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ABSTRACT

Weak increases in classroom cohesion for three seventh-grade classes instructed by a mastery learning technique compared to three conventionally instructed classes are demonstrated using block analysis of variance, triadic census (balance theory), and block modelling (role theory) analytic techniques on repeated-measures sociometric rating data. Each technique is described and clear examples of its use given. Since increased cohesion may have positive effects on student mental health, it is argued that researchers should routinely assess changes in classroom cohesion by these or other methods during classroom interventions. (Authors)

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THE IMPACT OF "LEARNING FOR MASTERY" INSTRUCTION ON CLASSROOM COHESION

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THE IMPACT OF "LEARNING FOR MASTERY" INSTRUCTION ON CLASSROOM COHESION

"Learning for mastery" instructional techniques frequently improve average classroom achievement (Bloom, 1968). Theoretically classroom cohesion should also increase with "mastery learning," for rather than competing against each other, students are attempting together (frequently in small discussion groups) to achieve a realistic preset common goal.

Previous research has given little attention to assessing changes in classroom sociometric structure. In this paper we attempt both to demonstrate and also to measure the degree of change in classroom cohesion by comparing before and after sociometric responses in three mastery learning and three conventional classrooms. We argue that not only should researchers give more attention to the impact of teaching methods on classroom cohesion, but also that the specific analytic methods used to examine structure in this study will prove useful to others in achieving this objective.

The Experimental Design and Data.

For twenty-three class days three seventh-grade classrooms with a total of forty-seven students were assigned to a "learning for mastery" (Bloom, 1968) instructional mode, while a comparable forty-six students in three other classes received conventional instruction over identical content material. The learning for mastery students received immediate feedback from frequent "learning exercises" (formative tests), and discussion time over the results of these exercises in small randomly-created groups directed by ninth-grade honor students. The conventional classes received the same exercises (labeled quizzes), but no feedback was given until after unit exams. Academic performance was assessed in all six classrooms by the same unit exams; as expected the mastery learning classes performed significantly better.

Before the start of the instructional units and again at the conclusion twenty-three class days later each student was asked to rate his willingness to work on a class project with each other student in his classroom. Each student used a nine point rating scale, with a '+4' defined as the socre to give to a person one wanted very much to work with, a '-4' as the score to give to a person one would not want to work with at all, and a '0' for persons for whom one did not care one way or the other. The other numbers were to represent weaker degrees of willingness to work or not to work with a classmate. The two square matrices of scores created for each classroom by this procedure, both a before and also an anfter matrix with each row representing an individual's rating of his classmates on this scale, constitute the basic sociometric data for the study.

Specific hypotheses and results.

1. The regression analysis.

If cohesion increases in the mastery learning classes, we expect the average rating in the posttest matrix to be higher than in the pretest matrix. We hypothesize an increased willingness to work with other classmates after having worked together in the mastery learning classes, but no changes in the conventional lecture classes.

If one is willing to treat the numeric ratings (ranging from -4 to +4) that each individual gave to each classmate as approximately continuous and interval, one can test for the significance of changes from the pretest to the posttest levels. A simple difference-of-means test is not appropriate, for within-subject ratings are not independent; some individuals will tend consistently to give higher ratings than will others. Likewise one cannot assume that the objects being rated are independent; some individuals will consistently be more popular than others. We are interested only in between time averages net of within subject and within object variations.

We assume three factors influence the score that a respondent gives to a classmate: (1) the respondent's general rating level; (2) the general popularity of the classmate being rated, and (3) the testing occassion, pretest or posttest. As Cohen and Cohen (1975) point out in their discussion of repeated measures, this analysis can be handled in a regression format simply by stringing out the pretest and the posttest matrix into a single long dependent vector, and use as independent variables a set of N-1 dummy vectors representing each subject's mean rating level, another set of N-1 dummy vectors representing the differences in popularity of subjects, and one dummy vector representing the testing occassion. Before assessing the relation of the ratings to time we simply subtract out of the total score variation that variation attributed to subject and popularity differences, reducing both the error sum of squares and the degrees of freedom.

The results of this regression analysis for each of the six groups are reported in Table 1. The class size, pretest mean, posttest mean, and change are given in the left column; in the right column are the total R for the regression model, the relation between the ratings and time net of subject and popularity variation, and the F-ratio for that partial r.

