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Cohesion and Performance in Virtual Teams: An Empirical Investigation

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ABSTRACT

Work groups are of critical importance to organizational effectiveness. Whether group members can function together cohesively affects the performance of a team. Therefore, the relationship between group cohesion and performance has been the focus of many studies. With advances in information technology, virtual teams have been employed in firms for a variety of tasks. Compared to face-to-face teams, however, virtual teams exhibit different characteristics. How cohesiveness is related to performance in virtual teams then becomes an interesting research question. In this paper, we develop a model of the relationship between cohesion and performance based on a synthesis of the existing literature. We empirically investigate this relationship by studying 22 virtual groups over four months. Our results reveal that in virtual teams, cohesiveness tends to influence performance over time, while performance has a reciprocal impact on cohesion as well.

Keywords

Group cohesion, performance, feedback, virtual teams.

INTRODUCTION

A virtual team is a group of "geographically and/or organizationally dispersed co-workers that are assembled using a combination of telecommunications and information technologies to accomplish an organizational task" (Townsend et al, 1998, p. 18). Communication technologies such as telephone, email and teleconferencing are used to connect members of virtual teams. With the advance of information technology, virtual teams have been employed in firms to a great extent. Organizations use virtual teams by incorporating a wide range of knowledge and expertise possessed by various individual members to accomplish projects at a fast pace. Virtual team management thus involves a breakthrough of corporate and cultural boundaries to enable team collaboration, which is of critical importance to organizational effectiveness. The performance of a team usually directly depends on whether group members can function together cohesively; however, compared to face-to-face teams, virtual teams are characterized by different traits and interactions. For example, it is hard to build cohesiveness at the initial stage in virtual teams due to the lack of "a social context". Moreover, virtual teams are less productive initially than face-to-face groups because of the inadequate transfer of rich information (Andres, 2002).

It has been suggested that there is a positive relationship between cohesiveness and performance in virtual teams (Langfred, 1998). Group performance from a previous phase can be perceived as feedback by team members and may influence group cohesiveness in the next phase. In this paper, we develop a model of the relationship between cohesion and performance (feedback) based on a synthesis of the existing literature. We empirically investigate this relationship by studying 22 groups over four months.

The following section presents a review of previous research on group cohesion and team performance. Next, a research model regarding cohesion, performance, and feedback is presented and hypotheses are proposed. This is followed by an empirical test of the hypotheses and a discussion of the results, along with suggestions for future research.

RESEACH MODEL
Cohesiveness

Team performance depends on the ability of a group of individuals to function together cohesively. The cohesiveness of a group is the extent to which group members like each other and desire to remain in the group. It is an outcome of the group development process. Cohesive groups are likely to have sociable and productive interaction between members (Yoo and Alavi, 2001). Cohesion is also a critical construct in team performance, as many studies that have examined cohesiveness in work groups report that cohesion improves group performance (Evans and Dion, 1991). Cohesion depends on the manner and the means by which group members interact with each other (McGrath, 1984). In virtual teams, group members

communicate through telephone, email, or video conferencing. Compared to face-to-face teams, the degree of group interaction in virtual teams is greatly lessened because the transmission of rich information is limited. Therefore, virtual teams lack a social context and adequate transfer of rich information, which makes it difficult to establish group cohesion especially at the initial stage (Burke, Aytes and Chidambaram, 2001).

Performance and Feedback

Evans and Dion (1991) conducted a meta-analysis of 27 studies to examine the relationship between group cohesion and performance. Their results reveal that cohesive groups tend to be more productive compared to non-cohesive groups. In other words, group cohesion and performance in virtual teams are positively correlated, and this relationship is moderated by such variables as goal acceptance (Podsakoff, MacKenzie and Ahearne, 1997) and group norms (Langfred and Shanley, 1997). However recently, researchers have begun to question which one is the causal factor. Does a group have good performance because it is cohesive, or are group members cohesive because they accomplish the task well? The purpose of this paper is to examine this question.

