Assigning Process-Oriented Roles in Concept Mapping Mediated Online Group Learning

Bo Cheng
Faculty of Education
The University of Hong Kong
Hong Kong
bob88708@hku.hk

Minhong Wang
Faculty of Education
The University of Hong Kong
Hong Kong
magwang@hku.hk

Abstract—**Group interaction is a key component of group-based learning. However, its implementation in existing learning practices is inefficient. Previous studies discussed the use of concept mapping in group learning. Apart from its clear benefits for group learning and interaction, deficiencies of using concept mapping in distance groups were also recognized, mainly related to labor division, group coordination, and collaboration strategies. This study aims to address the challenge by proposing an intervention strategy of assigning process-oriented roles, i.e., cognitive leader, metacognitive leader, and socio-emotional leader, to students in concept mapping mediated online group learning to facilitate group learning processes. An experimental study in authentic teaching practices was implemented to evaluate the effectiveness of the proposed strategy.**

Keywords-group learning; group interaction; concept mapping; role assignment

I. INTRODUCTION

Small group learning is a form of instruction widely advocated in schools around the world [1]. Compared with alternative forms of instruction, group-based peer learning is beneficial for students' progress in a variety of aspects, e.g., providing equitable learning opportunities, improving academic achievement, sharing cognitive load, refining perceptual beliefs and affection towards learning (e.g., attitudes, motivation, anxiety), and reaching positive social effects [2, 3, 4]. In group contexts, students' interaction is a key factor in determining the magnitude of benefits students can gain, which has been widely recognized especially in the area of collaborative learning [5, 6]. However, in practices true collaboration and productive interaction rarely happen among students working in groups [6]. Students are supposed to be able to naturally interact and effectively collaborate, however it is not the case. The inefficiency in students' group interaction has limited the value of group work in classroom practices [1, 6, 7].

Realizing the potential and challenge of group-based learning in education, researchers have devised various pedagogical approaches such as providing concept mapping or other graphical tools and assigning roles to mediate peer learning. The use of concept mapping in group learning has been discussed with its benefits to both learning and interaction [8]. The deficiencies of using concept mapping in distance groups were also recognized, mainly related to labor division, group coordination, and pre-training of collaboration strategies [8, 9].

This study aims to address the challenge by proposing an intervention strategy of assigning roles to students collaboratively learning in a concept mapping mediated online group learning environment to facilitate group cognitive, metacognitive and socio-emotional processes. An experimental study in authentic teaching practices was implemented to evaluate the effectiveness of the proposed strategy.

II. THEORETICAL BACKGROUND

A. Small group interaction and learning

The mediation of group interaction in students' learning has been investigated from various aspects, such as cognitive elaboration, socio-cognitive conflicts, guided participation, and social construction of knowledge [1]. Some features like students' being "mutually other-orientated" and inter-subjectivity are found to be favorable properties of students' social interaction [4, 5]. Previous literature also identified some types of productive interaction, which were typically processes of soliciting or suggesting proposition [2], giving or receiving elaborate explanation [2], explicit reasoning [10], and integrating and interrelating viewpoints [11].

B. Concept mapping as a group learning tool

In group learning tools are required for mediating collaborative activities [12]. Concept mapping is a specific strategy found to be beneficial for both interaction and learning in group contexts. Its advantages include sustaining group discussion [13, 14], shaping students' discourse to reach shared understandings and inter-subjectivity [13, 14]. For example, [15] showed that students in concept mapping task had more discussion of domain concepts, collaboratively elaborated conflicts and reasoning. Reference [14] revealed that the process of co-construction of propositions was supported in collaborative concept mapping, and similar results were reported in [13]. Reference [16] found that in students' computer-supported collaborative concept mapping, both task-related and interaction-control activities were evident in communication acts. Reference [17] reported that in online collaborative concept mapping learners engaged very much in learning related processes. Furthermore, the leaning benefits of group

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concept mapping were found closely relevant to achievement, comprehension, problem solving, and recall [8, 9]. Moreover, collaborative concept mapping was indicated to lower participants' anxiety [18], although such investigation on the motivational and emotional aspect of group learning has been very limited.

C. Role assignment

Roles are prescribed functions that guide individual behavior and facilitate group collaboration [19]. Instructional use of roles is found related to enhancement of both interaction and learning [20, 21]. Prior authors reported role assignment to be correlated with level of knowledge construction in distance groups [20, 22]. The literature also linked assigning roles to interactional benefits such as students' being more aware of group efficiency, stimulated group task coordination, and increasing of amount of task-content focused statements in group discussion [23]. In [24], roles of socio-emotional, conceptual and metacognitive functions were indicated to be related to individual students' perspectives on learning (e.g., disposition and orientation towards collaboration) and the levels of group reasoning. Roles were also proposed to be useful in supporting group cognitive processes and self-regulatory processes [19].

