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# Students' Perceptions on Problem Solving with Collaborative Computer Simulation

**Chia-Jung CHANG[a*], Chen-Chung LIU[a], Ying-Tien WU[a], Ming-Hua CHANG[a], Shih-Hsun FAN CHIANG[a], Bing-Cheng CHIU[a], Cai-Ting WEN[a], Fu-Kwun HWANG[b], Po-Yao CHAO[c], Chia-Hsi LAI[d], Su-Wen WU[d], Chih-Kang CHANG[e]**

[a]*Graduate Institute of Network Learning Technology, National Central University, Taiwan*
[b]*Department of Physics, National Taiwan Normal University, Taiwan*
[c]*Department of Information Communication, Yuan Ze University, Taiwan*
[d]*Jhongli Senior High School, Taiwan*
[e]*Hsinchuang Senior High School, Taiwan*
*baileysrong@gmail.com

**Abstract:** With the development of Web technology, a number of collaborative computer simulations are designed to support collaborative problem solving activities. However, studies show that some students often failed to collaboratively solve a problem with collaborative computer simulation. Little research has so far been done to explore the factors why students failed to solve problems with collaboratively computer simulation. The study designed a problem solving activity with collaborative computer simulation and attempted to identify the key factors to a successful learning task by analyzing students' perceptions on collaborative problem solving. The implication indicated that, with collaborative computer simulation, communication, coordination, mutual support, and effort may be the key factors to solve the problem.

**Keywords:** collaborative computer simulation, collaborative problem solving, quality of collaboration

## 1. Introduction

Collaborative problem solving has long been extensively applied in science education where students explore and understand the problem context (Care et al., 2015). With the development of Web technology, computer simulations may be a potential approach to supporting science learning since it can visualize abstract scientific concepts and support interaction learning (Rutten et al., 2012). Therefore, a number of computer simulations were designed to support group collaborative problem solving activities where two or more students interact with a computer simulation to collaboratively explore scientific phenomena or solve scientific problems. However, the mouse dominance behavior often naturally emerges in these situations. The lack of controls in a shared computer results in superficial and incoherent group discussion (Chang, Liu, & Shen, 2012).

To solve the problems mentioned above, some studies designed collaborative computer simulations where each member can control and interact with a shared simulation simultaneously (Jara et al., 2009; van Joolingen et al., 2005). The problems above seemed to be solved, however, collaborative problem solving is a complicated learning activity (Johnson & Johnson, 1991) and most students often failed to collaboratively solve a problem since they were unable to effectively analyze the problem (Lin et al., 2014) and conduct coherent discussion (Barron, 2003). Unfortunately, little research has so far been done to explore the factors why students failed to solve problems together with a collaborative computer simulation.

Therefore, this study aims to design a collaborative computer simulation to support students to collaboratively solve a physics problem. Moreover, the study further analyzes the students' perceptions on process of collaborative problem solving in order to explore the key factors that may lead to a successful problem solving with collaborative computer simulation.

## 2. Method

### *2.1 Participants and procedure*

The participants were 30 high school students in northern Taiwan. 15 participants were female and 15 were male. All participates were divided into 10 groups of three. Before the activity, the researcher introduced the activity task and demonstrated how to manipulate collaborative computer simulation. The duration of the activity was 50 minutes. After the activity, participants were asked to fill out a questionnaire to understand participants' perception toward the learning task.

### *2.2 The collaborative problem solving activity with collaborative computer simulation*

A collaborative computer simulation was developed by this study to support collaborative problem solving activity (Fig. 1). The simulation allows participants to manipulate the variables and test their solution. Participants could take notes in the shared panel to share information. Moreover, since the participants do not sit together, participants were asked to communicate via an online chatroom.

A kinematics problem designed for this study was served as the task of the learning activity. Figure 2 presents the task of the activity context. The goal of the task was to control box C to encase block B, which was hit by pendulum A. Each group had to manipulate three variables: Ha, Mb, and Hc. However, each group member can only control one variable. Therefore, group participants needed to coordinate their value of three variables in order to attain the goal.