The theory of time, interaction, and performance (TIP theory) argues that time matters to group performance (McGrath, 1991). We suggest that the performance from a previous phase can be perceived as feedback on the task completed and may influence group behavior in the next temporal period. For example, a group of students work together to accomplish a course project and are required to submit several deliverables before the final project is due. The course instructor returns the grades for each deliverable shortly after each submission. If the grade for the first deliverable turns out to be bad, the students would know that they have not met the instructor's expectation in terms of their task performance. They need to either change their group strategy or work much harder to get a better score for the second deliverable. Thus we propose that a virtual team establishes group cohesion first through collaboration, because cohesive groups have more frequent and less inhibited communication that consequently increases task performance (Lott and Lott, 1965). Cohesion brings good performance, which contributes to cohesion in the following period of time as positive feedback.

Our premise of the effects of feedback on group cohesion is based on control theory, which presents a feedback loop to explain the mechanical sensing of the environment (Weiner, 1948). The feedback loop consists of four elements: a referent standard or goal, a sensor or input function, a comparator, and an effector or output function. The sensor perceives an input and sends a signal to the comparator; the comparator tests the input against the standard. If there is a discrepancy between the input and the standard, the system takes action to reduce the discrepancy, and this process is repeated until the input matches the standard. Human control systems operate in the same basic way and individuals regulate their behavior in light of the feedback they receive to ensure the attainment of goals (Klein, 1989; Lord and Hanges, 1987). When applied to the group level, control theory implies that feedback affects a group by allowing group members to monitor the discrepancy between their performance and the goals they have established (Mesch, Farh and Podsakoff, 1994). Positive feedback to a group indicates that the discrepancy between group performance and their goals is minimized, and it improves group motivation. Group members are satisfied with each other since they have worked together to make this accomplishment, and group cohesion is likely to be enhanced. However, if the feedback is negative, group members perceive a discrepancy between their performance and their established goals. Group members may be dissatisfied with each other because it is hard to separate individual responsibilities in a group project thus members may blame others. Such behavior may hurt the feelings of group members and destroy group cohesiveness.

Following our discussion, Figure 1 presents our research model that portrays the relationship between cohesion, performance and feedback in virtual teams. Although previous research suggests that the relationship between cohesion and performance is moderated by other factors, such as group norms and goal acceptance, the investigation of moderator is out of the scope of this study. Rather, we focus on the effects of cohesion on performance during several periods of time, and we propose that group cohesion is positively correlated with task performance.

> *H1: Cohesiveness in virtual teams is positively related to performance.*

Based on control theory, we propose a positive correlation between feedback and group cohesion. Teams that receive positive feedback on their group performance tend to be cohesive as the discrepancy between their goals and performance is minimized so that team members are satisfied with each other.

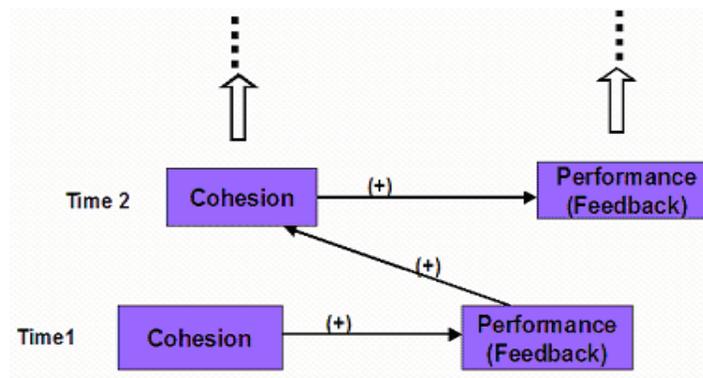> *H2: Feedback in virtual teams is positively related to cohesiveness.*

Figure 1. Research Model of cohesion, performance and feedback

RESEARCH METHOD
Research Design
We collected our data from an experiment with 22 groups that had 4 or 5 members each. Subjects were drawn from an undergraduate database class offered in three American universities located in three different states. Therefore, subjects were dispersed and were supported with groupware supporting message exchange and file uploading. A concise manual was distributed to the subjects before they started using the technology. Some researchers have addressed the problem of generalizability regarding the use of undergraduate students in research designs (Gordon, Slade and Schmitt, 1986). Based on our design, the findings from this study can be applied to dispersed project teams that are composed of novice employees facing time-based deliverables.

