Application of a Novel Collaboration Engineering Method for Learning Design: A Case Study

Abstract

Collaborative case studies and computer supported collaborative learning (CSCL) play an important role in the modern education environment. A number of researchers have given significant attention to learning design in order to improve the satisfaction of collaborative learning. Although Collaboration Engineering (CE) is a mature method widely used for collaboration design, there is limited research as to whether CE is useful for learning design, in particular, case studies. Therefore, in this paper we designed a contrastive case study in two small classes of a Chinese university. In the first part, we encouraged a teacher to use CE tools to design a learning process. Since Chinese students had limited access to CE platforms, we used our special tool—the Discussion Platform as the main CE tool. A total of 40 students and a teacher collaborated in our first experiment and were asked to complete a survey upon completion of the interviews. In our comparison study, the teacher gave the same task to another 31 students, yet omitted the use of CE tools to design the learning process. In this paper, we compare the results obtained and determine the advantage that CE methods have on learning effectiveness and student satisfaction.

Introduction

Case-based teaching and group learning techniques have been popular in education for a long time (Heim, 2012; Wilson, Goodman and Cronin, 2007; Rippin, Booth, Bowie and Jordan, 2002). Students often engage in discussion and collaboration during case studies (Anderson and Rourke, 2002; Dirk et al., 2013). Therefore, successful methods to design effective courses to learn through case studies are of particular interest to educators. In any interactive learning environment (ILE), design is a critical process (Mor and Winters, 2007). Since computer technologies are continuing to develop in education, educators use a wide variety of tools to assist teaching design (Bell and Federman, 2013). Following many years of research, computer supported collaborative learning (CSCL) has become a key trend in e-learning, and highlights the importance of social interactions as an essential element of the learning process (Koschmann, 1994; Chang, 2013). CSCL is a useful method to stimulate students to discuss information and solve problems from different perspectives (Lehtinen, 2003; Hernández-Leo et al., 2006). Although improvements in technology have eliminated the communicative limitation of group learning, CSCL is hindered by some problems, such as inefficiency and dissatisfaction with group teaching (Minnaert, Boekaerts, de Brabander and Opdenakker, 2011). The word "inefficiency" here means not making efficient use of resources such as time. In our experiment, the efficiency refers to how student can quickly learn the knowledge including the usage of ThinkLet tools and how student can quickly reach consensus and finish the task. And the word "dissatisfaction" means that students or teachers are dissatisfied with processes or results of the group teaching. Common problems such as easy to be distracted, difficult to control and low participation will lead to inefficiency or even failure. In addition to efficiency, satisfaction is another key indicator of success, especially in the IS/IT background (Susarla, Barua and Whinston, 2003; Briggs, Qureshi and Reinig, 2004; Briggs, Reinig and de Vreede, 2008).

Over the past decade, to facilitate collaborative working, researchers have been developing, applying, and evaluating ways to design productive, task-specific work practices (de Vreede, Briggs and Massey, 2009).

They focus on details of a work practice, the configuration and packaging of required technology, and documentation of the guidance to assist group collaboration. This stream of research and method is called Collaboration Engineering (CE), which is now considered to be an effective design method to design collaborative processes (Briggs, Kolfschoten, de Vreede and Douglas, 2006; Kolfschoten et al., 2006). According to the theoretical and practical studies, the CE method can produce high quality outcomes for collaborative efforts in many industrial and educational fields (Cheng, Nolan and Macaulay, 2013; Kolfschoten, de Vreede, Briggs and Sol, 2010; Cheng and Macaulay, 2014). A thinkLet is "a named, packaged facilitation technique that creates a predictable, repeatable pattern of collaboration among people working towards a goal" (Briggs, de Vreede and Nunamaker, 2001). Each thinkLet provides a concrete group-dynamics intervention and instructions for some group process (Kolfschoten et al., 2006). A series of ThinkLets are tools that could be arranged orderly and they can help instructors to guides students to the target. To reach that goal, the designed process may contain brainstorming ideas, connecting ideas, clarifying ideas and also reaching consensus.

Generally speaking, a thinkLet will have a name, detailed scripts, rules, parameters, and choice guidance, etc. For example, LeafHopper thinkLet is used for team members who need to jump from topic-to-topic, contributing as they are inspired, then moving on to new topics. Its scripts contain "Do this", "Say this", "Rules for roles", "Input parameters", "Output parameters", "Choose this thinkLet", "Do not Choose this thinkLet", "What will happen". More specific guidance and successful stories can be found in Kolfschoten et al. (2006). While only 70 thinkLets have been formally documented to date, it appears that the number of possible thinkLets may be infinite. ThinkLets have been used successfully for CE (Briggs, de Vreede and Nunamaker, 2003; de Vreede and Briggs, 2005), especially in training (Kolfschoten and Veen, 2005) and in collaboration research (Santanen, 2005).

Although there is a large quantity of research related to learning design, there is limited material on the use of CE methods in the field of learning design, let alone learning design for case studies. Therefore, in this study, we will: 1) apply CE methods in learning design; 2) compare the results of two types of CSCL – one using CE methods and tools and the other using other online tools; 3) determine whether CE methods can improve the effectiveness and satisfaction of the case studies. In the remainder of this paper we will begin with a review of the existing literature to present a more detailed description of the theoretical background, followed by our research questions. We then proceed with a discussion of the case study and analyze the results from a quantitative and qualitative approach. We conclude by addressing the implications and limitations of our study, and present ideas for further research.