Table 1 about here

In general the time effects are weak. Two of the three mastery learning classes showed a significant increase from the pretest to the posttest, while the third remained essentially constant. None of the three control lecture classes showed a significant increase, but one class showed a decrease. Since the probability of having two out of six significant increases if the null hypothesis level of 5% significance is accepted as the base is slightly more than 0.03, we can assume a tendency for the average in mastery learning classes to increase over time.

But the work choice information is not just numeric ratings; it can also be taken to represent a network of desired potential work relations among classmates. Looking only at mean ratings does not at all take advantage of this network information. We now turn to techniques that do.

2. Structural balance changes in each classroom.

In recent years a great deal of work has been done extending some of the elements of Heider's balance theory to measures of structural balance in sociometric structures. In particular balance theory suggests that if one person chooses another as a desired work partner, and the chosen person chooses a third person, the first person is also more likely to choose the third; in a version of friends of friends tend to be friends. Building on this theory Davis (1970) and Holland and Leinhardt (1976) have developed techniques for taking a total census of all possible sets of three persons in a group and counting the number of times this transitivity arrangement is violated; i.e., how often that both the first person chooses a second and the second also chooses a third person, but then the first person does not choose the third. Such a triple is labelled an 'intransitive' triple. A total census simply counts the number of such triples (as well as their type) in a group with defined positive relations. In addition random baselines have been worked out specifying how many such intransitive triples one would expect to find in a given group if choices were given at random, as well as significance tests for inferring if the observed number of intransitive triples is significantly less than the expected number, thus demonstrating a pattern to the choices. (Holland and Leinhardt, 1976)

Hallinan (1976) has demonstrated that open classrooms are more likely to exhibit less intransitivity than are more formally taught traditional classrooms. She argues that where more free interaction is possible, students are likely to have more information about the preferences of others, and thus make more informed, balanced, and less tension producing choices both on paper and in actual interactions. Likewise we hypothesized that the mastery learning classes will also show a lesser tendency toward intransitivity on the posttest, while the conventional classes should change little.

Four possible positive-choice sociograms can be drawn from each of the work rating matrices, one for the +4 choices only (the strongest level), one for both the +4 and +3 choices together, one for +2 choices and up, and finally one for the +1 level of choices and up. A triad census was conducted for each of these four sociogram for each of the six pretest and the six posttest matrices, producing a total of 48 triad analyses. Of the 48 matrices 47 had significance levels (tau) far in excess of the 1% level; thus all but one of the possible matrices had significantly fewer intransitive triads than expected if choices were given at random.

Hallinan (1974) has proposed as a measure of the degree of less-than-expected intransitivity the measure T_-, which is calculated by finding the ratio of observed intransitive triples to that predicted by the random baseline model, and subtracting that ratio of triad deficits from 1. In formula form $T_- = 1 -$ (observed no. of intransitive triples/expected no.). In this application in all cases the number observed was less than the number expected, so T_- is positive. The larger T_-, the greater the deficit of intransitive triples, and thus the less imbalanced the structure.

The hypothesis that the mastery classes are more balanced on the posttest than are the conventional classes receives little support from our data. Two analyses are reported in Table 2. The first compares the mean T_- scores for each of the 12 pretest levels for both the mastery and conventional classes. In Table 2A it appears that the mastery classes are slightly less intransitive on the pretest than are the conventional classes, and even though they remain less intransitive on the posttest the difference narrows. Table 2B reports the mean rank, found within each of the four levels and then averaged by type of class across the four choice levels. Again the mastery classes have higher rankings or bigger scores for the pretest, but the rank order actually favors the conventional lecture class for the posttest. Nor are any patterns favoring individual classes evident in the expanded matrix reporting T_ for all classes at all levels.

Table 2 about here

A prudent conclusion is that the mastery learning classes are not more likely to become significantly less intransitive (more balanced) over time than are the conventional classes. The difference in this conclusion from Hallinan's may be accounted for by pointing out that interaction in the mastery learning classes was not as free as that in open classrooms; rather students regularly worked in groups to which they were randomly assigned. There is even a possibility of a decrease in the T_ measure if some individuals become friendly with persons previously less well known to them, but because of classroom strictures are not freely able to communicate these findings to preexisting friends. In fact five of the twelve T_ change scores in the mastery learning group were lower on the posttest than on the pretest, compared to only two in twelve of such comparisons in the control group.

