The Effects of Group Composition of Self-Regulation on Project-based Group Performance

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Collaborative learning encourages the use of high-level cognitive strategies, critical thinking, and interpersonal relationships. Despite these advantages, most instructors reveal the difficulties of using project-based collaborative learning; a common problem is the failure of the group to work effectively together. Thus, this study attempted to provide practical advice on group composition with self-regulation. In a college course, 31 groups with 129 students were asked to discuss and prepare the final presentation material and present it together as a collaborative work. All students' self-regulation skills were measured at the beginning of the semester, and the collective self-regulation was computed as an average of the individual scores of each group. The results of regression analysis indicate that the group's collective self-regulation shows a highly significant positive effect on group performance and satisfaction, as self-regulation predicts individual academic performance. The results also show that there is a significant positive relationship between students' self-regulation and participation in group work.

Keywords : collaborative learning, group composition, collective self-regulation, group performance

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Introduction

The potential of collaborative learning has been recognized as instructional strategies to facilitate higher-order learning. Educational researchers suggest that collaborative learning encourages the use of high-level cognitive strategies, critical thinking, and positive attitudes toward learning (Garrison, Anderson, & Archer, 2001; Johnson & Johnson, 1999). Even though collaborative learning has positive effects on students' academic achievement, merely placing students in groups does not guarantee effective collaborative learning (Johnson & Johnson, 1999; Kreijns, Kirschner, & Jochems, 2003). It is, therefore, necessary to investigate practical applications of collaborative learning methods to facilitate successful learning.

Group composition, as an initial input factor among several others, has a significant influence on group process and learning outcomes. There are a number of ways to compose groups, but group composition could be divided into two general categories: heterogeneous or homogeneous. Students might choose their own groups, or instructors could assign students to groups. For instance, student-selected group composition is often too homogenous; high achievers are with other high achievers, low achievers with other low achievers, and females with other females. Whereas teacher-selected groups often result in the optimal combination. Webb and Palincsar (1996) reported that heterogeneous group composition promotes diversity and is more conducive to collaborative learning. Heterogeneous groups exhibit greater degrees of elaborative thinking, providing and receiving explanations, and perspective taking in discussion material; these in turn lead to deeper understanding, better reasoning abilities, and accuracy in long-term retention (Johnson & Johnson, 1999). However, research has shown mixed results. Several studies suggest that heterogeneity in terms of ability and experience leads to better performance when a wide range of competencies are required, but homogeneity leads to better performance when satisfaction, conflict, and communication are taken into account (Campion et al., 1993; Pears & Ravlin, 1987).

Thus, this paper attempts to investigate the effects of self-regulation on group processing and performance in order to provide a practical guideline for group composition that considers self-regulation. Research has suggested that self-regulated learning, the regulatory process whereby students plan, monitor, control and reflect on their learning to achieve their goals and perform better, is one of the most important factors in predicting a learner's academic performance (Pintrich & De Groot, 1990; Pintrich & Schunk, 2002; Zimmerman and Pons, 1986). Zimmerman and Pons (1986) concluded that students' use of self-regulated learning skills appeared to be highly correlated with their academic performance. Even though self-regulated learning skills of an individual student are crucial to the student's performance, no research has been undertaken on the relationship between individual self-regulation and collective self-regulation at the group level. Also, the effects of an individual student's self-regulation on groups remain unknown. Therefore, this study explores the effects of collective self-regulation (e.g. average self-regulated learning skills of group members) and of individual self-regulation on collaborative learning. Accordingly, empirical support for the needs of consideration of self-regulation in group composition is provided through group-level analyses of college students' project-based group activity.

Thus, this study investigates the following research questions:
1. Are collective self-regulation and the level of the highest self-regulation of students in each group significant predictors of group performance?
2. Are collective self-regulation and the level of the highest self-regulation of students in each group significant predictors of group satisfaction?
3. Does the level of a student's self-regulation relate to his/her participation in group work?

Theoretical Background

Collaborative Learning

The term collaborative learning refers to a structured, systematic instructional strategy in which students compose small groups or teams to learn and achieve group goals together (Slavin, 1990). There are many different forms of collaborative learning, but there are common fundamental principles (Lee, et al., 2006).

