptions of the system in order to assess students' emotional engagement towards to the group awareness tool.

4.4. Measures

To examine the multidimensional engagement of both experimental groups and control groups, we used the following measures. Noticed that, according to the measurement methods described blow, one score will be calculated and collected from one "group", instead to collect from each individual, as the measurements for each group's behavioral engagement, cognitive engagement, and emotional engagement.

4.4.1. Behavioral engagement

The Sinha et al.'s engagement rating schema (Sinha, Rogat, Adams-Wiggins, & Hmelo-Silver, 2015) is used to calculate collaborative group behavioral engagement, where the group engagement score is defined as the number of students showing on-task behaviors divided by the total number of students in the group for each observation, since group members who engage in off-topic conversation or distract remaining team members display low quality behavioral engagement (Van den Bossche, 2006). In addition, we adapted the well-known observational measure: Behavioral Observation of Students in School (BOSS) (Shapiro & Keller, 2006), to record individual student's behavioral engagement in this group writing activity (See Table 1). The BOSS has been used extensively to evaluate the effectiveness of education interventions on students (Mautone, DuPaul, & Jitendra, 2005). In the BOSS, the momentary time sampling technique (Saliva & Ysseldyke, 2004) was used to encode On-Task behavior including active and passive engagement behavior, where observers decide if the student was on-task at the beginning of the each interval (1 min in our case). The partial-interval sampling technique (Chapman, 2003) was applied to observe off-task behaviors, where an off-task behavior was detected if this behavior was exhibited at any point during the interval. To ensure inter-observer agreement on their interpretation of task engagement, we asked raters to observe a group of students in a different class over a similar observational period and then directly compared their ratings in each time interval. A high inter-agreement was found (92% agreement).

4.4.2. Cognitive engagement

It refers to the quality of the group-writing task, which is used in Hew et al. (2016) study, where they investigated the impact of the game mechanics on Asian students engagement in the task of designing questionnaires. Each part of the project proposal was scored by the researchers on a three-point scale, with 0 indicating poor quality and 2 good quality. A marking criteria was developed based on the lecturer's comments. Good quality project proposals should explain the aim of the project well, point out the significance of the project, presents at least 5 major use cases and describe them in detail, and use their own words to describe each application framework in detail and list out at least three advantages and disadvantages. If the written text is copy-pasted directly from the sources, they would get 0 mark. To check the objectivity of the scoring, two researchers independently scored the project proposals written by both experiment and control group students. For aim of study, key use cases and application frameworks, high or moderate Pearson correlations were reached $r = .64$, $r = .58$, and $r = .72$, respectively.

4.4.3. Emotional engagement

Students' positive emotion towards using the group awareness tool was measured using the following 5-item questionnaire adapted from Hew et al. (2016). Students provided answers to the statements on a 5-point scale (ranging from 1 = completely disagree to 5 = completely agree). Cronbach's alpha was 0.73.

1) I think the visualization added fun to this writing task.
2) I feel the visualization of group engagement ranking motivated me to make more contribution to my team.
3) I feel the visualization of individual engagement intensity bar motivated me to compete with other group members.
4) I think it is necessary to know my peers' engagement.
5) If possible, I am happy to use it again.

5. Results and discussion

5.1. Student behavioral engagement through direct observation

For the 90-minute session, all groups in both experimental and control settings were observed about 30 times. During the session, when the group of students submitted the writing task, the observation stopped immediately. As a result, an average number of 29.33 observations per group were found in the experimental group, whereas 27.94 observations in the control group (See Table 2). An independent *t*-test was conducted. Because in the measurements one score was calculated and collected from one "group", the number of groups was the N (24 in experimental setting and 16 in control setting, instead of individual students). Results showed that the equal variance between groups was assumed, and with 95% confidence interval significant difference was found ($t(38) = 4.310$, $p < 0.001$, Cohen's $d = 1.286$, effect size = 0.541). This difference might explain that the experimental group students spent time on looking at the group awareness tool and making more changes until the lab session finished, while the control group students gave early submission after they completed their individual writing task.

Table 2
The average number of observations, the minimum and maximum number of observations per group in a class.

Class	Average	Min	Max
Experimental group	29.33	28	30
Control group	27.94	26	30

Table 3
Means, standard deviations, and *t*-test for measures of behavioral engagement for experiment and control groups.

Measures	Class	N	Mean	SD	t	p	ES
On-task	Experimental group	24	806	098	2.363	0.023	0.78
Observation	Control group	16	737	076			
Word count	Experimental group	24	1813	14.750	56.685	< 0.001	18.26
	Control group	16	1541	15.043			

Table 3 shows that students in experimental groups ($M = 0.806$, $SD = .098$) were more engaged on the task than those in control groups ($M = 0.737$, $SD = .076$), $t(38) = 5.187$, $p = 0.023 < 0.05$, $d = 0.787$, $ES = 0.366$ through human direct observations. Moreover, based on the analysis of final documents, it has been found that students in experiment groups ($M = 1812.792$, $SD = 14.3750$) wrote significantly more than those in control groups ($M = 1540.813$, $SD = 15.043$), $t(38) = 56.685$, $p < 0.001$, $d = 18.485$, $ES = 0.994$. These results indicated that students using the Cooperpad with the visualization support spent more time on the task than those of students using a common online collaborative writing tool. Indeed, students in the control groups conducted more disengagement behaviors than those students in the experimental groups (See Table 4).