Literature review

Learning design

Research and theory suggest that design-based activities provide a rich context for learning (Willet, 1992). Learning design is one type of teaching-learning process that takes place in a unit of learning (e.g., a course, a lesson, or any other designed learning event). The key principle in learning design is that it represents the learning and support activities that are performed by different people (learners and teachers) in the context of a unit of learning (Koper, 2006). According to the practical studies, well designed process can encourage active learning, self-direction and critical thinking (Heim, 2012; Dirk et al., 2013). Bannan-Ritland (2003) proposed an Integrative Learning Design Framework that strives to combine the creativity of design communities with appropriate adherence to standards of quantitative and qualitative methods in education. Similarly, Collaboration Engineering (CE) is a method used to build processes for participants. The Collaboration Engineering approach prescribes that an expert designs a reusable, transferable and predictable process, which is then transferred to practitioners (Kolfschoten and de Vreede, 2007). The design of a collaboration process is described in the literature as a critical success factor (Fjermestad and Hiltz, 2001). The design patterns used in CE are called thinkLets, which is a named, scripted, and well-tested facilitation technique (de Vreede and Briggs, 2005). A typical thinkLet identification, recommends script elements (do this and say this), rules, input and output, and expected results (Kolfschoten et al., 2010). More detail examples can be found in the work of Briggs et al. (2001). A collaboration engineer can incorporate thinkLets into process designs giving a predictable and repeatable pattern of collaboration among people working towards a common goal (Briggs et al., 2001; de Vreede, Kolfschoten & Briggs, 2006). Therefore, we can use CE methods to create a learning design with the thinkLets patterns.

Collaborative learning

Computer supported collaborative learning (CSCL) refers to the creation of a collaborative learning environment through the application of computer technology to stimulate students into discussing information and problems from various perspectives, to re-construct and co-construct knowledge, or to solve problems (Stahl, 2002; Lehtinen, 2003). Fjermestad and Hiltz (2001) find that collaboration technology can reduce time by as much as 90 percent. According to Briggs, Kolfschoten, de Vreede, Lukosch and Albrecht (2013), there are at least three strategies to advance collaborative learning. Firstly, one of the strategies is to simplify collaboration tools, which often tend to focus on only specific collaborative activities rather than providing users with a complete collaborative work practice (Mittleman, Briggs, Murphy and Davis, 2008), such as Google Docs and Skype. Unfortunately, these mass market tools do not target the specific needs of particular collaboration groups (Mittleman et al., 2008). Secondly, increasing the transferability of facilitation skills is also an important strategy. Researchers have documented some collaboration techniques that are readily transferable to non-professionals, such as thinkLets (Mittleman et al., 2008; de Vreede et al., 2006; Kolfschoten et al., 2006). However, users have to determine the best method to support a particular thinkLet each time they wish to use it since there are limited existing collaboration technologies to support thinkLets directly (Kolfschoten et al., 2007). Finally, using the Collaboration Engineering (CE) method with the technology can advance collaborative learning. CE can be considered as a combination of facilitation and design that aims to create collaboration processes through the application of collaboration support tools such as Group Support Systems (GSS) without the professional facilitators (de Vreede et al., 2009; Kolfschoten et al., 2010; Kolfschoten and de Vreede, 2007). Collaboration process designers who have a set of specific thinkLets available can therefore shift part of their attention from inventing and testing solutions to choosing known solutions (Kolfschoten and Veen, 2005). This may reduce both the effort and the risk of developing group processes. Although there are a wide variety of studies on collaborative learning, very few of them could tell us exactly what kind of design method and tools can improve satisfaction for case studies (Briggs et al., 2008).

In our first study, we encouraged teachers and students to use Discussion Platform (Cheng, Li, Sun and Zhu, 2014), a CE tool which was designed by the third strategy covered previously (using the Collaboration Engineering method with the technology). When a teacher uses CE methods, they design learning processes with the aid of digital technologies. In our second study we asked teachers to give the same task to a group of students in another class using other online collaborative tools (e.g. Skype, QQ Chat, and Wechat), and used the results for comparison. In the second study, some tools use the first strategy (simplifying collaboration tools, such as Google Docs and Skype), while others use the second strategy (increasing the transferability of facilitation skills, such as only thinkLets without CE support).

Research questions

Some scholars in the Collaboration Engineering field have mentioned that some factors are important when applying the CE method, and could be considered as influencing factors, such as low participation (McFadzean and McKenzie, 2001; Cheng et al., 2013;), distraction (Briggs et al., 2003; Davison and Briggs, 2000) and inefficiency (Minnaert et al., 2011). Understanding influencing factors, espec ially their relationships, will help future CE design and improvement. Additionally, the perceived efficiency and users' satisfaction with the CE methods in the collaboration are two important measurement items in CE which could help measure the success of CE application, and have been measured using surveys by CE field scholars (Briggs et al., 2013). According to Peter Drucker, while efficiency refers to how well something is done, effectiveness refers to how useful something is (Drucker, 2006). When conducting the implementation of the CE method and the embedded tools in online collaborative learning, effectiveness is usually an item that is measured by CE researchers that can help to evaluate the implementation (Azadegan, Cheng, Niederman and Yin, 2013). In our context, efficiency referred to how student could quickly learn the knowledge including the usage of thinkLet tools and how student could quickly reach consensus and finish the task. Effectiveness referred to how well students can solve different problems and they felt satisfied about their learning.