First, positive interdependence and facilitative interaction are necessary in terms of activity. In collaborative learning, students need to work together to achieve group goals, so it is necessary to form a relationship of inter-dependence with other group members. In this process, facilitative interaction is essential. That is, individual learners are required to encourage and facilitate other members' participation.

Second, with respect to process, all collaborative learning methods share the idea that social skills and group processing are necessary. In order to effectively achieve group goals, social skills such as conflict management, leadership, and decision making are essential. Also, learners need to reflect on their group process and improve their collaboration.

Third, it is important to balance individual accountability and group goals in the assessment of successful collaborative learning. Individual and group rewards for group performance facilitate positive competition and make students realize the importance and necessity of collaboration. Accordingly, rewards facilitate and maintain the motivation of group members.

Research has suggested various collaborative learning models, and with the recent influence of constructivism, it suggests that group-work projects such as problem-based learning, project-based learning, and inquiry-based learning are ways of facilitating higher-order thinking and collaboration (O'Donnell, 2006). However, using group-work projects in practice is not so simple for instructors. There is little

guidance for instructors using group-work projects to guarantee the attractive effects of collaborative learning. Group composition, especially as an initial input factor for group work, exerts a significant influence on group activity and process, which are two fundamental principles of collaborative learning. It is, therefore, necessary to consider the practical applications of group composition.

Group Composition

As reported in the literature, there are many ways of composing small groups. Students may select their own groups or instructors may assign students into groups with pre-determined rules. Generally, student-selected group composition is very homogeneous because students select their group members based on their daily relationships, such as high achievers with other high achievers, or active students with other active students (Johnson & Johnson, 1999). On the other hand, instructor-selected group composition is more heterogeneous; instructors intentionally assign students into groups considering their individual characteristics including grade, gender, talent, or attitude toward learning. In addition, research further suggests that heterogeneous group composition is more effective in terms of deeper understanding, better reasoning skills, and accuracy in long-term retention (Johnson & Johnson, 1999, Webb & Palincsar, 1996). However, there is continuous argument about the lack of empirical evidence that relates heterogeneous grouping to optimal group learning.

Slavin (1996) claimed that high achievers benefited from giving elaborated explanations to low achievers, who also gained advantages by actively participating in group work with peer students' facilitation and encouragement. In contrast, other studies found that high achievers could be interfered with when they gave explanations to other students, and low achievers were also held back because of relatively low interaction compared with high achievers. (Rosenholtz & Simpson, 1985; Cohen, 1994).

Most studies of collaborative learning regarding group composition have focused on learners' academic ability (Campion, Medsker, & Higgs, 1993; Fuchs, Fuchs, Hamlett, & Karns, 1998; Hooper & Hannafin, 1988; Leonard, 2001; Lincheveski & Kutscher, 1998; Pearce & Ravlin, 1987; Hooper, Ward, Hannafin, & Clark, 1989). That is, the main interest of the studies was the instructional design for improving learner's academic achievement through collaboration; homogeneity or heterogeneity of academic ability in group composition was the most important factor. However, recent studies have addressed the importance of the group's mutual goals rather than individual achievement, and the group's overt behavior performed by a collection of individuals (Weinberger, Stegmann, & Fischer, 2007; Volet, Summers, & Thurman, 2009). At the same time, it is obvious that the group affects the behavior of these individuals. Moreover, group members' social skills and group processing have been considered to be the most significant factors that contribute to group performance in collaborative learning (Slavin, 1996). It is, therefore, crucial to examine the influence of individual self-regulation and group-based self-regulation on the dynamics and relational nature of the group's participatory process. Hence, self-regulation regarding group composition needs to be taken into account to gain a full understanding of collective behavior.

Self-regulation and Group Self-regulation

According to Zimmerman (2000), self-regulation refers to "self-generated thoughts, feelings, and actions that are planned and cyclically adopted to the attainment of personal goals" (p. 14). Hence, self-regulated learning is an active and constructive process whereby learners attempt to plan, monitor, control, and reflect on their cognition, motivation, and behavior in their learning to achieve their goals (Pintrich, 2000). Self-regulated learners are behaviorally, motivationally, and meta-cognitively active participants in their own learning processes (Zimmerman, 2000). Components of self-regulated learning skills include cognitive control and meta-

cognitive control, such as goal setting, planning, help-seeking, self-monitoring, self-evaluation, organizing, rehearsing, and memorizing. Pintrich and De Groot (1990) also reported significant relationships among motivational orientation, meta-cognition, and academic performance. Meta-cognition, in particular, was one of the best predictors of performance, while intrinsic motivation was strongly correlated with meta-cognition and cognitive strategy use.