In previous studies, the designing of roles were driven mainly by the functional consideration for task completion in specific contexts, instead of instructional use of tools for learning and interaction. The using of roles varied across contexts with various role names and functions, without a systematic division of roles based on validated findings on group processes in learning theories. Prior studies reported that scripted roles were used only for cognitive or metacognitive functions [19, 22, 23]. For example, [22] defined five functional roles of starter, moderator, theoretician, source searcher and summarizer to pre-structure students' collaboration activities. Reference [23] used four procedural roles of project planner, communicator, editor and data collector to prescribe students' group activities. Reference [19] adopted four reciprocal teaching roles, i.e., summarizer, questioner, clarifier, and predictor and proposed the use of roles targeting at group self-regulatory processes.

III. RESEARCH DESIGN

Apart from the apparent benefits of using concept mapping in group learning, its deficiencies in distance groups were recognized, mainly related to labor division, group coordination, and collaboration strategies [8, 9]. This study aims to address the challenge by proposing an intervention strategy of assigning three process-oriented roles, i.e., cognitive leader, metacognitive leader, and socio-emotional leader, to students collaboratively learning in a concept mapping mediated online peer learning environment for the purpose of enhancing group interactive learning. The role assignment was designed on the basis of frameworks and taxonomies proposed for guiding group interaction in prior studies on collaborative learning, which outlined essential aspects of group processes in three dimensions: group cognitive activities, group metacognitive activities, and group motivational and emotional activities [25, 26].

The research method used in this study was one factor (assigning roles vs. without assigning roles) between subject design. 85 undergraduate students from three classes participated in the online group learning. The students were randomly grouped into triadic groups within their own class and two classes were assigned as the experimental condition and the other one class was assigned as the contrast condition. In the experimental condition, students in each group were randomly assigned one of the three roles. The cognitive leader took the duties of initiating and encouraging group members' socio-cognitive interaction, e.g., information sharing, argumentation, integration and convergence of discussion, critical thinking, and exploration. The metacognitive leader was in charge of facilitating and coordinating the group regulatory activities, e.g., goal setting, task planning and progression monitoring, and reflection on group performance. The socio-emotional leader was responsible for maintaining a positive group atmosphere by way of encouraging morale-building communication and emotion regulation. Each of the role duties were scripted and modeled with sample sentence starters based on relevant findings in the literature (e.g., [10, 11,26]. In the contrast condition there was no assignment of process-oriented roles but only a general group leader was designated.

The online group learning platform was architected by the IHMC Cmaptool. In the platform for each group there included a task instruction environment and a task solution environment organized according to five group tasks using collaborative concept mapping. The task instruction environment used a teacher-built concept map to present 1) the task information including task description, learning objectives, and assessment criteria, and 2) supporting materials including instructions for collaborative concept mapping (e.g. use of the Cmaptool, concept mapping skills, and collaborative concept mapping procedures) and guidance for ethical group communication. In the experimental condition the role division and scripts were also embedded in the teacher-built concept map (see Fig. 1). The task solution environment was a shared activity space where group members can collaboratively perform all of the learning activities such as collaboratively drawing concept maps, initiating and responding to discussions in discussion threads, and sharing learning resources (see Fig. 2).

Before the experiment began, a serial of trainings regarding the main components of group work, like role duties, guidance for ethical group communication, concept mapping skills, and collaborative concept mapping strategies in the Cmaptool, were implemented. A pre-test survey was administered to collect students' background information as well as relevant knowledge, skills, and attitudes (KSAs) including knowledge of cognition, computer skills, communication skills, attitudes towards online learning, and attitudes towards small group learning. After each group task session, a group reflection task involving students' self-rating of quality of performing role duties and peer collaboration was assigned to each group.

After all the group task sessions were finished, a post-test survey was implemented to gather post learning data regarding students' engagement in group cognitive, metacognitive and motivational and emotional learning activities.

To examine the effectiveness of the intervention in influencing students' group interaction in term of the cognitive, metacognitive, and socio-emotional aspects, statistical analysis was performed on students' questionnaire responses and discourse analysis was implemented to explore students' group dialogue.

IV. RESULTS

A. Questionnaire data analysis

Multivariate Analysis of Covariance (MANCOVA) was used to analyze the differences in group interactional process between the experimental condition and the contrast condition. Students' engagement in group cognitive, metacognitive, and motivational and emotional learning activities as self-rated in questionnaires were the dependent variables and the pre-test KSAs were selected as covariates.