The key elements we investigate in this piece of research can be summarized in the following questions:

Q1: Can Collaboration Engineering methods be used in learning design and what are the relationships among influencing factors?

Q2: Can CE methods improve efficiency and satisfaction of the case studies?

Q3: Does the introduction of CE tools, for example, Discussion Platform, increase the effectiveness of online collaborative learning?

Method

We conducted a case study of undergraduate students enrolled on an e-business course at a university in China in order to validate whether CE could be used in learning design. In this case study, the students only learned the basic CE knowledge provided during their course. There were two experimental groups. One group was a "CE" group with 40 students in one class and the other group was a control group with 31 students in the other class. The two classes were taught by the same teacher. In the classes, students were divided randomly into groups to collaborate on the same case study throughout an academic semester. Each group consisted of four to five students. The objective was to encourage students to connect theoretical principles to existing practical problems by analyzing a Chinese e-business website. The students collected information about the website, determined problems, and gave solutions based on the theories. They finally gave a presentation on the problems every two weeks. These students were also required to write an analysis report about the problems and solutions before the final exam.

"CE" group

In the "CE" group, a teacher was acting as a collaboration engineer, designing the learning process using thinkLets. The teacher provided students with materials describing how to use thinkLets on the Discussion Platform, which is a collaborative tool supporting the thinkLets method (Cheng, Li, Sun and Zhu, 2014). The entire design process followed the CE approach developed by Kolfschoten and de Vreede (2009), which is shown in Figure 1.

We modified the researcher-led design and teacher-led collaboration (Barab and Squire, 2004) to teacher-led design and students-led collaboration. The approach consists of five steps. In the first step (task diagnosis), the teacher identified the goal and task. In the second step (activity decomposition), we encouraged the teacher to use a model consisting of six parts: generate, reduce, clarify, organize, evaluate, and build consensus (de Vreede et al., 2006). So the teacher could break down processes quickly. In the third step (task-thinkLet choice), the teacher selected different thinkLets. Students learned details about some basic thinkLets (de Vreede et al., 2006) in class, including FreeBrainstorm and Onepage (to motivate the generation of many ideas), BroomWagon (to reduce the items to the key ones through voting), FastFocus (to move from reduced to increased shared understanding of concepts) and Crowbar (to discover and discuss the reasons behind disagreements on certain issues). In the fourth step (agenda building), the teacher made an agenda and delivered it to the students. In the fifth step (design valuation), the teacher validated the learning design by the students' performance. The students' discussion data (including chat text, created ideas, voting score, and meeting schedules) were recorded on the teacher's computer, allowing the teacher to give each group feedback based on the data analysis and students' presentations. So the teacher could redesign the process periodically.

[Insert Figure 1 here]

We installed Discussion Platform onto the teacher's computer which was connected to the campus LAN. The server allowed the teacher to collect data about the students' case study processes. The teacher was also able to find teaching feedback from the database. Figure 2 shows the case procedures. The students were able to register their own usernames on the Discussion Platform and the group leaders/facilitator created their own discussion rooms. The group members logged into the specific discussion room with the unique room ID and password which were set by the group leader. The group leader was also able to set important information such as customized room names, subjects, and discussion schedules when they created new discussion rooms. This allowed the case studies to follow given schedules step-by-step. The group leader used Operating Buttons (such as voting, time keeping, move to next step, etc.) to design their own collaborative process. In the session, the students discussed freely. The teacher used the online recorded data and offline performance feedback to evaluate teaching effectiveness; and changed the thinkLets process, provided more theoretical frames for the case studies, and gave suggestions to students based on their learning analytics.

[Insert Figure 2 here]

Figure 3 shows an example of the collaborative process designed by the teacher in the first iteration. This example has used a small topic which will not take a long time. However, the time settings for each process could be dynamic if the students want more time. The group leader/facilitator created a discussion room on the Discussion Platform and designed the collaborative schedule. New participants to the pattern development process often encounter the "cold-start problem" of identifying potential patterns in data (Retalis, Georgiakakis & Dimitriadis, 2006). Winters and Mor have shown that short case study descriptions provide a productive "way into" the process for participants (Winters and Mor, 2009). Therefore, firstly, participants describe cases, exchanged the collected materials and expressed opinions. Secondly, the facilitator clicked buttons to begin a countdown period and broadcasted that Onepage had begun. The members then entered their ideas. After five minutes, the facilitator informed the other members that we had moved to Fastfocus stage and required each one to select ten important ideas. Then members gave important ideas a score of five within five minutes. The facilitator was then able to delete ideas with low mean scores. Before the Popcornsort stage, the facilitator created categories on the Discussion Platform according to suggestions from members. In the Popcornsort stage, the members moved the unclassified ideas to the specific items as quickly as possible. The facilitator then checked one category after the other and confirmed with the members that all ideas were in the correct categories. In the

Strawpoll stage, the facilitator began a vote and allowed all members to evaluate the classified ideas from one to five with regard to satisfaction, where five was most satisfied. In the Crowbar stage, the facilitator built a higher consensus and a task division was finally created.