Many empirical studies report that self-regulated learning skills are a significant predictor of learners' academic performance (Corno & Mandinach, 1983; Paris & Paris, 2001; Pintrich & De Groot, 1990; Schunk & Zimmerman, 1998; Zimmerman & Pons, 1986). As the same mechanism operates at the individual level, it seems intuitively reasonable to assume that the self-regulatory system should also operate in conceptually the same way at the group level. That is, group-based self-regulation may affect group process as well as group performance. The effect of group-based self-regulation or collective self-regulation, however, remains unknown. Self-regulation research mainly focused on the regulation of the individual self, but did not investigate the regulation of the group-based self. Similarly, research on collaborative learning concentrated on academic achievement, but did not take into account self-regulation (Sassenberg & Woltin, 2009). Therefore, this study explores the effects of collective individual self-regulation on collaborative learning behavior and achievement to propose a practical guideline for group composition.

Methods

Participants

In order to answer the research questions, data were collected from 129 college students enrolled in a presentation skills course. The students were from various academic departments, and they were randomly assigned to 31 groups, each group

composing of four to five students. One of the primary objectives of the course was to prepare students to produce presentation materials using Microsoft PowerPoint® and deliver presentations. The groups of students were, therefore, asked to spend an hour of every class for ten weeks in their group work, and were allowed to have extra group meetings. Each group developed its own situation for the presentation and discussed the purpose, audience, and contents of the presentation. The members of each group developed their presentation collaboratively and presented their final outcomes together at the end of the semester. The goal of this collaborative task was to encourage students to integrate and apply theories and skills to presentation activities. This open ended task, with a large problem space, served as the ill-structured task that is suitable for enhancing group interdependence.

Measures and Procedures

All students were asked to fill out the s, data were collected from 129 college students enrolled i developed by Pintrich and his colleagues (Pintrich et al., 1991) at the beginning of the semester. The survey is a self-reporting instrument that measures college students' motivational orientations and their uses of different learning strategies. The survey consists of 81 items and uses a seven point Likert-type scale, ranging from 1 (not at all true of me) to 7 (very true of me). The higher score means learners use more self-regulated learning skills while they are learning. Collective self-regulation refers to a group's self-regulated learning skills; thus, the scale was computed as an average of the MSLQ scores of each group member. Also, the highest level of individual self-regulation in each group was identified.

The group performances were measured based on the rubric developed by the instructor of the course, which included the presentation materials and their presentation. The rubric included organization, research, creativity, presentation mechanics, content, and audience response as criteria. The instructor and peer

students of other two randomly selected groups evaluated the group performance together. The correlation between the instructor scores and the average scores of peer students was .87(p < .001), which shows inter-rater reliability.

After the completion of group presentations, all of the participants filled out the satisfaction questionnaire about their group task and the learning experience. The participants were also asked to assess the participation of their peer students. Each individual student gave a percentage score to every member of the group including him/herself, so that the sum of the percentage scores of all group members equaled 100.

The study used linear regression analysis to examine the effect of students' collective self-regulation. Also, the influence of individual self-regulation, especially the highest level of self-regulation, on group performance and satisfaction were also tested. The effect of individual self-regulation on the contribution to the group work was tested as well.

Results

Descriptive statistics for the scales of individual and collective self-regulation, group performance, and group satisfaction are shown in Table 1.

Table 1. Summary table of descriptive statistics

Variables	Mean	SD	Reliability	Remark
Individual self-regulation (n=129)	4.71	.543	.936	Cronbach α
Collective self-regulation (n=31)	4.70	.298		
Group performance (n=31)	4.09	.2165	.872	Correlation
Individual satisfaction (n=129)	4.26	.4446	.902	Cronbach α
Collective satisfaction (n=31)	4.26	.4446		

The correlations between the predictor variables and the dependent variables, as well as those between the predictor variables, are presented in Table 2. All correlations are statistically significant and positive.