Neither of the two techniques discussed so far lets one deal with changes within and between subgroups within the classroom. The last technique described, block modelling, enables one to examine such relations by means of two-dimensional plots.

3. Block modelling.

We hypothesize that the group structure for the mastery learning classes will tend to become more diffuse over time, assuming that positive choices will tend to increase to class members who were outside of original groupings. One possibility is that these ties will be weak ties, perhaps involving intransitive triads, even as ties within original groupings are strengthened and reinforced. Any test of such a hypothesis must involve a way to identify subgroups within each class.

Block modelling, as developed by Harrison White and his students (e.g., White et al., 1976) is a reversal of attempts to find cliques in interaction or choice data. White argues that defining cliques in terms of total interactions will fail, for not all individuals who occupy a similar role position or are of a similar social type in a group will be able to interact because of time and physical constraints. In fact some social types by definition will not interact, for example social isolates. So instead of looking for blocks of interaction to define social types, one should instead look for the 'holes' or blank areas in interaction patterns over a number of interaction traits simultaneously.

One can look for 'holes' by trial and error by rearranging rows and columns of interaction or choice matrices to reveal as far as possible the blank spaces of non-interaction. For example, look at the five-block model for the group 6 pretest given on the first page of Appendix I. Each row represents an individual's expressed ratings. A 'one' indicates that the individual gave a rating of from +1 to +4 on the work question. Thus individual 14 gave positive ratings to individuals 12, 13, 19, 15, etc. The positive workmate choices by the first three groups of students tend to be concentrated in the first three blocks. The negative choices (-1 to -4) given on the next page of Appendix I, tend to concentrate on the last two blocks, approaching total unanimity. These two matrices are in great contrast to the usual random-looking appearance of originally collected data matrices, which for this group were originally in the order 1 to 19 rather than the permutation presented here.

Note that in this arrangement persons who tend to choose alike, both positively and negatively, are close together. At the same time individuals who were chosen alike also tend to be pulled together. We thus have a two-dimensional map of choices with persons arranged so that more similar choosers are pulled together and less similar ones pushed apart. The block lines are somewhat arbitrary attempts to divide the group into social types--into sets of people who in this case chose and were chosen alike for workmates.

In this example we had only one trait to block on. We were able to take full advantage of the positive and negative levels obtained in the original data collection. If we had more data traits to block on, we could include them simultaneously in the same analysis. We would feel more confidence in an arrangement if there were not only empty holes for 'work with,' but at the same time empty holes for 'like,' for 'eat in the lunchroom with,' for 'play at recess with,' for 'study with,' and so on. A great strength of block modelling is that it allows one to consider simultaneously a number of interactions or desired interactions measured at varying levels in order to derive groupings or social types.

How is a grouping like the one for class 6 obtained? For this data set five matrices were created from the original rating matrix, the first with 1's for locations with a +4 (very much like to work with) and 0's elsewhere, the second with 1's for a +3, the third with 1's for +2 and +1, the fourth with 1's for ratings of -1 and -2(prefer not to work with), and the last with 1's for ratings of -3 and -4. One could then proceed to simultaneously permute rows and columns of these five matrices in a systematic search for 'holes,' as White's group first did.

Fortunately approximately the same results can be obtained analytically (Schwartz, 1977). Each of the five matrices of 1's and 0's were treated separately. The mean for each row, excluding the diagonal, was found and subtracted from that row. This removes differences in individual choosing levels, the tendency for some persons to give higher ratings than do others. Then the mean of each column was found (again excluding the diagonal). This mean was subtracted from each element in the column, then the diagonal was set to this mean (so that it would not influence the covariance). The last step standardized for mean differences in popularity and also made each column average equal zero. In effect we have removed the main effects utilized in the original regression model--the individual differences in rating levels and the individual differences in popularity. What remains is the non-main or the interaction effects.

We now find the covariance matrix between the columns of each matrix. Since each matrix has the same mean, we can simply add all the individual covariance matrices to find the pooled interaction covariance matrix. After this standardization process covariance matrices from different traits can safely be pooled; for we are searching for pairs of persons who are similar in interaction effects across all traits simultaneously.

To cluster people the next step is to perform a principal components analysis of the pooled covariance matrix. For the group 6 pretest the first component explained 20.4% of the variance, with succeeding components dropping off to 8.8%, 7.9%, 7.4%, 6.5%, etc. Even though the first component explains only a minority of the variance, the other components tail off quickly and are fairly homogeneous. This result was typical of the other rating matrices also.