[Insert Figure 3 here]

Control group

In order to exclude other factors, we designed another case study to compare our results against. In the other class, 31 students were asked to complete the same task. However, in this class, the teacher neither designed the learning process for them nor encouraged them to use CE tools or Discussion Platform. The students were free to use QQ chat, Skype, and other online tools of their choice. In other words, they just used the first kind of collaborative tools, but not the second kind or the third kind of collaborative tools we mentioned in the literature section (Briggs et al., 2013). At the end of the semester, we gave the students the same survey as the "CE" group which was also anonymous and not used as a measure for their course evaluation, so that the students would not feel any pressure. Table 1 shows the difference between the "CE" group and the control group. In general, we assumed that there is no significant difference in the level of familiarity with using CSCL tools between the students in the control group and the CE group.

[Insert Table 1 here]

At the end of the semester, we asked all students – 40 students in the "CE" group and 31 students in the control group – to complete an anonymous survey which mainly refers to the work of Briggs et al. (Briggs et al., 2013). The survey contained 20 questions divided into four dimensions with each dimension containing five questions. The four dimensions included Satisfaction-with-process (SP), Satisfaction-with-outcome (SO), Tool Difficulty (TOOLDIF), and Process Difficulty (PROCDIF). The first two dimensions of the survey were used to measure "Satisfaction-with-process (SP)" and "Satisfaction-with-outcome (SO)". These two dimensions could show the effectiveness of the learning, that is how well students can solve a different problems and they felt satisfied about their learning and working. The "Satisfaction-with-process (SP)" dimension was used to determine if these participants were satisfied with the collaborative process designed. The "Satisfaction-with-outcome (SO)" dimension was used to determine if the students' outcome expectation had been met. In other words, we tried to conclude whether the students could connect theoretical principles to situated problems and give solutions with the platform support. Further, we validated whether the effectiveness and efficiency of the collaboration learning had been enhanced. Other two dimensions show the efficiency, which referring to how student could quickly learn the knowledge including the usage of ThinkLet tools and how student could quickly reach consensus and finish the task. The "Tool Difficulty (TOOLDIF)" dimension explained how users perceived the difficulty of the platform, and also contained five questions. In the "Process Difficulty (PROCDIF)" dimension we used five semantic anchor items to investigate the participants' perceptions of the degree to which aspects of the work process were easy or difficult. In addition, the 40 students in the CE group and the teacher also participated in a half-structure interview lasting from half to one hour. The interview was conducted by our research members, who were unknown to the students, so that the students felt free to talk about their feedback of the study. The interview questions referred to the work of Azadegan et al. (2013). The interview transcription would be divided into four dimensions and grouped with the same keywords.

Results and discussion

"CE" group

We first conducted an internal reliability test using Cronbach's Alpha coefficient. The results are given in Table 2 where it is seen that most items have a Cronbach's Alpha coefficient higher than 0.7 (for the PROCDIF group, if the fourth question is deleted, the Cronbach's Alpha coefficient rises to 0.728). The internal reliability of the 20 questions is 0.87, higher than the threshold level of 0.80, which means that the scale results have a high reliability. It can be seen that, in general, the participants show a high level of satisfaction for the collaborative case studies since all item groups receive a mean score higher than 3.8.

[Insert Table 2 here]

Participants' satisfaction with the process ranged from a score of 1 (very dissatisfied) to a score of 5 (very satisfied), with an average of 3.81 and the result was statistically significantly different from neutral ($t=2.611$, $df=39$, $p<0.01$). According to our interview record, most of the students expressed their satisfaction with the design process. One student commented that *"Compared to the previous methods, the thinkLets methods are more scientific and effective."* In the previous study, students often participated in face to face meetings with a general agenda. They would discuss the topic at a relaxed pace and few would use voting or classifying to obtain consensus. Other students shared similar positive feelings about thinkLets. For example, *"Firstly, by Freestorming, we can collect as many ideas as possible. By the Popcornsort and Bucketwalk, we can divide the ideas we collected from the brainstorming process into some definite sorts. Thirdly, by the Strawpoll process, we efficiently selected the most reasonable idea and got consensus quickly."* As in the previous literature review, researchers have concluded that thinkLets are useful design patterns in collaborative working (Mittleman et al., 2008; de Vreede et al., 2006; Kolfschoten et al., 2006). In our case study, we found that thinkLets can also improve the satisfaction of the learning design. For example, thinkLets can reduce distraction within the discussion which is an important issue in group learning (Cheng et al., 2013). One student said that *"With the help of the thinkLets process, we could also save a lot of time and reduce deviation from the topic at hand."* To sum up, thinkLets can help students to reduce distractions, get consensus quickly and create more ideas. By identifying these factors, we could establish the influencing factors to answer the first research question.