Table 2. Correlations between variables

Variables	1	2	3	4
1. Collective self-regulation	1			
2. Highest self-regulation of group	.756**	1		
3. Group performance	.552**	.457**	1	
4. Group satisfaction	.395**	.560**	.395**	1

* p < .05 ** p < .01

To answer the first research question, a stepwise regression analysis of group performance was performed on collective self-regulation and the level of the highest self-regulation of the student in a group at .05 significance level. As presented in Table 3, looking at the two predictors, students' collective self-regulation shows significant positive effects on group performance (β=.552, p=.001). The level of the highest self-regulation of the student in the group shows no significant effect, so it was removed from the regression (β=.093, p=.703). According to the statistics, 30.5% of the variance in group performance is explained by group members' collective self-regulation. In other words, the higher the students' collective self-regulation, the better they performed in group work. Also, the results show that group members' collective self-regulation has a greater effect on group performance than the leader of the group.

Regarding to the second question, a stepwise regression analysis of group satisfaction was performed on collective self-regulation and highest level of student self-regulation in a group. As presented in Table 4, collective self-regulation shows a highly significant positive effect for group satisfaction (β=.658, p<.001), explaining 43.3% of the variance in group satisfaction. But the highest level of student self-regulation of the group shows no significant effect on group

satisfaction.

Table 3. Regression results for collective self-regulation and the level of the highest student self-regulation in each group

	Predictor variables	B	SE	β	t	p	R^2
Added	Collective self-regulation	.401	.112	.552	3.566	.001	.305*
Removed	The level of the highest student in the group			.093	.386	.703	

* $p < .05$

Dependent variables: group performance

Table 4. Regression results for collective self-regulation and the highest level of student self-regulation in each group

Predictor variables		B	SE	β	t	p	R^2
Added	Collective self-regulation	.981	.208	.658	4.705	.000	.433*
Removed	The level of the highest student in the group			.146	.676	.504	

* $p < .05$

Dependent variables: group performance

To answer the third question, the researcher first calculated the rank of individual self-regulation and the rank of individual participation in each of the groups. Regarding the rank of individual participation, five groups reported that all group members participated evenly, so the five groups, or 23 students, were removed from this analysis. The researcher then calculated the Spearman rank correlation between the rank of self-regulation and the rank of participation. Across all participants, the rank of individual self-regulation was significantly correlated with the rank of individual participation in group (γ_s [106] = .278, $p < 0.01$), although the relationship does not appear to be very strong.

Conclusion

This study demonstrates that the group's collective self-regulation has a significant effect on group performance in project-based collaborative learning. This finding indicates that a group's collective self-regulation is a significant predictor of group performance, as individual self-regulation is a significant predictor of academic performance (Pintrich & De Groot, 1990; Pintrich & Schunk, 2002; Zimmerman and Pons, 1986). Moreover, the group's collective self-regulation has positive effects on group members' satisfaction with the task. Results also indicate that there is a significant relationship between students' self-regulation and their participation in group work. That is, students who have higher self-regulation skills than other members in his/her group participate more actively and lead group processes, compared with students who have lower self-regulation skills in the same group.

It is important to note that collaborative learning continues to encourage the development of higher-order cognitive skills in students. However, most teachers and instructors can attest to the difficulties of using project-based collaborative learning. A common problem is the failure of the group to work together effectively. Thus, this study attempted to provide practical advice based on empirical evidence on group composition with self-regulation. Instructors and designers should carefully consider not only individual self-regulation, but also group's collective self-regulation to allow better collaborative work in a project-based collaborative learning environment. As the results indicated, collective self-regulation of each group is a stronger predictor of group performance and satisfaction than the highest level of student self-regulation in the group. Thus, it is recommended that when forming the groups on the basis of individual self-regulation, instructors need to balance the average level of collective self-regulation across all groups.

Clearly, there is much scope for further research in this area to deal with the

complexities of the group process and interpersonal relations within a group. Moreover, this study used aggregated, individual scores to analyze the group level, taking into account the dependencies between individual values. However, there is the influence of groups on individuals that goes beyond inter-individual impact. That is, groups are more than a collection of individuals. In order to tackle the problems with which traditional uni-level statistical techniques are unable to cope, given the hierarchical systems of individuals and groups (De Wever, Van Keer, Schellens, & Valcke, 2007), multilevel analyses in future research are, therefore, necessary.

References

Campion, M. A., Medsker, G. J., & Higgs, C. (1993). Relations between work group characteristics and effectiveness: implications for designing effective work groups. *Personnel Psychology, 46*, 823-850.