Subjects were required to complete a database project by submitting four deliverables over sixteen weeks. After each deliverable, they voluntarily completed an online survey about their perceptions of group cohesiveness. With this design, subjects will not feel obligated to provide data; thus, the social desirability that may influence the validity of survey data is reduced (Ganster, Hennessey and Luthans, 1983). Group grades for each deliverable were returned to the groups shortly after each submission. Individual subjects were also evaluated based on peer evaluations from other group members. All the messages and files they exchanged were archived. At the end of the semester, all subjects voluntarily filled an extra survey after all the deliverables were turned in. Therefore, we collected cohesiveness data for five time periods and grades for four periods.

As described above, this experiment was conducted in a virtual environment. It differs from the environment in which teams meet fact to face because the development of cohesion is very different in the two environments. Our research design allowed us to study virtual groups over five temporal periods. The submission of each deliverable represents the end of a period. The analysis was conducted at the individual level and data were analyzed for five time periods. The results can be applied to the group level since cohesion reflects each individual's perception of the group cohesiveness, and a significant portion of the individual grade is based on the group grade. As subjects provided the data voluntarily, we have different numbers of observations for each period. The descriptive statistics and correlation matrix are presented in Table 1.

Measures
The same subjects participated in all five periods, therefore the observations are not independent. In order to detect the true effects, we conduct repeated measures ANOVA, which is appropriate when independent variables are categorical. There are two steps in our analysis. First, we examined how cohesion affects performance. Here, the dependent variable was performance, and the independent variable of interest was cohesiveness (coded as high = 1 and low = 0). Note that both cohesion and performance were from the same time frame in this analysis. Secondly, we switched the variables and used cohesion as a dependent variable. Feedback (coded as high = 1 and low = 0), which was the performance from the previous period, was the independent variable. For each step, our analysis represents four temporal periods: step one covers time 1 to time 5; step two covers time 2 to time 5.

Cohesiveness: We used Seashore's (1954) Index of Group Cohesiveness, which is designed to capture how team members perceive their groups' cohesion. This instrument has been previously validated (Chidambaram and Jones, 1993), and it has a

reliability (Cronbach's α) of 0.89. Scores range from 1 to 5, with higher scores indicating greater cohesiveness. Appendix A shows a sample of the scale.

Variables	Mean	S. D.	Correlation								
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Cohesion 1 [a]	3.17	1.28	1.000								
2. Performance 1 [a]	79.85	22.00	.046	1.000							
3. Cohesion 2 [b]	3.17	1.35	.910**	.252*	1.000						
4. Performance 2 [b]	76.36	23.34	.067	.673**	.113	1.000					
5. Cohesion 3 [c]	3.09	1.40	.875**	.297*	.933**	.166	1.000				
6. Performance 3 [c]	79.25	25.85	.009	.524**	.259*	.653**	.175	1.000			
7. Cohesion 4 [d]	3.18	1.38	.812**	.395**	.885**	.244*	.939**	.324**	1.000		
8. Performance 4 [d]	80.91	30.29	.032	.474**	.298**	.657**	.172	.806**	.327**	1.000	
9. Cohesion 5 [e]	3.01	1.44	.842**	.352**	.890**	.284*	.906**	.329*	.968**	.327*	1.000

   * P<.05   [a] Time 1 N = 82   [b] Time 2 N = 80   [c] Time 3 N = 68   [d] Time 4 N = 72   [e] Time 5 N = 56
  ** P<.01
 *** P<.001

Table 1. Descriptive Statistics and Correlations

Performance/Feedback: Group performance for each phase is reflected by a 100-point scale, with higher scores indicating better performance. Individual scores were calculated based on a combination of the group grade assigned for each deliverable and the peer evaluations from group members. Group grades were the average of the independent scores given by three experts in the database area. The score may be considered feedback on group performance. Specifically, the score for deliverable one reflects how a group performed in the first period. Higher scores represent better performance and a more positive feedback. Based on our second hypothesis, the influence of cohesiveness in the previous period on performance on the following period will be examined.