5.2. The quality of cognitive engagement

Table 5 shows the results of the comparison between experimental groups and control groups. Differences were tested using a t-test for independent samples. On average, experimental groups ($M = 4.08$, $SD = 0.93$) attained higher total performance scores than control groups ($M = 3.69$, $SD = 0.48$), but the difference was not significant, $t(38) = 1.567$, $p = 0.13$. This result is consistent with the Janssen et al. (2007) study which showed that the groups that access visualization of participation did not earn higher performance scores on the inquiry group task. However, for Subtask 2 (Key Use Cases) with high level of difficulty, the experimental groups ($M = 1.50$, $SD = 0.51$) significantly outscored control groups ($M = 1.13$, $SD = 0.34$), $t(38) = 2.57$, $p < 0.05$, $d = 0.853$, $ES = 0.393$. This might be caused by more collaborative writing activities occurring in subtask 2 in the experimental groups. If more than two students write on the same part of the proposal, we consider this collaborative writing. Based on the revision history data provided by the Etherpad, we can easily identify how many students were working on the same part of the project proposal during the process of writing.

Table 6 shows that students in both experimental and control settings invested more attention to subtasks 1 and 2 and less attention to subtask 3. For the Subtask 2, 83% ($n = 20/24$) of groups in experimental setting collaboratively wrote the Key Use Cases compared to 44% ($n = 7/16$) groups in control setting. In fact, it was observed that those students in the control groups just focused on completing her or his assigned subtask. However, after finishing their assigned subtasks, those students using the visualization in the experimental groups kept working on other parts of the proposal with high level of difficulty, particularly the Key Use Cases.

Table 4
The four frequent off-task behaviors were found. The value refers to the occurrences of the observed off-task behaviors in the student group.

Group	Verbal off-task chating	Play smart phone	Play computer game	Doze
Experimental group	30	40	4	1
Control group	67	70	12	8

Table 5
Means and standard deviations for experiment and control groups for group performance scores.

Group performance score		Experimental group (N = 24)		Control group (N = 16)		t	p	ES
		M	SD	M	SD			
Total score	Level of difficulty	4.08	0.93	3.69	0.48	1.57	0.13	0.53
Subtask 1: Aim of the project	Medium	1.21	0.41	1.13	0.34	0.666	0.51	0.21
Subtask 2: Key use cases	High	1.50	0.51	1.13	0.34	2.57	0.01	0.85
Subtask 3: Framework description	Easy	1.38	0.49	1.44	0.51	−0.386	0.70	−0.12

Table 6
The percentage of collaboration for experiment and control group.

Question type	Experiment group (N = 24)	Control group (N = 16)
Subtask 1: Aim of the project	67%	53%
Subtask 2: Key use cases	83%	44%
Subtask 3: Framework description	26%	28%

5.3. Students' perceptions of the system

Seventy two students in the experiment responded to the anonymous online survey. They were asked to indicate their perceptions of the group awareness tool used for the group writing assignment (see Fig. 2). Seventy-three percent of participants agreed or strongly agreed that the visualization added fun to the group-writing task. In addition, 65% of participants agreed or strongly agreed that the use of the visualization made them feel motivated to contribute to the work, while 72% of participants agreed or strongly agreed that the use of the visualization of individual engagement intensity bar motivated them to compete with other group members. Furthermore, 68% of participants agreed or strongly agreed with the statement "it is necessary to know my peers' engagement".

Based on the user comments on their experience with the system, obtained through the last online survey open question, the technical issue, such as the browser compatibility and network connection problem, was found to be one of the major issues that cause unpleasant user experience, because sometimes the group awareness tool did not accurately displayed on around ten student computers in the lab. When this issue came, they had to refresh the web page several times or install a latest version of Chrome or Firefox browser. This might explain why some students disagreed with the usefulness of the visualizations on quality measures 2 and 3. In summary, these findings suggested that students reported mainly positive agreements with statements about the ability of the group awareness tool to motivate them to participate more actively in the writing task and 73% of participants reported being happy to use it again.

6. Conclusion

Group awareness is an emerging topic in research on CSCL (Janssen et al., 2007, 2011; Jermann & Dillenbourg, 2008). Janssen et al. (2007) have examined the capacity for group awareness tools to foster social regulation activities and increase group performance based on the analysis of group communication through a chat program. This paper conducts an empirical study to examine the impact of a group awareness supported OCW tool and a common OCW tool on the engagement of 120 Chinese undergraduates enrolled in a software engineering courses. The study examines behavioral engagement via direct observation with BOSS (Shapiro & Keller, 2006) and quantitative computer-recorded information, such as word count. In addition, cognitive engagement is measured by the quality of the group-writing product (project proposal), and emotional engagement is measured by student self-reports.