Figure 1. The description of a kinematics problem

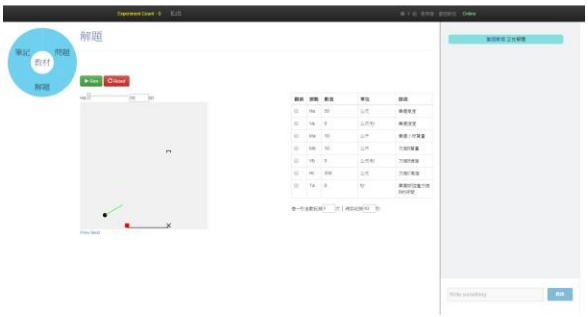

Figure 2. The interface of collaborative computer simulation

The team quality questionnaire, which developed by Hoegl and Gemuenden (2001), was adapted to obtain the participants' perception of collaborative process. The questionnaire was presented in a five-point Likert scale consisting of five categories of communication (8), coordination (4), balance of member contribution (3), mutual support (6), and effort (4). The overall Cronbach alpha value of the adapted questionnaire was .94, indicating that the questionnaire was sufficiently reliable. Since not all groups succeeded in their learning task, an independent *t*-test was used to analyze the perceptions of different groups, successful and unsuccessful groups, toward the quality of their collaborative process.

## 3. Results and discussion

The outcomes of the problem solving activity were examined to determine whether group successfully solved the task. Four groups successfully solved the task while six groups did not. In order to identify the key factors to successful collaborative computer simulation, the study further analyzed the successful group's and unsuccessful group's perceptions toward their collaborative process (Table 1). The result showed that although the successful groups perceived a higher quality of balance of member contributions than the unsuccessful groups did, there was no significant difference between two groups ($t$=-1.64, $p$>.05). Such results may indicate that the two groups both perceived group members' contributions in the task were equal. In addition, the successful groups perceived a significantly better quality of communication ($t$=-3.16, $p$<.01), coordination ($t$=-4.27, $p$<.00), mutual support ($t$=-2.50, $p$<.05), and effort ($t$=-2.61, $p$<.05) than the unsuccessful groups did. These results implied that

communication, coordination, mutual support and effort may be the key factors to a successful learning task with collaborative computer simulation.

Table 1: The successful group's and unsuccessful group's perceptions toward the collaborative process.

| | Group | *N* | *M* | *SD* | *t* | *p* |
|---|---|---|---|---|---|---|
| Communication | Unsuccessful | 18 | 3.58 | .53 | -3.16** | .004 |
| | Successful | 12 | 4.15 | .39 | | |
| Coordination | Unsuccessful | 18 | 3.57 | .67 | -4.27*** | .000 |
| | Successful | 12 | 4.52 | .46 | | |
| Balance of member contributions | Unsuccessful | 18 | 3.76 | 1.09 | -1.64 | .112 |
| | Successful | 12 | 4.31 | .44 | | |
| Mutual support | Unsuccessful | 18 | 4.09 | .76 | -2.50* | .019 |
| | Successful | 12 | 4.68 | .37 | | |
| Effort | Unsuccessful | 18 | 3.96 | .87 | -2.61* | .014 |
| | Successful | 12 | 4.67 | .42 | | |

*<.05, **<.01, ***<.001

## 4. Conclusion

The purpose of this study is to investigate the possible reason why students failed to solve problems with collaborative computer simulation and identify the key factors to a successful problem solving. The key factors to success may rely on the group members' effective communication, action coordination, mutual support, and individual effort. Further study needs to be undertaken with a larger sampling and longer intervention to provide additional evidence. Besides, it would be interesting to see how students of different ages and in different educational contexts perceive the collaborative computer simulation experience. Gathering information on these issues through further studies would be helpful for clarifying impact of a learning task with collaborative computer simulation in different educational settings.

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