The eigenvector for the first principal component provides the ordering used in the final matrices for group 6. Table 3 gives the ordered eigenvector from that analysis. One can see that the order used in the matrices of Appendix I is the permutation of rows and columns to the order given by the eigenvector of the first principal component. The blocking in those matrices was done to roughly correspond to the spread evident in that eigenvector, grouping together persons who had similar scores.

Table 3 about here

From these results several types of analyses are possible. First just the mere reording and dividing of persons into social types might lead to a search for correlates of that ordering, be it sex, race, social class, intelligence, etc. We do not perform such an analysis here.

Instead let us hold constant the blockings obtained in the pretest and place the posttest results into that same framework. We could stay at the five block level and analyze changes in proportions of positive and negative choices from the pretest to the posttest within blocks. The posttest blockings and the proportions within each block and the change in proportions for class 6 are presented on the third through sixth pages of Appendix I. However those matrices are too rich for easy analysis.

Let us fall back to a cruder level of distinctions. In the pretest for class 6 Blocks I, II, and III tend to be fairly positive to each other and negative to Blocks IV and V. Instead of splitting five ways let's split only two, combining Blocks I, II, and III and also Blocks IV and V. We will have 12 persons in the first block and 7 in the second. We perform a similar split for the other five classrooms. The proportion positive, negative, and changes for these two-block models are reported in Appendix II.

Even these results are too rich for easy analysis. The numbers of Appendix II are changed to plus and minus signs in Figure 1. If a block has more than the mean group positive proportion, we assign the block a plus; if it is more negative than the group mean, we assign a minus; if neither, a zero.

Figure 1

The first column of Figure 1 enab[illegible] quickly compare block averages to the class mean. Three of the classes (one, three and six) exhibit high within block positive proportions and high outblock negative proportions, the classic dichotomy. Class two comes close to that model, while classes four and five have blocks who are very favorable to outgroups, perhaps indicating a status hierarchy. Such hierarchies will be more evident with finer blocking.

The second column highlights changes in block distributions from the pretest to the posttest. Five of the twelve blocks in the mastery learning classes became more positive in the posttest, compared to only one of the twelve in the conventional lecture classes. A Fisher's Exact Test of this distribution gives a significance level of 7.7%, thus coming close to the conventionally accepted significant difference level even with this small sample.

The changes evident in column two can be broken down two ways, by whether the class was a mastery learning or a lecture class, and by whether the change was within the same block or toward another block. Table 4 gives that breakdown. Positive changes in the mastery learning classes were often directed toward members of other blocks (once in each group), while this happened less frequently in the conventional classes. The sole more negative entry in the mastery learning classes (in class three) was directed internally within a block. Apparently members of that block were in some sense 'down' on themselves and concurrently not more positive to the other group, even though that block became more positive toward them. The phenomenon of being 'down' on one's own block was more evident among the lecture classes; no block in that condition became more positive toward themselves.

Table 4 about here

Recall that the triad analysis showed no major c[illegible]ges in structural balance over time, but a possible weak trend to les[illegible]nsitivity in the mastery learning classes. The tendency toward more out-block choices supports the hypothesis that the clique structure of the mastery learning classes might become weaker over time, in the sense that positive ties are being created with other blocks, breaking down dichotomies within classes. It is worth recalling that one can observe a totally balanced structure in a group with two cliques who choose only positively within and only negatively toward each other. Although such a class is balanced, it is probably not the type we wish to foster. Since the mastery learning classes are moving away from the original dichotomies, we argue that they are in fact becoming more cohesive and less divisive.

Conclusions and Implications

Even in a short term implementation of a mastery learning instructional mode we find small but consistent tendencies toward increased classroom cohesion. Bloom (1968) has argued that increased cohesion can have positive effects on the mental health of students in learning situations. Since this is a desired outcome, more attention should routinely be given to assessing changes in classroom sociometric structure. This can be done not only for mastery learning situations, but by using techniques similar to those presented in this paper for other classroom interventions as well.

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FIGURE 1

The two-block models for the six classes. A plus indicates more positive choices or change than average, a minus more negative choices or change than average, a zero no great change or no excess of positive or negative, more zero a decrease in both positive and negative choices.