Table 1 reports the MANCOVA results. The table gives the estimates of marginal means of each category of interactive learning activities students engaged after adjusting the influences of covariates and the statistical tests of pairwise comparison of marginal means. The table indicates that means of the sub-categories of learning activities in each of the three dimensions of group interaction in the experimental condition are higher than those in the control condition except the anxiety score. The pairwise comparisons of the estimated marginal means tell that the mean differences of three sub-categories of learning activities, i.e., satisfaction, enjoyment and belongingness, between the two conditions are statistically significant. The results suggest that the intervention of assigning process-oriented roles to students in the concept mapping mediated group learning significantly enhances students' satisfaction with group learning, enjoyment in group learning, and belongingness in their small groups in the experimental condition. Besides, the multivariate test also suggests that there is an overall effect in promoting students' positive emotion for the intervention of assigning roles.

TABLE 1. DIFFERENCES IN THE THREE DIMENSIONS OF GROUP INTERACTION

	Estimates		**Pairwise Comparisons**		
	Mean	Std. Error	Mean Difference	Std. Error	Sig.
Cognitive aspect					
Information sharing	3.784[a]	0.12	0.2	0.2	0.31
	3.582[b]	0.16			
Disputation	3.460[a]	0.12	0.33	0.21	0.11
	3.133[b]	0.17			
Exploration	3.640[a]	0.12	0.27	0.2	0.19
	3.374[b]	0.16			
Convergence	4.024[a]	0.13	0.43	0.22	0.06
	3.600[b]	0.18			
Metacognitive aspect					
Planning	4.003[a]	0.14	0.36	0.23	0.12
	3.642[b]	0.19			
Monitoring	3.785[a]	0.12	0.38	0.2	0.06
	3.403[b]	0.16			
Reflection	3.673[a]	0.12	0.3	0.21	0.15
	3.370[b]	0.17			
Socio-emotional aspect					
Motivation					
Attention	3.672[a]	0.09	0.07	0.15	0.64
	3.601[b]	0.12			
Usefulness	3.791[a]	0.09	0.08	0.15	0.59
	3.712[b]	0.12			
Confidence	3.836[a]	0.07	0.2	0.13	0.11
	3.633[b]	0.1			
Satisfaction	3.766[a]	0.11	*0.378***	0.18	*0.04*
	3.388[b]	0.15			
Emotion					
Enjoyment	3.751[a]	0.1	*0.409***	0.17	*0.02*
	3.343[b]	0.14			
Pride	3.861[a]	0.1	0.29	0.16	0.08
	3.575[b]	0.13			
Anxiety	2.941[a]	0.12	-0.06	0.2	0.78
	2.997[b]	0.16			
Belongingness	3.859[a]	0.11	*0.471***	0.18	*0.01*
	3.388[b]	0.15			

a experimental condition; b contrast condition; **p<0.05

B. Discourse analysis

Students' group dialogs recorded in the online learning platform were examined via computer-assisted text analysis to further explore the differences in students' group interactive learning activities. All the messages of each student posted in each of the group task sessions were gathered and prepared into two corpuses, one for the experimental condition and one for the control condition. Based on previous literature e.g., [10] and a pre-analysis of the corpus, a dictionary of words for automatic text analysis was built. The words in the dictionary for text analysis were organized in accordance with the cognitive, metacognitive, and socio-emotional dimensions of group interaction and the sub-categories of learning activities in each dimension. The dictionary was verified via concordance analysis (i.e., keyword in contexts) using Antconc to ensure that the search words in the dictionary were valid to represent the assumed categories of learning activities in students' discourses. Each of the search words in the dictionary were checked before they were selected as the indicative words. Finally, paired sample t-test was carried out to compare means of frequency of indicative words in each category of learning activities evident in students' discourses in the two conditions. Table 2 gives the paired-sample t-test results. The results indicates that that the difference in frequency of indicative words of socio-emotional discourse (i.e., motivation and emotion related talk) between the two conditions is statistically significant, suggesting that assigning process-oriented roles enhances students' socio-emotional interaction in group learning. This result confirms

the differences in students' group interaction between the two conditions reflected in students' survey responses.

TABLE 2. DIFFERENCES IN FREQUENCY OF INDICATIVE WORDS OF GROUP DISCOURSES RELFECTING DIFFERENT CATEGORIES OF LEARNIG ACTIVITIES

