GSS Facilitation Restrictiveness in Collaborative Learning

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Abstract

GSS technology, extensively applied in decision making contexts, is now seeing increased application in the educational sector. Previous work has suggested that GSS applications can have significant positive effects on both theprocess and outcome of collaborative learning. This study extends this work to examine the importance of content and process facilitation in GSS-supported collaborative learning. Our results indicate that content facilitation has no significant bearing on student learning. Process facilitation is more influential, with knowledge acquisition by students requiring a less restrictive environment.

1. Introduction

Group Support Systems (GSS) technology, developed over the last two decades, was initially researched in laboratory-based experiments. More recently, fieldwork has examined how GSS function in real world environments involving businessmen, diplomats, soldiers and students. GSS were originally designed to support discussion and decision making in the commercial/business sector, but in the last few years there has been a surge of interest in its usage to support collaborative learning, e.g. [1,22,23,24,25,33]. Previous empirical results indicated that GSS had significant positive effects on both the process and the outcome of collaborative learning. GSS were shown to encourage participation and to enhance knowledge acquisition [22]. GSS-supported learners also demonstrated higher levels of interest in the material and perceived that they achieved higher levels of learning than without GSS [1,23].

Although previous studies reported positive effects of GSS on learning, they have not explained how such effects could be affected by facilitation. The potential effects of facilitation on the process and outcome of electronic meetings have been investigated extensively [4,8,10,13,14,16,17,27,28,40], but not in the context of collaborative learning. According to the facilitation framework proposed by Bostrom et al. [8], a facilitator can influence three general targets: meeting process, relationships and task outcomes. Structures are applied primarily through the development of the meeting process (agenda/activities: the how?). These structures influence the exploration and accomplishment of tasks (content: the what?) and relationships (affect/emotions: feel about?). In return, the individual's and/or the group's relationships influence an individual's involvement in and contribution to the process, the quality of his/her contribution, and his/her commitment to and acceptance of the task outcomes (decision, plan, etc.). While most researchers agree on the importance of the facilitator's role, it is not clear how interventionist it should be. Some researchers, e.g. [3,12], stress the active role of the facilitator in defining the agenda and enforcing it. Others, e.g. [13], on the other hand, call for more open and less restrictive facilitation. Teachers who use GSS to support collaborative learning need some specific guidelines for their new role as facilitators. Although some studies, e.g. [10] have discussed good practices, it is still not clear how much influence the facilitators should exert on the various facilitation dimensions. Teachers may be tempted to introduce too much structure in an attempt to focus the discussion. But, is restrictive process facilitation good or bad? Teachers may also feel obligated to give as much feedback as possible. But, does content facilitation really matter? These are important questions that remain to be answered.

In this research, we examine the effects of restrictiveness of content and process facilitation on collaborative learning. We do not attempt to fully explain the relationship between restrictiveness and learning, as this would be too ambitious to achieve in a single study. Instead, we compare two specific levels of restrictiveness in terms of effects on the learning process and outcome. In addition to studying the main effects of restrictiveness for both process facilitation and content facilitation, we also examine possible interaction effects between the process and content dimensions.

The layout of this paper is as follows. Following the introduction, we present the background and theory underlying the study. Next we present the research methodology, describing the experimental design,

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procedure and measurement. We then discuss the results and their implications. In conclusion, we summarize the contributions of this study and propose future research.

2. Background and Theory

2.1 Collaborative Technology

Collaborative technology, for example group support systems (GSS), has been used in learning contexts for a number of years, e.g. [1,12,19]. Such technology is lauded for its capacity to increase the opportunity for all members of a group to participate in discussions. Such discussions may be loosely structured, with participants free to create their own topics and submit any ideas they choose, tightly structured, with a pre-set agenda and substantial facilitator control of activities, or anywhere in between. In addition to providing various levels of structure, participants can communicate in parallel, choose to be identified or anonymous, and rely on the tool as a form of group memory. Through the use of these features, collaborative technology can alleviate some of the negative consequences of group interactions, often referred to as process losses [15,36], such as production blocking, airtime fragmentation and evaluation apprehension. Since group members are able to focus on the discussion topic at hand and the comments of others, "the opportunity for process gains from synergy and learning should increase" [30, p.1326].