Class	n	PRETEST PROPORTIONS		CHANGE	
Class 1	$n_1 = 6$	+	−	More +	More +
	$n_2 = 6$		+	Less [illegible]	More 0
Class 2	$n_1 = 11$	+	0	0	More +
	$n_2 = 11$	−	+	Less −	More +
Class 3	$n_1 = 15$	+	−	0	More +
	$n_2 = 14$	−	+	0	More −
Class 4	$n_1 = 13$	±	+	More −	More [illegible]
	$n_2 =$ [illegible]	−	+	0	Less +
Class 5	$n_1 = 13$	+	−	More −	0
	$n_2 = 15$	+	+	0	More −
Class 6	$n_1 = 12$	+	−	0	Less −
	$n_2 = 7$	−	+	More +	Less −

Table 1

Differences in mean rating levels and significance tests for the three mastery learning and three conventional lecture classes.

Class	Class size	Pretest mean	Posttest mean	Increase / Decrease	Model R	Partial time r	F for time r	Significance
MASTERY LEARNING CLASSES								
Class 1.	12	6.44	6.85	Increase: 0.41	0.579	0.137	4.17 with 1;219 d.f.	Significant at 0.05
Class 2:	22	5.40	5.79	Increase: 0.39	0.564	0.093	7.27 with 1;839 d.f.	Significant at 0.01
Class 3.	29	5.83	5.81	Decrease: 0.02	0.555	-0.001	0.003 with 1;1511 d.f.	Not significant
CONVENTIONAL LECTURE CLASSES								
Class 4.	24	5.68	5.62	Decrease: 0.06	0.556	-0.017	0.30 with 1;1011 d.f.	Not significant
Class 5.	28	5.22	4.99	Decrease: 0.23	0.595	-0.057	4.55 with 1;1403 d.f.	Significant at 0.05
Class 6.	19	[illegible].85	5.13	Increase: 0.28	0.500	0.062	2.38 with 1; 611 d.f.	Not significant

TABLE 2

A. The mean T_ score for the pretest and posttest over all levels by type of class.

	Pretest	Posttest	Increase
Mastery	0.369	0.398	0.024
Lecture	0.320	0.355	0.035

B. The mean rank of each T_ score within each level of choice by type of class.

	Pretest	Posttest
Mastery	2.83	3.58
Lecture	4.17	3.42

Table 3.

For the class 6 pretest matrix, the ordered eigenvector for the first principal component of the pooled interaction covariance matrix.

I.D.	Eigenvector
14	-0.30
12	-0.27
13	-0.27
19	-0.25
15	-0.19
18	-0.19
16	-0.18
8	-0.13
3	-0.12
17	-0.11
10	-0.07
4	0.05
11	0.23
6	0.24
1	0.24
7	0.25
9	0.32
2	0.32
5	0.33

TABLE 4

Type of changes from pretest to posttest by type of class and by whether the change was in the same block or toward the other block.

	Mastery Learning			Conventional Lecture		
	Same block	Other Block	Total	Same block	Other Block	Total
More positive	2	3	5	0	1	1
No change	2	1	3	1	3	4
More neutral	1	2	3	2	2	4
More negative	1	0	1	3	0	3

APPENDIX I

The five block model for class 5, for illustration p oses. Four blocked matrices are included. positive choice the pretest and the posttest, as well negative choices o the pretest and the posttest. The last pages give the proportion of 1's in each block and the proportion change from the pretest to the posttest.

BLOCKED MODEL FOR
GROUP 6 PRETEST. POSITVE CHOICES.

```
     1 1 1 1 * 1 1 1     1                 *
     4 2 3 9 * 5 8 6 8 3 7 * 0 4 * 1 6 1 7 * 9 2 5

14     1 1 1 * 1 1 1   1   * 1   *         *
12   1   1 1 *   1 1 1 1 1 *   1 * 1       *
13   1     1 * 1 1 1 1 1 1 *     *         *
19   1 1 1   * 1   1   1 1 * 1   *     1   *
    ***********************************************
15   1 1 1 1 *   1 1 1 1   * 1   *     1   *
18   1 1 1 1 * 1   1     1 *     *         *
16     1 1 1 * 1     1 1   * 1   *         *
 8     1 1 1 *     1   1   *     *         *
 3   1 1 1 1 * 1   1 1     *     *         *
17   1 1 1 1 * 1 1 1 1     * 1 1 * 1     1 *
    ***********************************************
10     1   1 * 1   1 1 1 1 *     *         *
 4     1     *       1 1   *     *         *
    ***********************************************
11     1     *             *     *   1 1 1 * 1   1
 6           *             *     * 1   1 1 * 1   1
 1         1 *     1   1   * 1   *         *   1
 7           * 1   1   1 1 *   1 * 1 1 1   * 1 1 1
    ***********************************************
 9           *             *     *   1 1   *   1
 2           *     1       * 1   * 1   1 1 *
 5         1 *     1       * 1   * 1 1 1 1 * 1
```

