Can We Solve Low Participation, Distraction and Inefficiency? A Case Study of Distributed Collaborative Learning in Industries

Xusen Cheng
University of International Business and Economics, Beijing, China
xusen.cheng@uibe.edu.cn

Yuanyuan Li
University of International Business and Economics, Beijing, China
yuanyuanli0911@gmail.com

Ying Zhao
University of International Business and Economics, Beijing, China
zhaoying34506@163.com

Abstract

In a collaborative learning environment, people face obstacles including low participation, distractions and inefficiency. With the development of collaborative systems, people in distributed group prefer Computer Supported Collaborative Learning (CSCL), making the obstacles even harder than obstacles in face to face meetings. Although Collaborative Support System (CSS), which is developed on Collaboration Engineering (CE) theories, can support teamwork effectively and efficiently, there is little research on how CSS can support collaborative learning. In our study, we made experimental case studies on 33 experts coming from different industries. These experts were asked to do collaborative learning using our designed CSS and then interviewed. Finally, survey data were collected to evaluate the system and generate the conclusion. We find that 1) compared to face to face meetings and other online meetings, CSS will receive high satisfaction in solving low participation, distraction and inefficiency; 2) several factors, which are related to participation, attention (minimize distraction) and efficiency, play crucial roles in collaborative learning.

1. Introduction

Collaborative learning is a philosophy of teaching in which learners work together on a common goal, exchanging their opinions on a subject, clarifying the meanings of concepts or jointly make a judgment [1][39]. Computer Supported Collaborative Learning (CSCL) not only permits employees to take courses via the Internet [2], but also allows employees from all over the world to study together. In addition, employees can gather information from both their instructor and fellows [3]. In recent studies, researchers find that although collaborative learning is a good way to learn from others, people will also meet with emerging issues including low participation, distraction and inefficiency [3] [4] [5] [6] [7]. Compared with the face-to-face collaborative learning, online learning can reduce the interaction among members, making low participation, distraction and inefficiency problems more seriously. Moreover, the failure of collaborative efforts could lead to time and money wasting and it can even erode strong working relationships [8][37]. Therefore, many teams rely on professional facilitators to design and conduct high value tasks in collaboration [9]. Nevertheless, professional facilitators are expensive and it will take a long time to finish the training [10] [11].

Research and field experiences have provided evidence that Collaboration Engineering (CE) is an approach to create sustained collaborative support by designing work practices for high-value recurring tasks without professional facilitators [11]. In addition, Briggs et al. [12] find that Collaborative Support System (CSS) not only can improve effectiveness of collaborative learning and interaction among participants, but also has a shorter development cycle. Therefore, we can use CE methods to develop CSS and solve problems (for example, low participation, distraction and inefficiency) in CSCL.

However, previous research has paid little attention to the question that how CSS can be used in collaborative learning and the question emerges as what's difference between the CSCL and f2f collaborative learning. Meanwhile, since staff development is important in workplaces, managers have to consider reducing cost together with improving training effectiveness [13]. Therefore, in this research, we try to find out:

1) Compared with face-to-face collaborative learning, can CSS overcome problems including low participation, distraction and inefficiency?

2) Compared with other online collaborative tools, can CSS perform better in distributed groups?

3) What factors will influence CSS performance and users satisfaction?

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In this paper, we will first review the literature to present a more detailed description of the theoretical background on CSCL and CSS. We will then talk about the case study and use both quantitative and qualitative approaches to analyze the results. Finally, we will conclude, by addressing the implications and limitations of our study, followed with presenting ideas for further research.

2. Background

2.1. Computer Supported Collaborative Learning (CSCL)

A learner gradually makes sense of experientially through conversation, practical activity, negotiation and collaboration with others [14] [15]. Mason suggested that "Integrated" model was a resource-based model where the course was based on collaborative activities, discussions and joint assignments [16]. Many researchers also made the same conclusion that the trend of virtual learning environment should be integrated (hybrid) and it would have more interactions in collaborative learning [17] [18].