The role of the facilitator in collaborative technology has been shown in much previous research to be very important. As Bostrom et al. [8, p.147] remark, "one cannot understand or manage GSS sessions without focusing on facilitation". Facilitation and structure are two key components of the application of collaborative technology to learning, and a key element of facilitation is knowing how to introduce appropriate structures so as to help a group achieve a better outcome. However, in the learning context, there is little consensus on how this facilitation should be undertaken.

Previous work addressing the application of GSS tools to decision making (but not specifically collaborative learning) suggests that flexible modes of facilitation are preferred, with minimal use of prescriptive structures to guide the decision process. For example, Dickson et al. [13] note that facilitation should be open and adaptive rather than restrictive. At the same time, Bostrom et al. [8, p.153], in their analysis of the group dynamics literature [26,39] note that "applying structured procedures produces better results than normal group interaction [while] more-structured interventions are generally found to be superior to less-structured or naturally occurring group interaction".

Despite these findings, experimental GSS research has found that, for example, groups may resist a unilateral imposition of a task structure, even though such 'supported' groups achieved more satisfaction and consensus than groups that were totally unsupported by technology [13]. Anson and Heminger [5] found that flexible process facilitation resulted in significant improvements in participant perceptions of group processes and task outcomes. Much of the literature describes the role of the facilitator vis-à-vis meeting processes, with much less focus on meeting content. Traditionally facilitators have been encouraged not to become involved with content issues (e.g. [17]), though in practice many may do so, especially if the group requests this involvement [11].

2.2 Theories of Collaborative Learning

Where the application of collaborative technology to learning is concerned, two theories can be considered: collaborative learning theory and process restricted adaptive structuration theory. Collaborative learning theory (CLT) was developed from the work of such psychologists as Johnson and Johnson [20] and Slavin [34]. The collaborative process involves learners working with one another on a problem-solving task and so participating in the discussion of a wider variety of ideas than they would if working alone. The result of this collaboration is that learners fine-tune the skills they require to synthesize knowledge [7] while also thinking critically [35].

Leidner and Fuller [23], in their examination of individual constructive learning, make the trenchant observation that much classroom time is occupied by the taking and subsequent regurgitating of notes, though there may in practice be little assimilation and comprehension of the information. Thus, there is an explicit need to increase not only the interest and motivation that students have in courses, but also their understanding of material, so that their performance can be enhanced. Leidner and Jarvenpaa [24, p.50], in a study of electronic classroom cases, found that preferred contexts involved giving students the opportunity to interact with computers, while also working "independently of the instructor" so as to "encounter their own problems".

Related to CLT is Rogers' [31] description of the right of individuals to have the freedom to learn what they want and in the manner of their choice. CLT suggests that learners enjoy communicating when they are given a non-threatening and liberated environment in which to participate [23]. To make this happen, the right atmosphere has to be developed so that the facilitator can focus on providing the resources and opportunities for learning to take place, rather than merely managing and controlling learning. Rogers [31, p.103] used the following quotation from Lao Tzu [38] to explain how a facilitator can take the role of a leader in a learning environment:

A leader is best when people barely know that he exists,
Not so good when people obey and acclaim him,
Worst when they despise him.

Rogers [31] suggests that facilitation involves empowering learners to take control of and responsibility for their own efforts and achievements. The general role played by the facilitator involves meeting the needs of a group of learners, and assisting the group to achieve its goal. To develop the right atmosphere for knowledge acquisition, Bentley [6, p.10] identified three key requirements to facilitate a group of learners, viz.:

1. *Provide opportunities for the learners to go in the direction that they want, or seem to want, to go in;*
2. *Constantly be aware of what is happening in the group;*
3. *Stay quiet and be attentive to the needs of the individual learners in the group.*

By fulfilling these requirements, the facilitator can serve the group and ensure that his/her energy is focused on group needs. To enable the proper facilitation of learning, Casey et al. [9] suggest that the facilitator should find an appropriate strategy to stimulate learners' awareness in others by sharing their insights, and by offering learners the opportunity to "work it out for themselves".