BLOCKED MODEL FOR
GROUP 6 PRETEST. NEGATIVE CHOICES.

	14	12	13	19	*	15	18	16	8	3	17	*	10	4	*	11	6	1	7	*	9	2	5
14					*						1	*			*	1	1	1	1	*	1	1	1
12					*	1						*			*		1		1	*	1		
13					*							*			*	1	1		1	*	1	1	1
19					*		1		1			*		1	*	1	1		1	*			1
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15					*							*		1	*	1	1		1	*	1	1	1
18					*				1			*	1	1	*	1	1	1	1	*	1	1	1
16	1				*		1					*		1	*	1	1	1	1	*	1	1	1
8					*		1				1	*	1		*	1	1	1	1	*	1	1	1
3					*		1				1	*			*	1	1	1	1	*	1	1	1
17					*					1		*			*					*	1	1	1
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10					*							*			*	1	1	1	1	*	1	1	1
4					*							*			*	1	1	1	1	*	1	1	1
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11			1		*			1			1	*	1		*					*		1	
6	1	1	1	1	*	1	1	1	1	1	1	*	1	1	*					*		1	
1	1	1			*						1	*		1	*	1	1		1	*	1		
7	1	1	1	1	*		1					*	1		*					*			
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
9	1	1	1	1	*	1	1	1	1		1	*	1	1	*	1			1	*			1
2	1	1		1	*	1				1	1	*			*					*			
5	1		1		*		1				1	*			*					*			

BLOCKED MODEL FOR
GROUP 6 POSTTEST. POSITIVE CHOICES. SAME FORM AS PRETEST.

	14	12	13	19	*	15	18	16	8	3	17	*	10	4	*	11	6	1	7	*	9	2	5
14		1	1	1	*	1	1	1		1		*	1	1	*					*			
12			1	1	*	1	1		1	1		*	1	1	*	1		1		*			
13	1	1		1	*	1	1	1	1			*		1	*					*			
19	1	1	1		*	1		1	1	1		*	1	1	*			1		*			
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15	1		1	1	*		1	1	1	1		*	1		*					*			
18	1	1		1	*	1			1	1	1	*			*			1		*			
16	1		1	1	*	1	1		1	1		*			*					*			
8		1	1	1	*	1				1		*			*					*			
3	1	1	1	1	*	1		1	1			*	1	1	*					*			
17	1	1	1	1	*	1	1	1	1	1		*	1	1	*	1	1		1	*			1
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10		1		1	*	1	1	1	1	1		*			*					*			
4	1	1	1	1	*	1	1					*			*					*			
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11		1			*						1	*			*		1	1	1	*		1	1
6					*							*			*	1		1		*	1	1	1
1	1	1	1	1	*	1	1	1	1	1		*	1		*					*			1
7	1				*			1	1	1	1	*	1		*	1	1	1		*	1	1	1
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
9					*							*			*		1			*		1	1
2		1			*							*			*	1	1	1	1	*	1		1
5				1	*			1	1			*	1		*	1	1			*			

LOCKED MODEL FOR
ROUP 6 POSTTEST. NEGATIVE CHOICES. SAME FORM AS PRETEST.