In recent years, collaborative learning, Web 2.0 and learning design have been identified as hot topics in learning technology development [19]. With the development of information technologies, Computer Supported Collaborative Learning (CSCL) attracts increasing attentions in distributed groups. In addition, sharing knowledge among employees has been seen as critical process in organizations [40]. CSCL refers to create a collaborative learning environment by using computer technology to stimulate students to discuss information and problems from different perspectives, to re-construct and co-construct knowledge or to solve problems [20] [21]. Nevertheless, CSCL frequently faces with some problems, such as low participation, distraction and inefficiency [3] [4] [5] [6] [7]. In recent years, researchers have tried varies methods to solve these emerging issues in distributed groups. For instance, Cheng et al. [4] discussed the participation importance in student online collaboration over time, Kolfschoten et al. [30] used design patterns to improve learning efficiency, and Briggs et al. [5] designed theory to minimize distraction.

However, there is little research discussing how to solve all issues in one platform. Therefore, it is crucial to create an integrated learning platform to improve the effectiveness of collaborative learning and solve problems.

2.2. Collaboration Support System (CSS)

After many years field research, facilitation methods have been widely accepted since they can improve the effectiveness and efficiency of the collaboration. The facilitation could be more helpful with the assistance of a professional facilitator [22], a person who gives instructions to guide the group members in their activities and to help them focus on task outcomes [23]. However, professional facilitators are expensive [10]. Researchers therefore turn to Collaboration Engineering (CE) study, which could be considered as a combination of facilitation and processes design with collaborative support tools such as GSS [24].

Briggs et al. [25] proposed that the next generation of collaboration technologies could present users not just with tools, but with well-designed work practices and they called the practice centric technologies as Process Support Systems (PSS). Briggs et al. [26] then put forward facilitator-in-a-box approach, or CACE/PSS, which fully documented collaborative applications, encapsulated effective work practices and guided teams through step-by-step group activities. Collaborative learning doesn't require professional facilitators anymore, because professional facilitation skills have been encapsulated in the system by using facilitator-in-a-box approach. Briggs et al. [12] then proposed Collaboration Support System (CSS), which combines Computer Assisted Collaboration Engineering (CACE) for creating Process Support Applications (PSA) with a PSS. In this study, we use an improved CSS named Discussion Platform [27] as a practical system to make experimental case studies.

3. Case studies

In order to validate that CSS facilitated online website can support collaborative learning, we use an exploratory empirical examination [38]. In this research, we conducted 33 experimental case studies of collaborative learning in different industries in China. In these case studies, we first gave managers simple trainings and taught them how to use our developed group support system which is called Discussion Platform. Then managers went back to their companies and use Discussion Platform in their team meetings to support collaborative learning. By using CSS to stimulate employees to discuss information and problems from different perspectives, to re-construct and co-construct knowledge or to solve problems, managers would try to solve low

participation, distraction and inefficiency problems. After finishing collaborative learning, managers were required to finish an online questionnaire and in-depth interview.

3.1 Integrated CSS

Discussion Platform is a CSS which was developed to be run in WAMP environment. WAMP means Windows/Linux, Apache, Mysql and Perl/PHP/Python, a group of open source software which is commonly used to build dynamic Web sites or servers. Although they are independent programs, they now have an increasingly high degree of compatibility because they are often used together.

Discussion Platform provides flexible ways for managers to reschedule their training. Because of facilitator-in-a-box approach [12], Discussion Platform also encapsulated structure CE method. See Figure 1.

Figure 1. Discussion Platform control panel

On the Discussion Platform, employees can register their own usernames and group leaders can create their own discussion rooms. When groups intent to the do the collaborative learning, their will log on a specific discussion room with a unique room ID and passwords which are set by a group leader. The group leader will also set some important information such as customized room names, subjects, passwords and discussion schedules when he creates new discussion rooms. Therefore, case studies can follow schedules step by step. The group leader can use Operating Buttons (such as voting, time keeping, move to next step) to design their own collaborative process.