ANALYSIS AND RESULTS
Principal Components Analysis
First, even though Seashore's Index of Group Cohesiveness has been validated previously, we used Principal Components Analysis to extract factors and test the reliability of this scale. Table 2 shows that there is one factor extracted, explaining 73.76% of the variance. The reliability Alpha =0 .9028. Therefore, Seashore's measure is appropriate to use in our study.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.688	73.755	73.755	3.688	73.755	73.755
2	0.718	14.364	88.119			
3	0.351	7.024	95.143			
4	0.172	3.430	98.574			
5	0.071	1.426	100.000			

Table 2. Total Variance Explained: Seashore's Index of Group Cohesiveness

Repeated Measures ANOVA Step 1
In this step, we examine the relationship between cohesiveness and performance over the first four periods using repeated measures ANOVA. First, we conduct Mauchly's test to check the assumptions of sphericity for repeated measures. All mauchly's tests are non-significant, indicating the condition of sphericity has been met. Cohesion, the independent variable, is coded as high (=1) and low (=0). The dependent variable, performance, is measured as a score based on 100-point scale. The higher the score, the better is the performance. Table 3 presents the effects of time and cohesion. We report the conservative Greenhouse-Geisser tests (Field, 2003).

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.
Time	3090.631	2.690	1148.915	3.086	0.036
Cohesion	1946.135	1.000	1946.135	3.122	0.086
Time*Cohesion	887.273	2.451	361.941	0.590	0.590

Table 3. Tests of Within-Subjects Effects

First, time appears to have a significant ($p<0.05$) main effect on performance, which indicates that all groups tended to perform better over time. This effect can be attributed to maturity: at the very beginning of the semester, students do not have much course-related knowledge and thus may not perform well in the project; but as the semester goes on, they learn more and can apply the knowledge they have learned in class to the project. It is not surprising to see that students are likely to perform better in the latter part of a semester than at the beginning.

Cohesion appears to have a weak ($p<0.10$) main effect on performance (regardless of time), indicating that stronger cohesion contributes to better performance with the relationship moderated by other factors. This result matches previous research: Podsakoff et al (1997) suggest that the relationship between cohesion and performance is moderated by goal acceptance; Langfred and Shanley (1997) find that the relationship is moderated by group norms. In addition, as it takes time for cohesion to develop, the fist session of our experiment may have been insufficient for cohesion to develop fully, explaining the weak effect of cohesiveness.

Lastly, there is no interaction effect of time and cohesion as shown by Figure 2 (1=low cohesion; 2=high cohesion) and verified by the analysis. But the graph does indicate that the high-cohesion groups performed better all the time as compared to the low-cohesion groups. Therefore, given the overall results, our first hypothesis is partly supported.
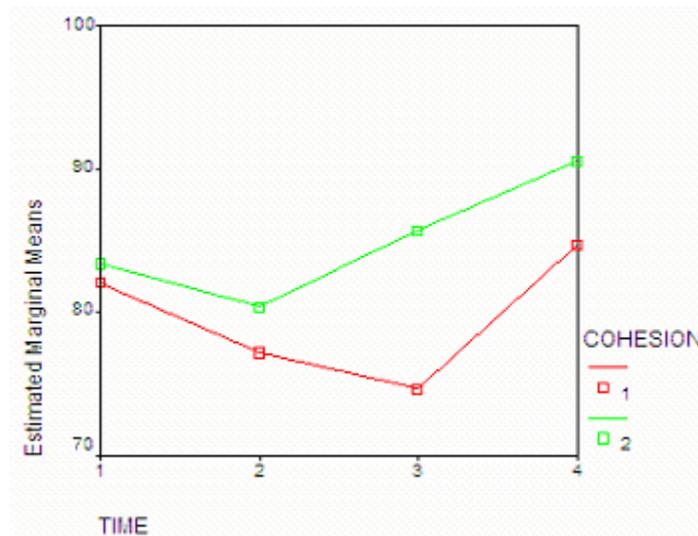

Figure 2. Estimated Marginal Means of Cohesion

Repeated Measures ANOVA Step 2
In the second step, we examine the relationship between feedback and cohesiveness from the second period to the last period using repeated measures ANOVA. The independent variable this time is feedback and it is coded as high (=1) and low (=0). The dependent variable is cohesion, measured by Seashore's (1954) Index of Group Cohesiveness. The instrument (Appendix A) contains five items measured in a 5-point Likert scale. Scores range from 1 to 5, with higher numbers indicating stronger cohesion. The effects of time and feedback using the Greenhouse-Geisser tests are shown in Table 4.