Cohen, E. G. (1994). Restructuring the classroom: conditions for productive small groups. *Review of Educational Research, 64*(1), 1-35.

Corno, L., & Mandinach, E. B. (1983). The role of cognitive engagement in classroom learning and motivation. *Educational Psychologist, 18*(2), 88-108.

De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2007). Applying multilevel modeling to content analysis data: Methodological issues in the study of role assignment in asynchronous discussion groups. *Learning and Instruction, 17*, 436-447.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., & Karns, K. (1998). High achieving students' interactions and performance on complex mathematical tasks as a function of homogeneous and heterogeneous parings. *American Educational Research Journal, 35*(2), 227-267.

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education, 15*(1), 7-23.

Hooper, S., & Hannafin, M. J. (1988). Cooperative CBI: the effects of heterogeneous versus homogeneous grouping on the learning of progressively complex concepts. *Journal of Educational Computing Research, 4*(4), 413-424.

Hooper, S., Ward, T. J., Hannafin, M. J., & Clark, H. T. (1989). The effects of aptitude composition on achievement during small group learning. *Journal of Computer-Based Instruction, 16*, 102-109.

Johnson, D. W., & Johnson, R. T. (1992). Positive interdependence: Key to effective cooperation. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in cooperative groups* (pp. 174-199). New York: Cambridge University Press.

Johnson, D. W., & Johnson, R. T. (1999). *Cooperation and competition: Theory and Research.* Edina, MN: Interaction Book. Co.

Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Indentifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. *Computers in Human Behavior, 19*, 335-353.

Lee, I., Leem, J., Sung, E., & Jin, S. (2006). A study of the development of collaborative learning model and behavioral elements in e-Learning environment. *The Journal of Korean Association of Computer Education, 9*(2), 27-36

Leonard, L. J. (2001). From indignation to indifference: teacher concerns about externally imposed classroom interruptions. *Journal of Educational Research, 95*(2), 103-109.

Linchevski, L., & Kutscher, B. (1998). Tell me with whom you're learning, and I'll tell you how much you've learned: mixed-ability versus same-ability grouping in mathematics. *Journal for Research in Mathematics Education, 29*(5), 533-554.

O'Donnell, A. M. (2006). The role of peers and group learning. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of Educational Psychology* (3nd ed.) (pp. 781-802). Mahwah, NJ: Lawrence Erlbaum Associates.

Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist, 37*(2), 89-101.

Pearce, J. A., & Ravlin, E. C. (1987). The design and activation of self-regulating work groups. *Human Relations, 40*, 473-488.

Pintrich, R. R., & De Groot, E. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*, 33-40.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and application* (2nd ed.). Columbus, OH: Merrill-Prentice Hall.

Pintrich, P. R., Smith, D., Garcia, T., & McKeachie, W. (1991). *The motivated strategies for learning questionnaire (MSLQ).* Ann Arbor, MI: NCRIPTAL, The University of Michigan.

Rosenholtz, S. J., & Simpson, C. (1985). The formation of ability conception: Developmental trend or social construction. *Review of Educational Research, 54*(1). 31-63.

Sassenberg, K., & Woltin, K.-A. (2009). Self-regulation of group members: The case of regulatory focus. *Social and Personality Psychology Compass, 3*(2), 118-132.

Schunk, D. H., & Zimmerman, B. J. (1998). Conclusions and future directions for academic interventions. In H. Schunk & B. J. Zimmerman (Eds.), *Self-regulated learning. From teaching to self-reflective practice* (pp. 225-234). Hillsdale, NJ: Lawrence Erlbaum Associates.

Slavin, R. E. (1990). *Cooperative leaning: Theory, research, and practice.* Englewood Cliffs, NJ: Prentice Hall.

Slavin, R. E. (1996). Research on Cooperative Learning and Achievement: What we know, What we need to know. *Contemporary Educational Psychology, 21*, 43-69.

Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained? *Learning and Instruction, 19*, 128-143.

Webb, N. M., & Palincsar, A. S. (1996). Group processes in the classroom. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 841-873). New York: Simon & Schuster.

Weinberger, A., Stegmann, K., & Fischer, F. (2007). Knowledge convergence in collaborative learning: Concepts and assessment. *Learning and Instruction*, 17, 416-426.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13-41). San Diego, CA: Academic Press.

Zimmerman, B. J., & Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal, 23*, 614-628.

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