According to Briggs et al. [28], CE has six steps: generate, reduce, clarity, organize, evaluate, and consensus building. To accompany with those steps, Discussion Platform provides support such as new idea creation, voting, classification and discussion. Participants in the session can communicate using chat room in text or use voice communication tools complementally.

3.2 Cases description

There is a variety of e-training types on workplaces: on-line multicast course (often presented as a video conference), interactive virtual classroom (tutored exercises), self-training (students build their own knowledge from offline courses and independent tutorials), and e-projects (big real cases to be solved into a team) [13]. In this study, we are interested in the last learning style, which is more common in present workplace learning.

To evaluate the CSS performance (e.g.) participation, distractions and efficiency, we invited 33 managers from different industries (including finance, IT, real estate, food processing, manufacture and mining) to use Discussion Platform to do their distributed collaborative learning in their team. Although participants are all part-time MBA classmates, the diversity of the background (different positions and age) can show us a general picture in business. These leaders, the average working experience is 16 years, are responsible for arrange regular team training in their daily work. Some of leaders have mature training methods, but some just train their members in casual ways.

In our experiments, we trained managers how to use Discussion Platform and thinklets, so they could use the CSS to support their e-training and follow a reusable process. Figure 2 shows a reusable process which was designed according to Briggs et al.'s [28] model, as well as Kolfschoten and de Vreede's designed methods [11]. In this process, learners typed their ideas as many as possible in the Discussion Platform in the first 20 minutes. Next, a facilitator told other participants that the Fastfocus stage required them to select 10 more important problems and to give each problem a score within 10 minutes. In the Popcornsort stage, the facilitator created some categories in the Discussion Platform according to the suggestions from members, so members could move the unclassified ideas to the specific items as quickly as possible. In the Broomwagon stage, the facilitator asked that whether all ideas were in the right category. In the Strawpoll stage, the facilitator started a vote to make a final group decision and all participants evaluated the classified ideas from score 1 to 5 as the satisfaction increasing. In the Crowbar stage, the facilitator tried to build higher consensus and a task arrangement was given in the end.

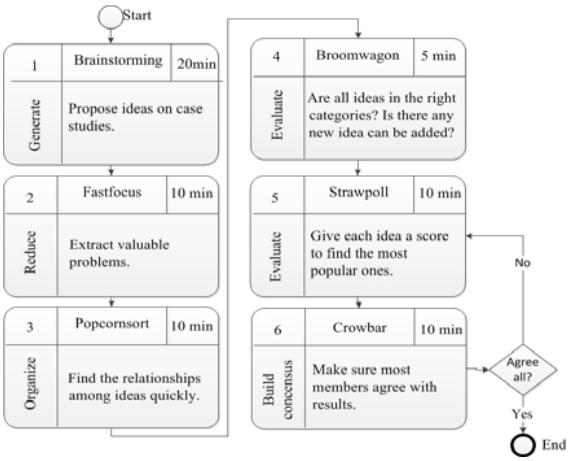

Figure 2 the Collaborative learning process

When managers finished their training, they used the CSS in their groups' distributed collaborative learning. Most of them chose to do case study learning in their industries. In the meanwhile, we encouraged employees to review what they were taught, what they read and what they learned from experience, to develop their own constructions of knowledge.

After the experiment, each manager of a workgroup required to finish an online questionnaire to measure their satisfaction on the CSS and the collaborative process. The questionnaire was tested in Briggs et al.'s work [12]. We chose 20 questions and used Likert scale to measure users' satisfaction with process, users' satisfaction with outcome, users' perceived ease of CSS and users' perceived ease of process. We particularly stressed to measure whether the CSS tools and the process could over overcome problems including low participant, distractions and inefficiency.