In contrast to CLT is process restricted adaptive structuration theory (PRAST). Wheeler and Valacich [40] explain how collaborative technology and facilitation may act as appropriation mediators through the forces of guidance and restrictiveness to influence specific procedural dimensions of the social interaction process, and ultimately, decision outcomes. Collaborative technology can add process structure to the meeting through the use of a detailed agenda which the facilitator can employ to guide the group during the meeting [12]. In this way, it is possible to focus the group's attention on the task at hand in depth and reduce the chance for that focus to be diverted.

One of the major roles of the facilitator is to help learners find the most appropriate solution to a problem. PRAST suggests that the facilitator can make use of the structure inherent in the technology, e.g. the agenda, to support the group's social and cognitive processes, freeing the learners to focus their attention on more substantive issues [32]. By managing the sequencing and connectedness of the group activities, and by breaking the task into smaller and more manageable pieces, the facilitator can ease the group's work and help learners to focus on and analyze task-related information more effectively [3].

In addition to CLT and PRAST, researchers have considered the extent to which the facilitator should influence the content of a group's interaction. In general, facilitation involves empowering learners to take responsibility for their own efforts and achievements. The facilitator may choose to exert his/her influence to prevent the group from following non-constructive paths and protect the group from taking inappropriate actions [17]. Furthermore, the facilitator can choose to provide learners with flexible content feedback in response to their needs, and even take an active role in the meeting to provide expert advice, direction and counseling. In a content-facilitated learning environment, learners may perceive the content facilitator to be an expert, and hence believe that the facilitator is more likely to lead them to good decisions (cf. [17]). However, the influence that enables facilitators to enhance a group's process and outcome may also have a negative impact, with facilitators unintentionally violating their duty to be open-minded and unduly swaying the content of a group's interaction. In general, however, there is no agreement in the literature as to whether facilitators should provide more or less content structure to groups of learners.

Clearly there are differences between CLT and PRAST, which reflect the former's focus on learning contexts, and the latter's focus on decision making contexts. CLT proposes that group members should be able to tackle their problems in a flexibly-facilitated environment, while PRAST proposes that group members need to have their activities structured in order that they be able to focus on the task at hand more effectively. Where content structure is concerned, opinions vary widely, some taking the line that content should not be interfered with, others that the facilitator should provide expert guidance to aid the learners in their deliberations. Each of the theories has its proponents, and each seems plausible, if for different reasons. However, as far as we are aware, no previous research has attempted to investigate both content and process structure in a collaborative learning context in a single study. Based on the research model depicted in Figure 1, we investigate the individual and combined effects of process and content facilitation on the process and outcome of collaborative learning. We compare the learning effects of two levels of process and content restrictiveness (low vs. high). More specifically, we suggest that the facilitator should provide appropriate freedom (low restrictiveness on process and content structure) for students to interact and learn from each other in the collaborative-technology supported environment. Our hypotheses are:

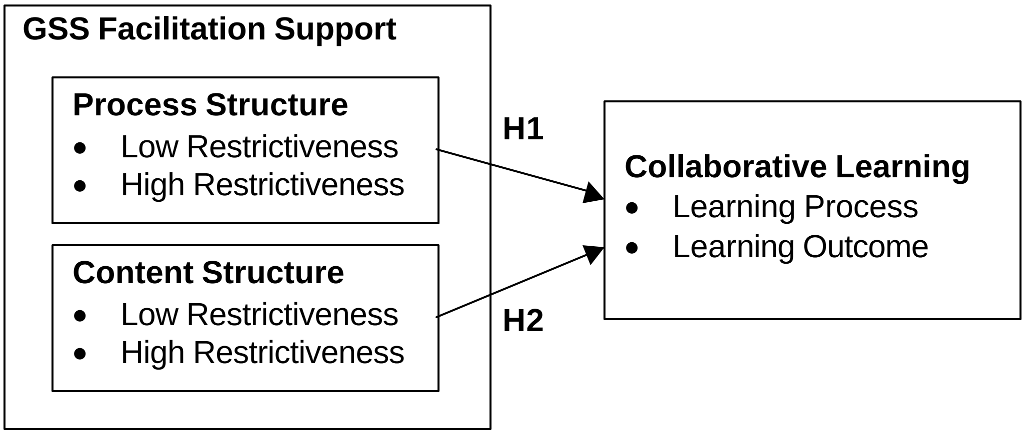

Figure 1: Research Model

Process Facilitation Restrictiveness		Content Facilitation Restrictiveness: Low	Content Facilitation Restrictiveness: High
	High	HPR-LCR	HPR-HCR
	Low	LPR-LCR	LPR-HCR

Figure 2. Experimental Design

H1: There will be a significant inhibiting effect of process restrictiveness on the learning process and outcome.

H2: There will be a significant inhibiting effect of content restrictiveness on the learning process and outcome.

Our hypotheses imply that members of groups that are provided with a lower level of both process and content restrictiveness will achieve the best results in terms of the learning process and outcome as compared with members of other groups.

3. Research Methodology

To study the main and interaction effects of process facilitation restrictiveness and content facilitation restrictiveness on the learning process and outcome, we conducted a field experiment with 120 senior students enrolled in an electronic commerce course. Although participation was voluntary, 120 out of 140 students opted to participate, as the experiment was very similar to their natural learning setting and was perceived as a valuable learning experience. We used a between group 2X2 factorial design representing two levels of restrictiveness (low and high) on two facilitation dimensions (process and content). As illustrated in Figure 2, the students were randomly assigned to 4 treatments: 1) low process restrictiveness and low content restrictiveness (LPR-LPC), 2) low process restrictiveness and high content restrictiveness (LPR-HPC), 3) high process restrictiveness and low content restrictiveness (HPR-LPC) and 4) high process restrictiveness and high content restrictiveness (HPR-HPC). Three groups of 10 students each were assigned to each treatment resulting in a total of 12 groups.

The task consisted of a GSS-based discussion of an e-commerce case. It involved the analysis of the e-business model of a local supermarket, where the students were supposed to apply a number of frameworks presented in previous lectures to identify the strengths and weaknesses of the presented business model and suggest improvements. To alleviate possible evaluation apprehension effects, the student contribution was anonymous. The students were familiar with the task, as they routinely used the GSS to discuss e-commerce cases, as part of the requirements of the course where they were enrolled. The case discussion lasted one hour and was followed by an online survey designed to assess the students' perceptions of the quality of the discussion. After a short break, the students were given a concept-mapping test designed to assess the learning outcome of the meeting.

Process Restrictiveness Treatment

GroupSystems' "agenda" tool was used to set the level of structure restrictiveness. For the high restrictiveness group, the agenda included four activities: defining the task objectives (5 minutes); studying the facts of the case (10 minutes); discussing the methods for reaching the objectives (10 minutes); and lastly, generating the final list of recommendations (10 minutes). The time allocation to the different activities was based on a pilot run. The agenda was designed to restrict the discussion procedure to the pre-defined steps. The group discussion, in this setting, was expected to be more focused and within schedule. For the low restrictiveness group, the agenda consisted of only two activities: discussion (25 minutes) and drafting the list of recommendations (10 minutes). This setting allowed students to control and adjust the flow of discussion freely.

Content Restrictiveness Treatment

The instructor assumed the role of the facilitator. For the low restrictiveness group, the instructor acted as the system operator, starting and stopping the GSS sessions. The instructor was also responsible for executing the pre-set agenda without contributing his own comments to the discussion. Therefore, there was no instructor-student, content-specific interaction during the meeting. For the high restrictiveness group, the instructor was involved in the discussion. Using the *GroupSystems' "categorizer"*, the instructor sorted the content of the students' contributions into three different "buckets" labeled "relevant", "marginal" and "irrelevant". The instructor also gave feedback to the students in the form of comments (e.g., highlighting the importance of some ideas) or ideas (e.g., reminding the students of some important points that they missed).