The study results show that students using the OCW tool with group awareness support write more words and present more on-task behaviors than those without the group awareness support. Regarding the quality of the overall project proposal, the study does not find significant difference between the experiment groups and control groups.

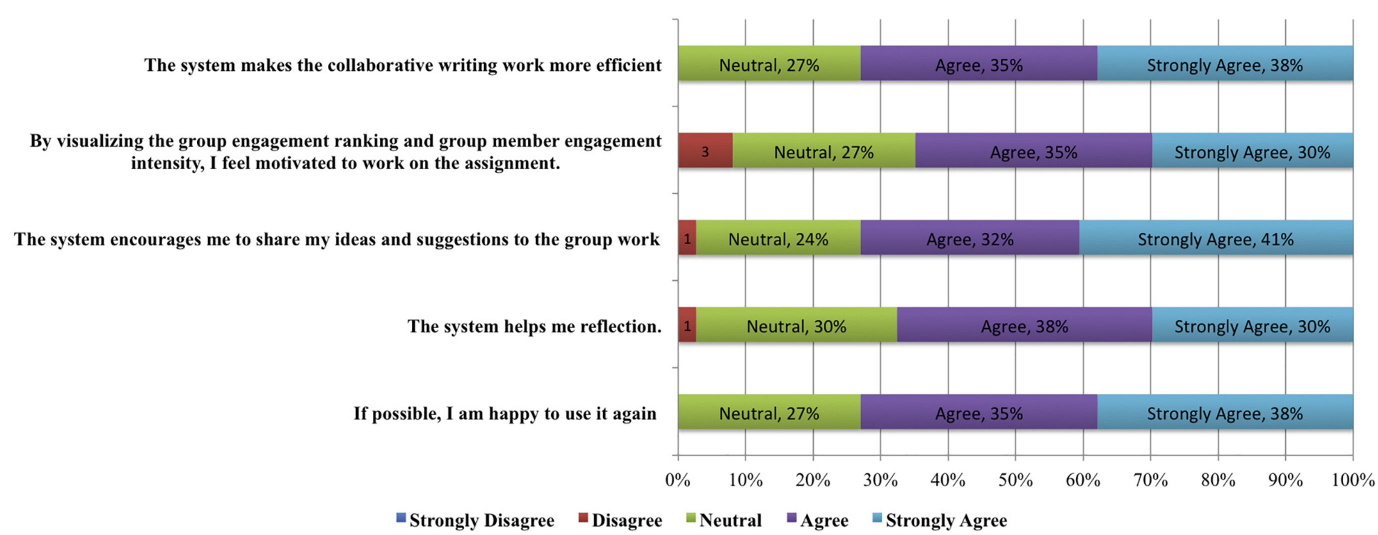

Fig. 2. Students' perceptions of Cooperpad.

This result agrees with the findings in Janssen et al. (2007) study. However, when it comes to writing the most difficult part of the proposal, the experimental group students significantly outperform the control group students. In fact, students using the group awareness tool tend to collaborate more on more difficult task components. Finally, as for student emotional engagement, the majority of students express positive emotions towards the system and feel that this visualization tool has motivated them to work on the group task.

It should be aware that some factors might have affected the results of this study. First, group size is an important factor in CSCL. This study uses groups of three members. In such smaller groups, everyone is assigned to a sub-task and their responsibility to participate is high, which makes it so easy to perceive which team member is off-task. But, if larger groups were applied and some team members did not have specific tasks, the results might have changed. Another factor is the nature of the group task, which may also influence the study result. In this study, the group task can be easily divided into three parts and each member works on the individual part. As a result, students tend to cooperate rather than collaborate on task (Dillenbourg, 1999). Third, the proposed group awareness tool is more suitable for performing synchronous collaborative writing tasks rather than asynchronous ones, since the visualization of individual engagement intensity is only useful when group members perform tasks synchronously. Fourth, although the two-hour time frame for the writing task is manageable for most of students, it is still possible that the time frame is short for a few students. Therefore, these students may just want to make sure that they are dangerously able to submit the completed assignment before the deadline no matter how much effort their teammates have made. Last, this study has a small sample size—it contains only 24 experimental groups and 16 control groups. In sum, these factors may make it difficult to generalize the study results.

Problem-based Learning (PBL) is a constructivist learning paradigm in which small groups of students work collaboratively to solve complex issues in a real world project context (Brodie, Zhou, & Gibbons, 2008). It is an increasingly important part of education reform all over the world, particularly in engineering (Richardson & Delaney, 2009). Our future work will investigate how the system supports student engagement for a task that requires simultaneous problem solving in software engineering courses over a long period of time, such as the System Analysis & Design course. The group task can be specified as less dividable so that group members are supposed to collaborate with each other on the task of providing resolution to a situation, by analyzing the situation, determining what has happened, and making recommendations.

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