Then we gave all managers semi-structured interviews lasting approximately 1 hour which sought to identify their feedback on the CSS. Moreover, we tried to find out important factors that influenced the outcome of the collaborative learning.

4. Results and discussion

4.1. Survey analysis

Currently, we have received 30 effective questionnaires. Although there are 33 managers (23 of which are male) in our experiments, only 30 have finished the online questionnaires. We then used SPSS to do the questionnaires analysis. We first did an internal reliability test by using the Cronbach's Alpha coefficient. In Table 2, all items have a Cronbach's Alpha coefficient higher them 0.8, which means that the scale results have a high reliability.

In general, participants show their high satisfaction about the collaborative learning since all groups item receive a mean score high than 3.7, especially the Satisfaction-with-outcome scale receives a highest mean (3.993) with a standard deviation of 0.881. In fact, users show their high satisfaction on both CSS and design process, since all items have a mean between 3.78 and 3.99. In the F-test, we can't find the statistically significantly different between samples and the overall.

Table 2: Statistical data analysis results

Label	Measure(1=negative; 5 =positive)	Que.Num	Cronbach's Alpha	Mean(SD)	F-test	Sig
SP	Satisfaction−with−process scale.	5	0.899	3.893(0.711)	0.326	0.86
SO	Satisfaction−with−outcome scale.	5	0.82	3.993 (0.681)	1.082	0.369
TOOLDIF	Perceived ease or difficulty of tools scale.	5	0.893	3.780(0.784)	0.524	0.718
PROCDIF	Perceived ease or difficulty of work processes scale.	5	0.921	3.953(0.827)	0.249	0.91

**. Correlation is significant at the 0.01 level (2-tailed).

Pearson's Correlation Analysis revealed statistically significant relationships among some of the exploratory measures (see Table 3).

Table 3: Pearson's correlations among exploratory measures

	SEX	AGE	SO	SP	TOOLDIF	PROCDIF
SEX	1.000	-0.334	-0.321	-0.219	-0.274	-0.184
AGE	-0.334	1.000	0.064	0.081	0.075	0.058
SO	-0.321	0.064	1.000	0.846**	0.846**	0.799**
SP	-0.219	0.081	0.846**	1.000	0.753**	0.767**
TOOLDIF	-0.274	0.075	0.846**	0.753**	1.000	0.818**
PROCDIF	-0.184	0.058	0.799**	0.767**	0.818**	1.000

According to the correlation analysis, we find following relationships.

1. *Satisfaction - with - outcome* was strongly associated with *Perceived ease or difficulty of tools*, *Perceived ease or difficulty of work processes* and *Satisfaction - with - process*. In other words, the easier people reported the tools and process, and the more people felt satisfied with the process, the more likely they were to feel satisfied with the outcome.
2. *Satisfaction - with - process* was strongly associated with *Perceived ease or difficulty of tools* and *Perceived ease or difficulty of work processes,* which means the easier people reported the tools and process, the more likely they were to feel satisfied with the process.

3. *Perceived ease or difficulty of work processes* was strongly associated with *Perceived ease or difficulty of tools.* In other words, the easier people reported the tools, the easier they would feel about the process.
4. *Age* and *sex* don't have the statistically significantly different from other factor. In our experiment, different age and sex don't have different effects on the factors.

To sum up, we draw these relationships in Figure 3.

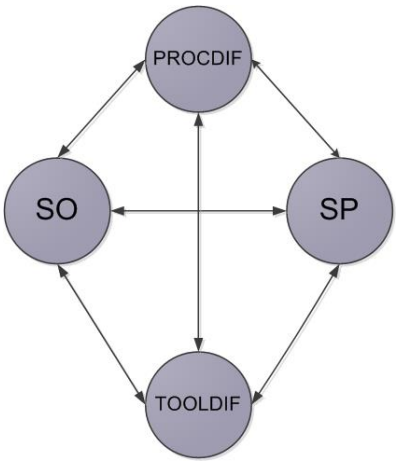

Figure 3. Correlation analysis results

Therefore, we find that *Perceived ease or difficulty of tools*, and *Perceived ease or difficulty of work processes* are two significant parts that could make the users satisfied with the collaboration process and outcomes. This gives us more clues for further evaluation using interviews that we should put more time in asking them the questions about tools and processes.