Participants' satisfaction with outcome ranged from a score of 1 (very dissatisfied) to a score of 5 (very satisfied), with an average of 4.25. In addition, there was no statistically significant difference from neutral. Students showed a high satisfaction with the result. Students felt that they achieved a positive outcome with the help of the scientific methods and collaboration process. One student replied that *"We always receive feedback from the teacher every two weeks. We can determine what theory hasn't been understood easily."* We also received comments from the teacher: *"I am greatly satisfied with the teaching results. You know all students show their passion in case studies. The final reports they submitted are better than all previous classes. Actually, I am also learning from the process and have adjusted my teaching materials constantly."* We found that the teacher valued students' participation (Cheng, Li and Zhao, 2015) which is enhanced in our experiment.

Participants' perceptions of the ease or difficulty of the Discussion Platform tools ranged from 1 (very easy) to 5 (very difficult), with a mean of 4.13, which was statistically significantly lower than neutral ($t=-2.621$, $df=39$, $p<0.01$). All students agreed that the tools were easy to grasp; they did not have to waste much time learning them. One student indicated that *"The Discussion Platform is easy to use. Its interface is very simple and exact."* Additionally, the teacher also gave a positive reply on the Discussion Platform *"I find it is simpler to retrieve students' data on the platform. Based on the database, I can do new process design or give suggestions to students. Actually, it is easy to determine if everybody has participated in the collaboration process."* These comments on the tools gave us the answers to the third research question about the CE tools.

Participant reports of the degree to which their group considered the multiple perspectives of group members ranged from 1 to 5, with a mean of 4.14, there is no statistically significant difference from neutral. Students who followed the learning process expressed their views on the tools. *"Since the collaboration process is designed step-by-step, we could follow the process easily. The scientific principle also makes the collaboration process effective." "The thinkLets can make the collaboration process much clearer. We just need to follow the four steps and finally get the answer we want."* These selected comments showed their feedback on the design process so we could draw conclusions for the second research question.

We also conducted a correlation analysis of quantitative data from the questionnaire. Pearson's correlation analysis revealed statistically significant relationships among some measures. The results are shown in Table 3.

[Insert Table 3 here]

The analysis results showed that under the condition of this study, Satisfaction-with-process was strongly associated with perceived ease of tool use. The easier a tool was to use, the more likely the user was to feel satisfied with the process. Satisfaction-with-outcome was statistically significantly related to perceived ease of tools and work processes. Therefore, the more at ease people are with the tools and process, the more likely they were to feel satisfied with the outcome. Our analysis also revealed relationships between age and the perceived ease of the work processes. The higher a participant's age, the easier the work process was perceived to be. In addition, we were unable to quantify a relationship between gender and other elements in this study. In the previous research, Cheng, Li, Sun and Zhu (2014) also found that age had a positive influence on the design process learning and that gender had no influence on results. According to the interview feedback, we found supporting arguments for these relationships among these influencing factors. Some students mentioned that they were satisfied with the results because the process was easy to learn and it had effective function. *"I don't think I would like it if the process was complex. In our discussion, we just repeated the same thinklets so we could focus on our topic. I like the process. We really did a good job."* In addition, the Discussion Platform was simple to use, so they could apply the designed process without obstacles. In this case, TOOLDIF contributes to the satisfaction of both process and outcome. We also noticed that higher grade students would learn the new process more quickly. Since older students have often learned related case studies methods and have more experience in doing case studies, they could learn the CE process more easily than the younger students. That is why the higher age students were inclined to give higher scores for PROCDIF.

To conclude, we have drawn the significant relationships in Figure 4. These relationships show that: 1) The higher the participant's age, the easier the participant perceives a work process; 2) Respondents were more likely to feel satisfied with the process and outcome if they reported that the tools were easy to use; 3) The easier the process was, the more likely the participants were to feel satisfied with the outcome in addition to reporting that the tools were easy to use.

[Insert Figure 4 here]

Control group

We also conducted an internal reliability test using Cronbach's Alpha coefficient. The results are shown in Table 4 where all items are seen to have a Cronbach's Alpha coefficient higher than 0.7. In the SP and SO groups, scores of 0.874 and 0.955, respectively, were calculated. The internal reliability of the entire 20 questions was 0.949, greater than the threshold level of 0.90, which means that the scale results have a high reliability. In particular, the perceived ease or difficulty of tools (TOOLDIF) ($t=-6.674$, $p<0.001$) and satisfaction-with-outcome (SO) (t=-3.918, p<0.005) was statistically significantly different from neutral. We can infer that the reason for this is because the students used different online tools which modify the results.

[Insert Table 4 here]

Comparison of the results of the two experiments shows that the “CE” group using the CE methods has a higher satisfaction in all dimensions (Figure 5). In Figure 6 we can see the results of the independent sample test between the two groups. Since we can find significant difference between the two groups in all dimensions, we can conclude that: 1) The CE methods can help to improve the process satisfaction and learning outcome satisfaction, and 2) The CE tool Discussion Platform is perceived to be better understood and can help enhance process perception.

We can conclude, based on these results, that CE methods when used in learning design make a positive contribution. With the support of Discussion Platform, which is perceived to be easy to learn and easy to follow the process, the students demonstrated high satisfaction with collaborative learning.