Measurement

Learning Process - The learning process was assessed according to two dimensions: 1) the discussion intensity as measured by the total number of contributions (ideas and comments) made the students in the group and 2) the student's satisfaction with the quality of his/her own contributions, the quality of contributions of the other group members and the overall relevance of all contributions. While discussion intensity was based on the GSS log, the students' satisfaction was assessed with the post-treatment online survey, using the three-item instrument developed by Tyran [37], involving the rating on a five point Likert-type scale (Strongly Agree = 1, Agree = 2, Neutral = 3, Disagree = 4, Strongly Disagree = 5) of the following statements:

1. I was typically satisfied with the quality of my own contributions during the electronic discussion.
2. I was typically satisfied with the quality of contributions made by the members of the class during the electronic discussions.
3. The contributions (ideas/comments) were relevant to the objective of the discussion.

Learning Outcome - The learning outcome was assessed by the complexity and level of integration of the knowledge acquired by the students, using concept-mapping techniques [29]. Concept mapping is a well-accepted method for monitoring student comprehension [18,21]. The students were given a list of concepts and were asked to create as many meaningful relationships as possible between the given concepts. All relationships had to be labeled with propositions indicating their respective meanings. The proposed relationships could be of two types: direct links and cross-links. Direct-links relate concepts that belong to the same hierarchy. They are useful for defining general concepts in terms of more specific concepts. Cross-links, on the other hand, relate concepts from different hierarchies. They are useful for representing meaningful relationships between different concepts. The knowledge acquired by the students, as represented by the proposed relationships, can be characterized by its complexity and its level of integration (interconnectedness). As a measure of knowledge complexity, we used the total number of valid direct-links. To measure knowledge integration, on the other hand, we used the total number of valid cross-links. The validity of these measures was demonstrated in Khalifa & Kwok [22]. The assessment of the proposed links was done by two "experts" (knowledgeable academics) independently. The scores given by the two assessors were averaged.

4. Results and Discussion

In this study, analysis of variance procedures were used to test hypotheses for each independent variable. ANOVA was used to detect the main effect and the interaction effect of content and process restrictiveness on the dependent variables, while T-tests were conducted to find significant differences between treatment conditions. The results were mixed and did not fully support our hypotheses. The only significant effect was that of process facilitation on the complexity of the knowledge acquired by the students, providing some support for hypothesis 1. The following is a detailed description of the results.

Although the number of contributions (ideas/comments) was measured at the group level rather than the individual level and hence could not be compared statistically, it still provided some indications. As illustrated in Table 1, the average number of contributions per student was higher for high content-restrictiveness groups (19.31) than for low content-restrictiveness groups (14.73), which is not consistent with hypothesis 2 and higher for low process-restrictiveness groups (18.02) than for high process-restrictiveness groups (16.02), which is consistent with hypothesis 1. The effect of content restrictiveness (a difference of 4.58), however, seems to be more important than that of process restrictiveness (a difference of 2).

Table 1. Average Number of Contributions

	LCR	HCR	Overall
LPR	17.79	18.26	18.02
HPR	11.67	20.37	16.02
Overall	14.73	19.31	

The number of contributions, although indicative of the intensity of the discussion, does not necessarily reflect the discussion quality. To test for the main and interaction effects of content restrictiveness and process restrictiveness on the perceived quality of the discussion, we averaged the responses for the three items (used to measure the perceived discussion quality) and conducted an ANOVA. As illustrated in Table 2, we did not find any significant main or interaction effects.

Table 2. ANOVA Results for Quality of Contributions

	DF	F ratio	Sig. of F
Content	1	2.37	0.126
Process	1	1.65	0.201
Content x Process	1	0.285	0.594

While the results concerning the effects on the learning process were inconclusive, those regarding the learning outcome provided some support for our hypotheses. As illustrated in Table 3, the average score for knowledge complexity is the highest for the LPR-LCR group (5.1) and the lowest for the HPR-HCR group (4.08). Similar results are found for knowledge integration with an average score of 3.13 for the LPR-LCR group and 2.85 for the HPR-HCR group.