4.2. Interview analysis

In-depth interviews were conducted in our research after experiments. The face to face interview is a frequently used technique to explore new factors and could be used as a further step of surveys [31] [32]. In our previous quantitative analysis results, we found that tools and processes had important relationships with users' satisfaction. So we focused on questions about tools and processes related to participation, distraction and efficiency.

We interviewed 33 managers in different groups who had participated in the collaborative learning. In the handling of the interview data, we gave each group a detailed number (ID) first. After that, we extracted critical statements of the interview and keywords. Then we classified keywords and drew conclusions. We mainly compared the feedback about face to face collaborative learning, CSS supported collaborative learning, the feedback about CSS and other online support tools.

4.2.1. Face-to-face V.S CSS

In Table 4, we presented the difference in f2f collaborative learning and CSS learning in efficiency, participation and attention.

Firstly, CSS can make the collaborative learning efficiently because the system can reduce disturbance and provide a clearer goal and a defined schedule. In addition, the CSS is more convenient than f2f collaborative learning. Participants suggest that in the CSS, they just need to follow the leader's facilitation and focus on the sub issues. Compared to the collaborative learning they have made before, the new facilitation process can stop some inefficient phenomena such as unrelated topics or the endless arguments. In the efficiency part, we find both objective factors ("less affected" and "convenience") and subjective factors ("timing", "clear goals" and "attention") make CSS more efficiency than face to face meeting learning.

Secondly, CSS can reduce the low participation problem. Since CSS can provide a flexible and convenient platform for collaborative learning, it can broaden team members across area. In addition, in the virtue environment, introverted people dare to share their opinion. Researchers found that employees learned new skills and knowledge most from interaction with diverse people [29]. Therefore, high participation will result good performance of collaborative learning.

Table 4 Comparison between F2F and CSS

	Face to face	CSS (Discussion Platform)	Keywords	Conclusion
Efficiency	*It is easy to slope away to other irrelevant topics(I8) The way face to face can be influenced by other people. It is less effective than online way. (I13)*	*In the Internet, it is convenient to work separately. So we can improve efficiency.(I1) It is efficient, and the agenda has a time limit and will make the participants more concentrated on the topic. (I8) I think it can reach conclusions within the limited time. It is so good. (I13)*	Less Affected	Some **objective factors** make CSS efficiency
			Convenience	
			Timing	Some **subjective factors** make CSS efficiency
			Clear Goals	

Participation	*It is common we have face to face meeting when we are not distributed, we will choose face to face meeting. (I1)*	*During the business trip, We have to choose online collaborative ways to meet some emergency.(I1)* *We don' need to find a place to gather together when using online collaborative learning. It is very convenient. (I10)*	Cross-region Emergency Convenience	Online collaborative learning makes participation more **flexibility**.
	I don't like to talk too much in meeting.(I2)	*I have to think deeply when typing (I2).* *Some introverted person dare to express themselves by online group chat. (I7)*	Literal Expression	**Literal expression** can help people think carefully by typing in the system, thus encouraging their participation.
Attention	*It is disorder when we discuss something f2f.(I2)* *When f2f, we have to wait for one's presentation of his ideas one by one, sometimes, we missed some ideas. (I9)*	*We can see everybody's thoughts directly though record to pick up which is of value.(I2)* *Compared to f2f, it won't leave out important viewpoints. (I7)* *We don't need to ask someone to do a meeting record. The platform can directly give it to us. Easy for us to pick up anything important. (I10)*	Easy to Read Comprehensive Focused	**Recording** test can make the record complete to choose the most important, thus improving participants' attention.
	Sometimes people will change their original intention when discussing with others f2f.(I4) *F2f seems to be lacking in frankness.(I13)* *I subject to others' idea for the sake of friendship.(I19)*	*Within the limited time, everyone tries their best to express themselves.(I4)* *Anonymity can protect us from authority disturbance. (I8)* *People may echo leaders' views, then the outcome will not real.(I9)*	Timing Anonymity	**Anti-interference** makes people more concentrated on the topic itself.