Conclusion

This paper primarily contributes to learning design research for collaborative student case studies. The primary theoretical contribution of this paper is in the successful application of the CE method in the field of learning design and learning analytics (Ferguson, 2012). Our results have shown that CE methods can solve CSCL problems including inefficiency and user dissatisfaction (Minnaert et al., 2011). The thinkLets were also shown to be an effective design pattern which contributes to design pattern research in learning design (Koper, 2006). Additionally, we can answer the research questions we raised before:

Q1: Can Collaboration Engineering methods be used in learning design and what are the relationships among influencing factors?

The positive feedback about CE and the high satisfaction scores of the “CE” group prove that CE methods can be used in learning design. The application of the CE methods caused students to be satisfied with the collaborative process designed and the learning outcome. According to the teacher feedback, students using the platform support could better connect theoretical principles to define problems and give solutions (Heim, 2012; Dirk et al., 2013). In addition, our results also reflect the relationships among influencing factors. For example, students were more likely to feel satisfied with the outcome if they reported that the process was easier. Therefore, we can learn that when teachers use learning design to improve learning effectiveness, they should pay attention to perception. In addition, our results concluded that students of a more mature age were able to perceive the learning processes more easily, which is similar to the results achievedin the research of Cheng et al. (2015).

Q2: Can CE methods improve efficiency and satisfaction of the case studies?

We found that, compared to the conventional learning approach, the learning design methods can largely improve the efficiency and satisfaction of the case studies. According to the interview feedback, thinkLets can help students to reduce distractions, get consensus quickly and create more ideas. It proved that thinkLets are efficient design patterns in collaborative learning (Mittleman et al., 2008; de Vreede et al., 2006; Kolfschoten et al., 2006). Participants’ satisfaction is important for success (Susarla et al., 2003; Briggs et al., 2004; Briggs et al., 2008). Therefore, a modern educator should not only provide access to information, but also needs to carefully craft the conditions for learners to enquire, explore, analyze, synthesize, and collaboratively construct their knowledge from the variety of sources available to them (Mor and Craft, 2012). Mor and Craft also stated that the role of educators has now changed from providers of knowledge to designers of learning. A modern educator should focus on learning methods, tools, and theoretical frameworks (Mor and Craft, 2012). In our experiment, we explored how CE methods and tools can help build the learning design process.

Q3: Does the introduction of CE tools, for example, Discussion Platform, increase the effectiveness of online collaborative learning?

Compared to the mass market tools for collaboration (Mittleman et al., 2008), we achieved more positive results when discussion was supported by Discussion Platform, perceived to be easy to learn and to follow the process. Discussion Platform can help teachers and students to participant in the learning process. High rate of participation can help enhance satisfaction (Cheng et al., 2015). The students reported a high level of satisfaction with collaborative learning. In other words, CSCL will be more effective with CE tools support.

Nonetheless, our research has its own limitations. Firstly, the research was conducted in the special context of a Chinese university and the findings in this study may not be generalized to another context. In addition, we also ignore mobile connections in our experiments. Although students can log onto the platform from mobile devices if they are connected to the campus network, we omitted the mobile connection factor since it is inconvenient to measure without a specialized mobile client. We intend to develop mobile clients for Discussion Platform in the future. Our future research will also attempt to further validate the results in different cultural and global contexts by conducting further experiments, interviews, and surveys.

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FIGURES AND TABLES

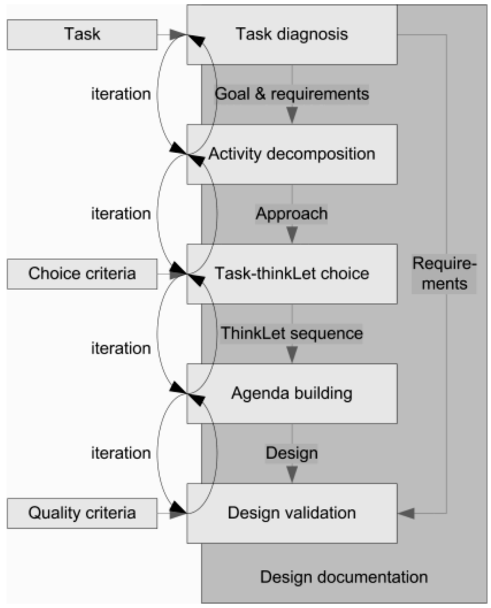

Figure 1. An approach to design collaboration processes (Kolfschoten and de Vreede, 2009)