Variables	Paired Samples Test				
	Means	Paired differences	T	df	Sig.
Information exchange	0.129 [a] 0.086 [b]	0.043	1.039	10	0.323
Disputation	0.051 [a] 0.017 [b]	0.034	1.01	6	0.351
Exploration	0.104 [a] 0.17 [b]	-0.066	-1.936	33	0.062
Convergence	0.09 [a] 0.063 [b]	0.028	0.434	3	0.694
Planning	0.554 [a] 0.421 [b]	0.134	1.037	13	0.318
Monitoring	0.113 [a] 0.138 [b]	-0.025	-1.431	5	0.212
Reflection	0.077 [a] 0 [b]	0.077	1.54	2	0.263
Motivation and emotion	0.082 [a] 0.023 [b]	0.059	*2.766***	25	*0.011*

a experimental condition; b contrast condition; **p<0.05

V. DISCUSSION AND IMPLICATIONS

An intervention strategy of assigning process-oriented roles to students participating in concept mapping mediated online group learning was designed and an experimental study was implemented to evaluate its effectiveness in facilitating group interaction. Questionnaire data analysis found that the intervention enhanced the socio-emotional aspect of group interaction, i.e., promoted students' satisfaction, enjoyment, and belongingness during small group learning. No significant differences were found in students' group cognitive and metacognitive activities between the experimental conditions and the contrast condition. The discourse analysis of students' group dialogue verified the results, that is, students in the experimental condition engaged in more motivation and emotion related talk in the collaborative activities.

The results contribute meaningful findings to the area. Prior studies on using roles put emphasis into analyzing the effects in facilitating group cognitive processes, e.g., knowledge construction [20], or the metacognitive aspects of group discussion, e.g., awareness of group efficiency, group task coordination [23]. In contrast with prior findings, this study provides complementary evidences that assigning process-oriented roles to guide students' peer talk and cooperation in concept mapping mediated group learning enhances students' motivational and positive emotional engagement in the group learning activities. While motivation and emotion is an important dimension of students' group learning [26], there is a lack of attention to this aspect in previous studies.

The findings provide some implications for research and practice of small group learning. In theoretical concern, this study contributes to literature in providing evidences of pedagogical usefulness of assigning process-oriented roles in influencing the motivational and emotional aspect of group interaction. In the practical aspect, prior work reported roles were used only for cognitive or metacognitive functions [19, 22, 23]. This study designed three process-oriented roles targeting at all of the cognitive, metacognitive, and socio-emotional aspects of group interactive learning, and found that the role division and assignment had an overall motivational and emotional effect. The findings contribute to the literature by examining the pedagogical usefulness of assigning process-oriented roles in influencing motivational and emotional aspect of group interaction.

VI. CONCLUSION

Using experimental design in authentic teaching practice, this study finds that assigning process-oriented roles to students in concept mapping mediated online group learning enhances students' motivational and emotional engagement in group interaction. The findings complement prior literature on instructional use of roles in small group learning. While prior studies recognized the deficiencies of using concept mapping for group learning, this study reached greater potential of using concept mapping by assigning process-oriented roles to students in concept mapping mediated group learning, and empirically obtained evidence of its educational value.

While in prior literature instructional use of roles were found to be beneficial for improving the cognitive or metacognitive processes in group learning, in this study there found no such benefits. The reason may be related to the data analysis methods. The detailed processes differences in students' group collaboration may not be tackled in students' questionnaire responses or in the text analysis. Future research will move forward to address the issue by triangulated methods.

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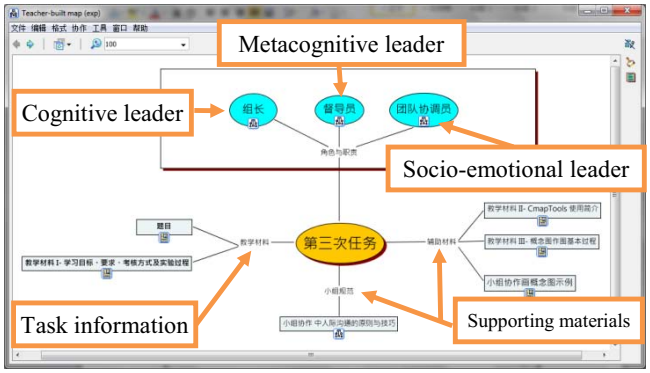

Figure 1. Task instruction environment

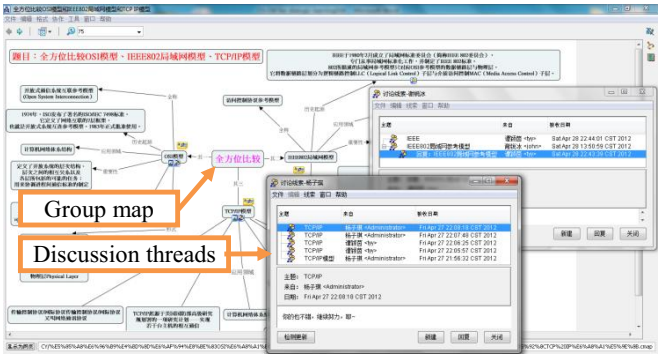

Figure 2. Task solution environment