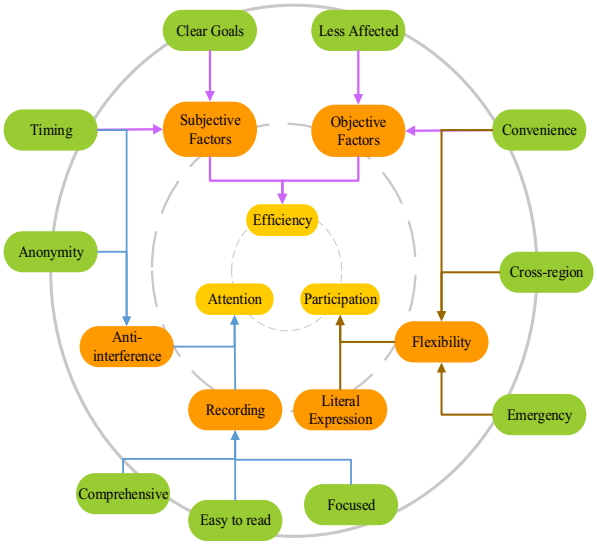

Figure 4. Successful factors relationship map (SFRM) of CSS compared with F2F

Thirdly, CSS can make people more concentrate on the topic. In the CSCL, distraction is a common issue in face to face meeting [5] [6]. In the collaborative learning, CSS can record learning process automatically and trainers can review their learning transcripts. Since team members type their ideas in Discussion Platform, they have to organize their opinions and they also have more time to think comprehensively. Users can also learn others' thinking methods through text analysis. In addition, anonymity can protect employees from authority disturbance, so people can focus on the topic itself.

In order to have a visual impression on the factors' relationships, we put the three levels keywords into a three levels circle based successful influence factors relationship map (SFRM). Referring a research onion style map [33], the SFRM shows advantages of the CSS (See Figure 4).

In the core circle of the Figure 4 is three important questions we want to investigate, that is efficiency, attention (minimize distraction) and participation. In the second circle, we can find key factors that have direct relationship with the final result. For example, "flexibility" and "literal

expression" have direct connection with "high participation". In the third circle, we distract keywords that mentioned by interviewers and these keywords play a fundamental role to satisfy participants. We can find that there are some keywords have different influence on the core circle factors. For example, in the one hand, "timing" has effects on "attention", because when we set a time guild, we will focus our attention in limited time and finish tasks. In other hand, the time limitation will also have effects on efficiency. We can see that "less affected", "convenience" and "attention" also appear two times in the relationship map.

4.2.2. Online meeting tools V.S CSS

In the market, there are plenty of discussion tools with tremendous characteristic. However, Discussion Platform is a different collaborative tool which is a simple and structural system developed on an integrated e-learning model [16] and CSS theories [12]. In order to find out the difference between CSS and other online tools, we interviewed managers what they thought of Discussion Platform compared to other meeting support tools such as QQ (a popular Chinese chatting tool), SNS, MSN Messenger and Skype.

We find that CSS gain more appreciation than other popular meeting tools in participation, attention (minimize distraction), and efficiency. We summarize the results in Table 5.

Firstly, compared to the online discussion tools, Discussion Platform has multi-modules, time limitation, democratic voting and reasonable process. In conclusion, the CSS is easy to use, effective to receive results in limited time and useful in making decision. Therefore, CSS can improve efficiency.

Secondly, CSS encourages people do brainstorming in order and voting process to guarantee everyone's opinion value. So it can improve participation.