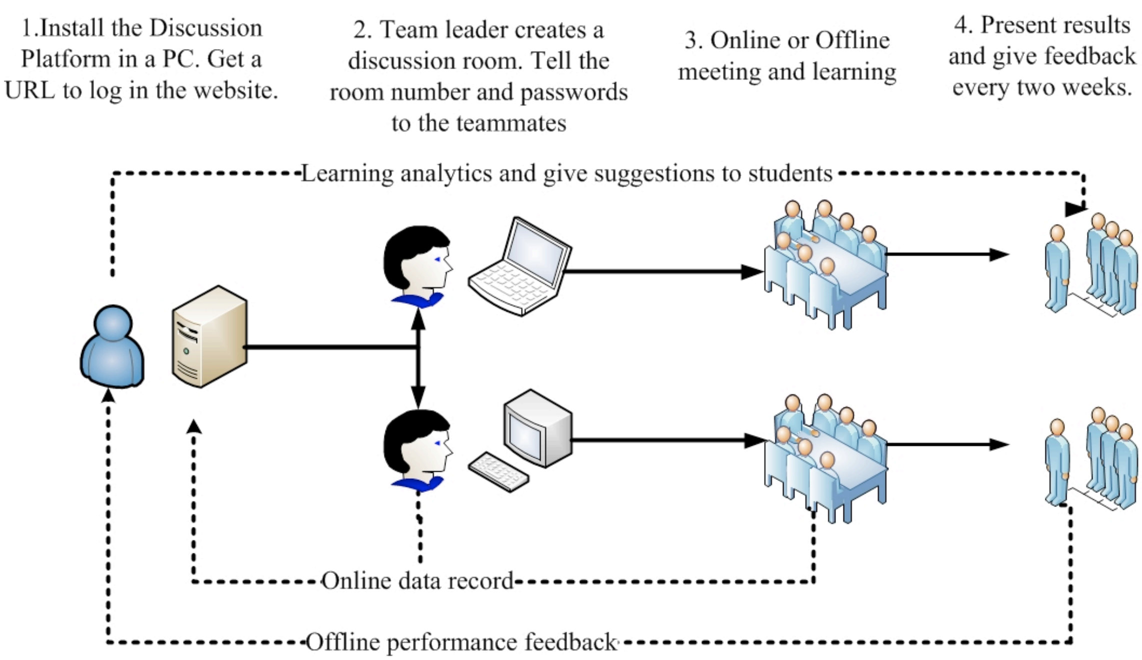

Figure 2. Case procedures

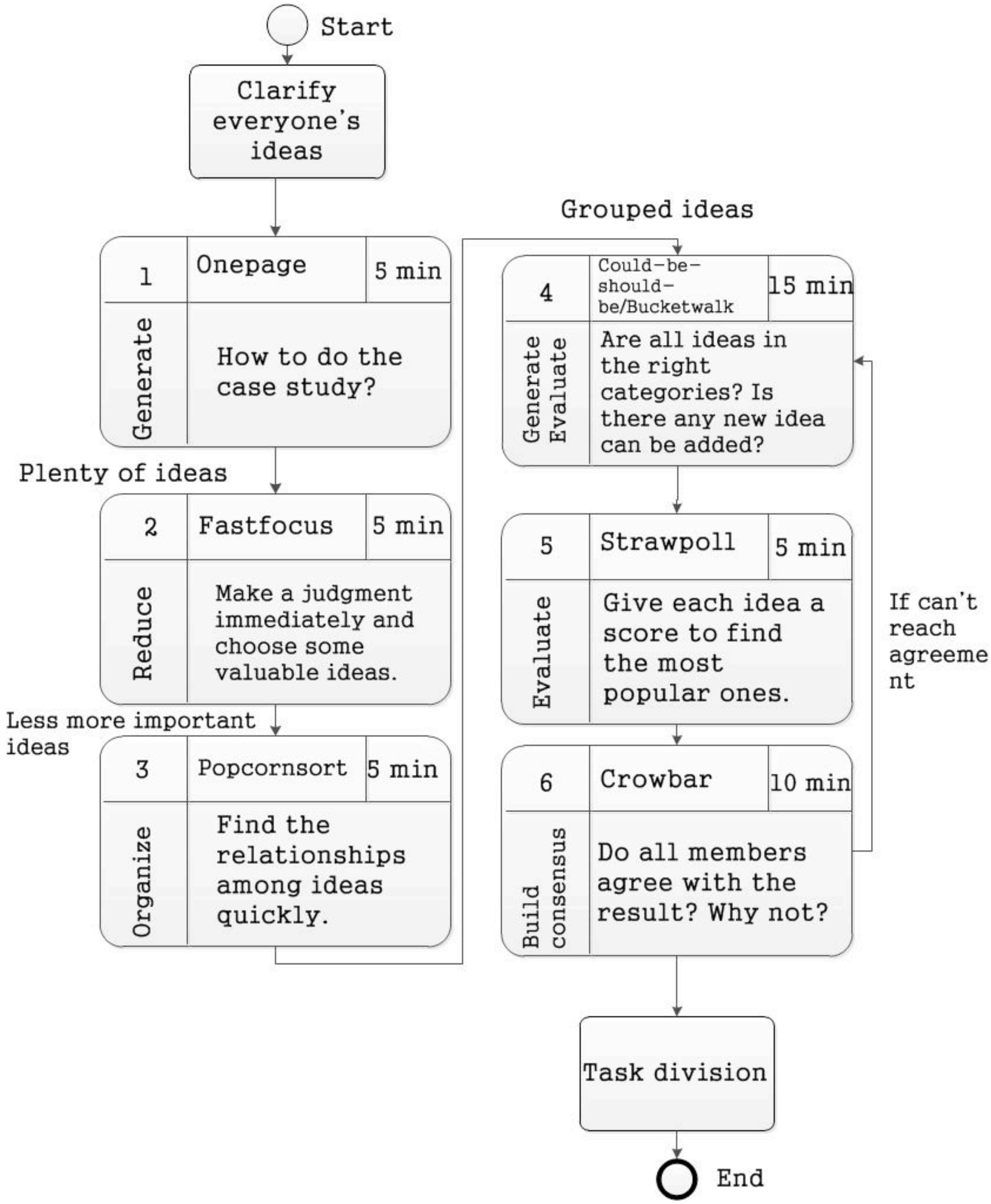

Figure 3: Collaboration process

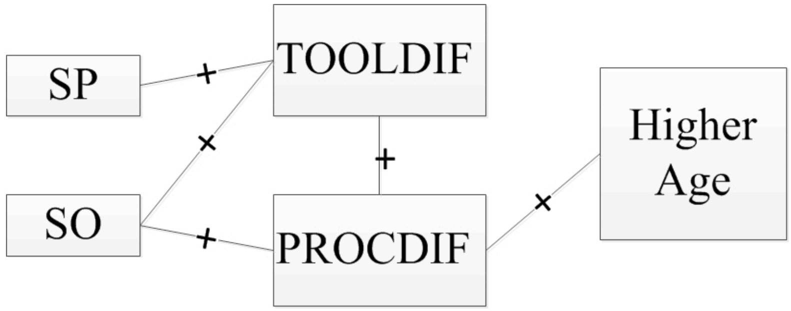

Figure 4: Relationship map

	Group	N	Mean	Std. Deviation	Std. Error Mean
SP	1	40	3.8125	.75691	.11968
	2	31	3.2774	.74418	.13366
SO	1	40	4.2500	.50179	.07934
	2	31	3.1806	1.10677	.19878
TOOLDIF	1	40	4.1250	.66361	.10493
	2	31	3.1742	.67080	.12048
PROCDIF	1	40	4.1400	.51679	.08171
	2	31	3.0968	.59749	.10731

Figure 5: Comparison between the two groups

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SP	Equal variances assumed	.005	.944	2.976	69	.004	.53508	.17980	.17639	.89377
	Equal variances not assumed			2.982	65.166	.004	.53508	.17941	.17679	.89337
SO	Equal variances assumed	40.910	.000	5.440	69	.000	1.06935	.19658	.67719	1.46152
	Equal variances not assumed			4.996	39.548	.000	1.06935	.21403	.63663	1.50208
TOOLDIF	Equal variances assumed	.149	.701	5.960	69	.000	.95081	.15954	.63252	1.26909
	Equal variances not assumed			5.951	64.309	.000	.95081	.15977	.63167	1.26995
PROCDIF	Equal variances assumed	1.238	.270	7.879	69	.000	1.04323	.13240	.77909	1.30736
	Equal variances not assumed			7.734	59.490	.000	1.04323	.13488	.77338	1.31307

Figure 6: Independent sample t test between the two groups

Table 1: Difference between the two groups

	"CE" group	*Control group*	*Same*
Participants	40 students (17 of them male).	31 students (15 of them male).	Each group had four or five students.

Collaborative Tools	Discussion Platform.	QQ chat, Skype, or other online tools.	Online and offline discussion combined.