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.
Time	0.716	2.929	0.245	0.322	0.805
Feedback	6.652	1.000	6.652	10.065	0.004
Time*Feedback	4.335	2.709	1.600	1.968	0.132

Table 4. Tests of Within-Subjects Effects

There is a significant main effect of feedback on cohesion, indicating that the more positive the feedback a group receives, the greater the cohesion (regardless of time) the team will have. Our second hypothesis, thus, is supported. However, there is no significant interaction effect of time and feedback. But if we look at Figure 3 (1=less positive feedback, 2=positive feedback), feedback appears to have a quadratic effect on cohesion: positive feedback results in a U, while negative feedback results in an inverted U. This suggests that the effect of feedback gets magnified later in the life of the group. Those groups who always get the more positive feedback are motivated to collaborate closely to accomplish the project; but those who get less positive feedback are discouraged and the groups may fall apart as they get to the end of the project. On the one hand, our analysis based on control theory is supported: teams with more positive feedback will be cohesive because team members are satisfied with each other and they tend to like each other more as their group goals (e.g. to get a good grade for the project) have been accomplished; but cohesion in those teams with less positive feedback may be diminished since team members are likely to be unhappy with other team members who may be thought of as not having worked hard enough to do better. On the other hand, this situation violates the traditional paradigm that expects all groups to follow the same historical path. It potentially may support Gersick's (1988) punctuated equilibrium model, which depicts the development process of a group as a punctuated equilibrium: groups develop steadily till a midpoint when a sudden revision of the group's framework may change the pace of the group. This process is similar to what is portrayed in Figure 3. Groups with more positive feedback basically have the opposite experiences regarding cohesiveness compared to those with less positive feedback. The results are interesting even though the interaction effect is non-significant, which might be a problem related to the sample size.
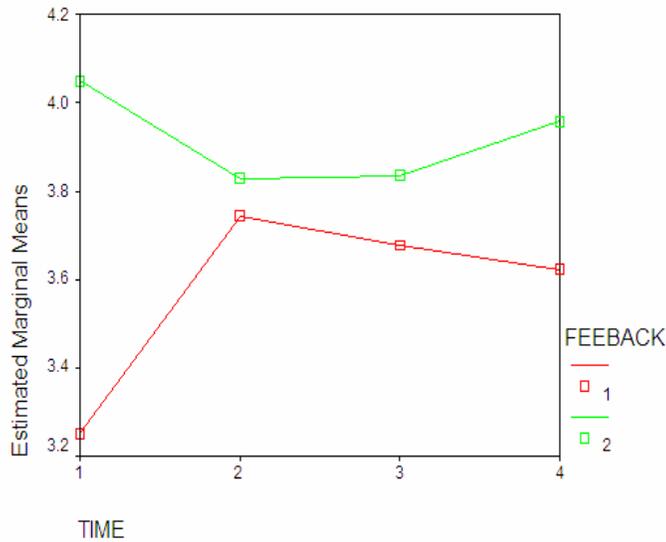

Figure 3. Estimated Marginal Means of Feedback

DISCUSSION

In this study, we empirically investigated the relationship between cohesion and performance (feedback). Based on a synthesis of previous research, we proposed a model that cohesion initiates performance, which can be perceived as feedback on group performance that influences group cohesiveness in the following periods. The results, consistent with the previous research, show that cohesion is positively correlated with performance, with potential moderating effects of other factors. We also found that when performance is considered as feedback, it has a reciprocal impact on group cohesiveness. Positive feedback enhances group cohesion in virtual teams. More interestingly, we find that feedback seems to have a quadratic

effect on cohesion. Specifically, the effect of feedback gets magnified later in the life of a group, which provides some ammunition to support Gersick's (1988) punctuated equilibrium model.

However, our study has some limitations that should be considered in future research. First, we did not isolate the effects of the reciprocal relationship. But variables such as group size and group diversification may influence the relationship and they should be controlled to reduce the noise. Second, our sample size is still relatively small so we could not conduct group level analysis. In particular, we could not detect the true interaction effects of time and feedback. We suggest that other researchers may repeat the study with a larger sample size to examine more details of the relationship between cohesion and performance (feedback). It would also be interesting if future studies could examine our research model in co-located teams to compare the results and investigate other factors that may influence the relationship.