Thirdly, the CE process in the CSS make people focused on the topic and the role of facilitator in discussion help people minimize distraction.

Table 5 Comparison between Online meeting tools and CSS

	Online meeting tools Eg. QQ, MSN, Skype.	CSS (Discussion Platform)	Keywords	Conclusion
Efficiency	*QQ and Skype let participants talk any topic they want which lead to low efficiency for group learning (I4)*	*Discussion system use different modules to meet our needs. (I1)* *Discussion can make our ideas clear. (I2)* *It is simple to use and understand its functions. (I13)*	Multi-module	**Ease of use** contributes to high efficiency.
			Simple to use	
	QQ can't constraint discussion time. (I4)	*It makes good use of time. (I4)* *The outcome is objectiveness. (I12)* *I think it have advantage in efficiency over QQ, because of the module to make a vote on classification results. (I19)*	Objective outcomes	**Effective Results** in short period contributes to high efficiency.
	In QQ or Skype, every word and sentence are showing the chatting box and disordered (I2) QQ and Skype cannot be used to make a decision actually.(I3)	*System uses process to help us make decision in a short period.(I2)* *In this system, we are more serious and focus on what we are doing (I5)It set a time constraint so we have to make decision effectively.(I6)Voting makes us have shared goals.(I11)*	Process	Efficient **decision-making**: Decision-making is efficient
			Clear goals	
			Timing	
Participation	*In Skype, when we have a problem to discuss, everybody was talking in chaos.（I2）*	*We have produced a lot of useful ideas in the brain storming stage (I3)* *It makes us think more.(I9)*	In order Brainstorming	**Productivity** can benefit participation
		I think Discussion platform is better in the module voting. (I19) *Everyone must vote and submit, or you will not check the final results.(I21)*	Voting	**Voting** can encourage participation
Attention	*It is easy to digression. (I7)*	*This process develops a strong self-discipline and push ourselves concentration(I5)*	Process	**Focused** on the topic can make people

	QQ is just a real-time chat tools, while the process in Discussion system is targeted and efficient.(I9)	*Compared with QQ and Skype, setting a time constraint can make you feel tension. (I6)*	Timing	concentration.
		There are no distractions because of the limited time when following the orders of facilitators. (I8)	Facilitator	The role **Facilitator** in Discussion makes our attention

In order to have a visual impression on the factors' relationships, we also draw a three level' circle (See Figure 5), which is based on successful influence factors relationship map (SFRM). In the core circle of the map is efficiency, attention (minimize distraction) and participation. In the second circle, we can find 1) "ease of use", "decision making" and "effective results" have direct relationships with efficiency; 2) "facilitator" and "focused" have direct relationship with "attention (minimize distraction)"; 3) "productivity" and "voting" have direct relationship with "participation". In the third circle, we find that "timing", "process" and "voting" appear several times.

If we put Figure 3 and Figure 4 together, we can only find two common keywords: "clear goals" and "timing". So we can see that CSS received greater satisfaction than f2f and other online tools because it had clear goals and a timing controller.

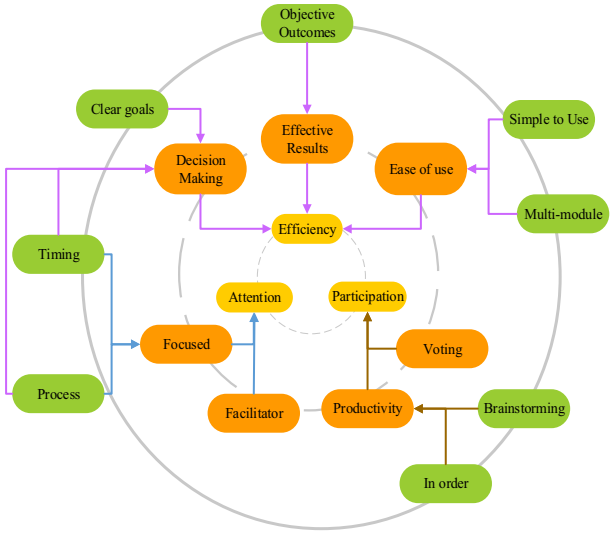

Figure 5. Successful factors relationship map of CSS compared with other online tools.