Teacher	Designed the processes.	No learning design.	Evaluated the students' behaviour.
Task	Used CE methods to do the task.	Used conventional methods to do the task.	Analyzed a Chinese e-business website. Gave presentations every two weeks.

Table 2: Statistical data on the effectiveness ("CE" group)

Label	*Measure (1=negative; 5 =positive)*	*Questions Num.*	*Cronbach's Alpha*	*Neutral*	*Mean (SD)*	*t*
SP	Satisfaction-with-process scale.	5	0.713	3.5	3.81(0.76)	2.611*
SO	Satisfaction-with-outcome scale.	5	0.750	4.2	4.25 (0.50)	0.630
TOOLDIF	Perceived ease or difficulty of tools scale.	5	0.784	4.4	4.13(0.66)	-2.621*
PROCDIF	Perceived ease or difficulty of work processes scale.	5	0.676(0.728)	4.2	4.14(0.52)	-0.734

* Correlation is significant at the 0.05 level (2-tailed)

Table 3: Pearson's correlations among exploratory measures

	SP	*SO*	*TOOLDIF*	*PROCDIF*	*AGE*	*SEX*
SP	1					
SO	0.214	1				
TOOLDIF	0.517**	0.366*	1			
PROCDIF	0.298	0.530**	0.426**	1		
AGE	0.121	-0.03	0.122	-0.327*	1	
SEX	0.047	-0.87	-0.133	-0..276	0.256	1

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

* Correlation is significant at the 0.05 level (2-tailed)

Table 4: Statistical data on the effectiveness (Group 2)

Label	*Measure (1=negative; 5 =positive)*	*Questions Num.*	*Cronbach's Alpha*	*Mean (SD)*	*t*
SP	Satisfaction-with-process scale.	5	0.874	3.277(0.832)	1.603
SO	Satisfaction-with-outcome scale.	5	0.955	3.181 (1.444)	3.918**
TOOLDIF	Perceived ease or difficulty of tools scale.	5	0.731	3.174(0.933)	6.674**
PROCDIF	Perceived ease or difficulty of work processes scale.	5	0.706	3.103(0.852)	1.104

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