REFERENCES

1. Andres, H.P. (2002) "A comparison of face-to-face and virtual software development teams." *Team Performance Management*, 8, 39-48.
2. Burke, K., Aytes, K., and Chidambaram, L. (2001) "Media effects on the development of cohesion and process satisfaction in computer-supported workgroups," *Information Technology and People*, 14(2), 122-141.
3. Chidambaram, L., and Jones, B. (1993) "Impact of communication medium and computer support on group performance: a comparison between face-to-face and dispersed meetings," *MIS Quarterly*, 17(4), 465-488.
4. Daft, R.L., and Lengel, R.H. (1986) "Organizational information requirements, media richness, and structural design," Management Science, 32 (5), 554-571.
5. Evans, C.R., and Dion, K.L. (1991) "Group cohesion and performance: a meta-analysis," *Small Group Research*, 22(2), 175-186.
6. Field, A. (2003) *Discovering Statistics*, London: SAGE Publications.
7. Ganster, D.C., Hennessey, H.W., and Luthans, F. (1983) "Social desirability response effects: three alternative models," *Academy of Management Journal*, 26, 321-331.
8. Gersick, C. (1988) "Time and transition in work teams: Toward a new model of group development," *Academy of Management Journal*, 31(1), 9-41.
9. Gordon, M.E., Slade, L.A. and Schmitt, N. (1986) "The 'science of the sophomore' revisited: From conjecture to empiricism," *Academy of Management Review*, 11(1), 191-207.
10. Klein, H.J. (1989) "An integrated control theory model of work motivation," *Academy of Management Review*, 14, 150-172.
11. Langfred, C., and Shanley, M. (1997) "The importance of organizational context, I: A conceptual model of cohesiveness and ineffectiveness in work groups," *Public Administration Quarterly*, 21(3), 349-369.
12. Langfred, C.W. (1998) "Is group cohesiveness a double-edged sword? An investigation on the effects of cohesiveness on performance." *Small Group Research*, 29, 124-143.
13. Lord, R.G., and Hanges, P.J. (1987) "A control system model of organizational motivation: Theoretical development and applied implications," *Behavioral Science*, 32, 161-178.
14. Lott, A.J. and Lott, B.E. (1965) "Group cohesiveness as interpersonal attraction," *Psychological Bulletin*, (64), 259-309.
15. McGrath, J.E. (1984) *Groups: Interaction and Performance*, NJ: Prentice Hall.
16. McGrath, J.E. (1991) "Time, interaction, and performance (TIP)," *Small Group Research*, 22(2), 147-174.
17. Mesch, D.J., Farh, J., and Podsakoff, P.M. (1994) "Effects of feedback sign on group goal setting, strategies, and performance," *Group and Organization Management*, 19(3), 309-333.
18. Podsakoff, P.M., MacKenzie, S.B., and Ahearne, M. (1997) "Moderating effects of goal acceptance on the relationship between group cohesiveness and productivity," *Journal of Applied Psychology,* 82(6), 974-.
19. Seashore, S.E. (1954) *Group Cohesiveness in the Industrial Work Group*, MI: University of Michigan Press.
20. Townsend, A.M., DeMarie, S., and Hendrickson, A.R. (1998) "Virtual teams: Technology and the workplace of the future." *Academy of Management Executive*, 12(3), 17-28.
21. Weiner, N. (1948) *Cybernetic: Control and Communication in the Animal and the Machine*, Cambridge: MIT Press.
22. Yoo, Y., and Alavi, M. (2001) "Media and group cohesion: relative influences on social presences, task participation, and group consensus," *MIS Quarterly*, 25(3), 371-390.

APPENDIX A
Seashore's Index of Group Cohesiveness (Adapted for student work groups)
1. Do you feel that you are really a part of this group?
>   Really a part of my group
>   Included in most ways
>   Included in some ways, but not others
>   Don't feel I really belong too much
>   Don't feel I belong at all

2. If you had a chance to do the same kind of work in another student work group, how would you feel about moving?

>   Would want very much to stay where I am
>   Would rather stay where I am than move
>   Would make no difference to me
>   Would rather move than stay where I am
>   Would want very much to move

How does this group compare to other student groups on each of the following points?

	Very much better	Better than most	About the same	Worse than most	Very much worse

The way people
3. Get along together
4. Work together
5. Help each other