4.2.3. Improvement

In the meanwhile, we can find some problems and suggestions for Discussion Platform.

Firstly, some interviewers hope that voice input can be added. In the present version of CSS, we don't add voice chatting function. Although trainers can use other tools complementally, managers still think it could be better to integer them.

"The only problem is that it needs you to type words where if there is a voice input that will be perfect" (I1); "I cannot make a voice input" (I9); "It is better to add a voice input function" (I10).

Secondly, instructions of the tools and modules should be added to the front page. Although Discussion Platform is ease to use, it contains many CE methods. If managers don't take a training to learn how these CE methods work, it will be hard for them to find the secret of CSS.

"More detailed instruction of the tool and how to use each module is needed."（I9）

Thirdly, it would be better to have more statistical analysis of the voting results. We know just present average analysis and standard deviation analysis. Managers think it can add more statistical analysis and visual graphic analysis.

"If there is a better statistical analysis function of the voting results it will be better." (I2)

6. Conclusions

Our research has successfully used CSS tools to support collaborative learning to solve low participation, distractions and inefficiency problems. Discussion Platform, as a facilitated online website, helps team members do collaborative learning effectively. According to questionnaire analysis results, Discussion Platform receives a high degree of satisfaction. Furthermore, from interview analysis results, we can draw following conclusions:

1) Compared to face to face collaborative learning, CSS can overcome problems including low participant, distractions and inefficiency;

2) Compared to other online collaborative tools, CSS can perform better in distributed groups.

3) There are crucial factors that will influence CSS performance and users satisfaction, including "timing", "clear goal", "process", "anonymity" and "voting".

This paper primary contributes to Collaboration Engineering (CE) research on CSS practical implementation [12]. People often learn from others

[29], but virtual learning environment reduces the interaction in the process which will result the poor performance including low participation, distraction and inefficiency [3] [4] [5] [6] [7]. This study extends Cheng et al. [4]'s studies regarding participation in online collaboration, Kolfschoten's studies in learning efficiency [30] and Briggs et al.[5]'s studies in distraction. We not only verify some crucial factors in previous studies (for example, ease of use effects in learning efficiency [30], facilitator ability effects attention [12] and good process effects participation [11]), but also find other new factors (for examples, clear goals, good processes and control time effect efficiency; productivity, voting and flexibility effect participation; and recording, control time and anonymity affect attention). In addition, this research also extended the previous tools and process research used in student context [27] into a business context where we have a different correlation analysis results. The SFRM model we created will also provide clues for further research of studying the factors found in collaboration and group decision making experiments.

From a practical aspect, our research provides managers an outstanding method to schedule team learning. Industry managers can use CSS to support collaborative learning in distributed groups. In addition, CSS can help managers to schedule team learning and prevent from endless and irrelevant chatting. We also verify that integrated and multimedia supported training will receive high appreciation in working environment [11] [16] [17] [18].

Nonetheless, our research has its own limitation. Firstly, the research is conducted in a special context of Chinese industry where people prefer collective culture. It may have different feedback and findings from different countries and cultural background (e.g. individual culture). In addition, we also ignore the mobile connection in our experiments. Although we have developed mobile app for Discussion Platform, we still didn't test it in industries. Finally, except for age and gender, we didn't consider other demographics. Since we only collect the feedback from managers, we didn't contact learning groups and couldn't consider group compositions. However, groups' diversity influence group performance [34][35[36]. Future research should not only consider the impact of tools and processes, but also the impact of people. Moreover, control groups could be used to further validate the results in different cultural and global contexts by conducting further experiments, interviews and surveys.

7. Acknowledgement

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