Table 3. Means (S.D.) Results for Knowledge Complexity and Integration.

	Mean Scores / (S.D).			
Dependent Variable	LPR-LCR	LPR-HCR	HPR-LCR	HPR-HCR
Knowledge Complexity	5.10 (1.97)	5.46 (2.47)	4.61 (2.12)	4.08 (1.94)
Knowledge Integration	3.13 (1.42)	2.61 (1.40)	2.85 (1.23)	2.77 (1.55)

As shown in Table 4, the ANOVA results indicated a significant main effect of process facilitation restrictiveness on the complexity of the knowledge acquired by the students, providing some evidence for hypothesis 1. The other main and interaction effects, however, were not found to be significant.

Table 4. ANOVA Results for Knowledge Complexity and Integration

Dependent Variable	DF	F ratio	Sig. of F
Knowledge Complexity			
Content	1	0.054	0.817
Process	1	6.817	0.010
Content x Process	1	1.524	0.219
Knowledge Integration			
Content	1	1.546	0.216
Process	1	0.059	0.808
Content x Process	1	0.838	0.362

In addition to the ANOVA tests, *t*-tests were conducted to find significant differences between the LPR (LPR-LCR & LPR-HCR) and HPR (HPR-LCR & HPR-HCR) groups (see Table 5). There is a clear indication that low process restrictiveness leads to the acquisition of more complex knowledge structures by the learner.

Table 5. Results of *t*-tests for Knowledge Complexity Between LPR and HPR Treatment Conditions

Dependent Variable	**LPR** Mean (S.D.)	**HPR** Mean (S.D.)	t-value	p-value
Knowledge Complexity	5.25 (2.18)	4.32 (2.03)	2.616	0.010

Overall, the results did not support hypothesis 2, showing no evidence of the content facilitation restrictiveness having any effects on the process and outcome of collaborative learning. There were also no interaction effects between content facilitation restrictiveness and process facilitation restrictiveness. The level of feedback provided to the students during the case discussion did not have any effects on the perceived discussion quality or the complexity and integration of the knowledge acquired by the students. Content facilitation did not hurt, but did not help either. These results support the common belief that in collaborative learning environments, the students learn more from actively exercising their knowledge than from passive lectures. Such results should, however, be treated with caution, as the effects of content facilitation could vary depending on the timeliness and quality of the facilitator's contributions. As for hypothesis 1, the results were mixed. The restrictiveness of process facilitation did not have any significant effects on the perceived quality of the discussion, but did hinder knowledge acquisition. Less restrictive process facilitation led to the acquisition of more complex knowledge structures. This provides support for researchers who favor more flexible process facilitation.

5. Conclusion

In this study, we have examined some of the potential effects of two variables that a facilitator can influence in a GSS-supported learning environment: meeting process (process structure) and task outcome (content structure). In studying these potential effects, we looked for possible answers in the collaborative learning theory, the process restricted adaptive structuration theory and a number of empirical studies. We found conflicting suggestions, some supporting more restrictive environments and others calling for more flexible facilitation. Believing that the arguments for flexibility are more consistent with the objectives and spirit of collaborative learning, we hypothesized that the restrictiveness of content and process facilitation would hinder both the process and outcome of learning. Our empirical results did not support all of our hypotheses. We found no significant effects of content facilitation restrictiveness, implying the limited influence of the facilitator's feedback. As for process facilitation restrictiveness, we found some support for our hypothesis, with restrictiveness hindering significantly the learning outcome: knowledge acquisition.

The results provide some preliminary support for flexible facilitation in GSS-supported collaborative learning. The generalization of these results, however, should be treated with caution for a number of reasons. Firstly, the subjects of the field experiment had sufficient prior knowledge in the learning task to engage in a meaningful discussion without relying heavily on the instructor's feedback. This explains perhaps the insignificant effects of content facilitation in this particular case. Secondly, the complexity of the learning task could interfere with the effects of process facilitation, a factor that was not examined in this study. There is clearly a need for more research before any conclusive results can be reached.

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