	14	12	13	19	15	18	16	8	3	17	10	4	11	6	1	7	9	2	5
4													1	1		1	1	1	1
2														1		1	1	1	1
3										1			1	1	1	1	1	1	1
9										1			1	1		1		1	1
5										1		1	1	1	1	1		1	1
8												1		1		1			
6											1	1	1	1	1	1	1	1	1
8										1	1	1	1	1	1	1	1	1	1
3										1			1	1	1	1	1	1	1
7															1		1		
0										1			1	1	1	1		1	1
4							1			1				1	1	1	1	1	1
1																			
6	1	1	1	1	1	1	1	1	1	1	1	1							
1										1				1		1			
7		1	1	1	1	1						1							
9	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1			
2	1		1	1	1	1	1		1	1	1	1							
5			1															1	

GROUP 6 PRETEST. BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	III	IV	V	TOTAL
I	0.917 0.000	0.792 0.167	0.375 0.125	0.125 0.750	0.000 0.667	0.486 0.347
II	0.917 0.042	0.633 0.233	0.333 0.417	0.125 0.792	0.000 1.000	0.444 0.463
III	0.375 0.000	0.583 0.000	0.000 0.000	0.000 1.000	0.000 1.000	0.278 0.389
IV	0.125 0.688	0.250 0.417	0.250 0.625	0.750 0.250	0.667 0.250	0.375 0.444
V	0.083 0.750	0.111 0.556	0.333 0.333	0.750 0.167	0.333 0.167	0.296 0.444
TOTAL	0.542 0.292	0.491 0.287	0.306 0.361	0.319 0.611	0.185 0.667	0.398 0.424

GROUP 6 POSTTEST. BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	III	IV	V	TOTAL
I	0.917 0.000	0.667 0.083	0.875 0.000	0.188 0.750	0.000 0.917	0.514 0.347
II	0.833 0.000	0.733 0.100	0.417 0.500	0.167 0.792	0.056 0.667	0.481 0.370
III	0.750 0.000	0.583 0.250	0.000 0.000	0.000 0.875	0.000 0.833	0.361 0.417
IV	0.375 0.438	0.417 0.375	0.250 0.375	0.667 0.167	0.750 0.000	0.486 0.292
V	0.167 0.667	0.111 0.611	0.167 0.667	0.583 0.250	0.667 0.167	0.296 0.500
TOTAL	0.625 0.208	0.528 0.259	0.417 0.361	0.306 0.597	0.259 0.537	0.447 0.374

BLOCK CHANGE FOR GROUP 6. POSTTEST MINUS PRETEST.
ABOVE: POSITIVE PROPORTION CHANGE.
BELOW: NEGATIVE PROPORTION CHANGE.

	I	II	III	IV	V	TOTAL
I	0.000	-0.125	0.500	0.063	0.000	0.028
	0.000	-0.084	-0.125	0.000	0.250	0.000
II	-0.084	0.100	0.084	0.042	0.056	0.037
	-0.042	-0.133	0.083	0.000	-0.333	-0.093
III	0.375	0.000	0.000	0.000	0.000	0.083
	0.000	0.250	0.000	-0.125	-0.167	0.028
IV	0.250	0.167	0.000	-0.083	0.083	0.111
	0.250	-0.042	-0.250	-0.083	-0.250	-0.152
V	0.084	0.000	-0.166	-0.167	0.334	0.000
	-0.083	0.055	0.334	0.083	0.000	0.056
TOTAL	0.083	0.037	0.111	-0.013	0.074	0.049
	-0.084	-0.028	0.000	-0.014	-0.130	-0.050

APPENDIX II

The proportion of choices positive and negative in each block after creating the two-block models for each class. The sizes of each block are given in Figure 1, as well as a translation of these proportions to above or below the class average.

GROUP 1 PRETEST. BLOCK PROPORTIONS.
ABOVE: PROPORTION POS[illegible] [illegible]ELOW: PROPORTION NEGATIVE.

	I	II	[illegible]
I	0.700 0.067	0.417 0.194	[illegible] [illegible]
II	0.611 0.278	0.80[illegible] 0.13[illegible]	[illegible]7 12
TOTAL	0.652 0.182	0.591 0.157	[illegible] [illegible]

GROUP 1 POSTTEST. BLOC[illegible]TIONS.
ABOVE: PROPORTION POSI[illegible] [illegible]ELOW: PROPORTION NEGATIVE.

	I	II
I	0.867 0.100	0.694 0.194
II	0.583 0.167	0.700 0.067
TOTAL	0.712 0.136	0.697 0.136

BLOCK CHANGE FOR GROUP [illegible] [illegible]TEST MINUS PRETEST.
ABOVE: POSITIVE PROPORTION [illegible]GE.
BELOW: NEGATIVE PROPORT[illegible]GE.

	I	II	
I	0.167 0.033	0.277 0.000	[illegible]228 [illegible]16
II	-0.028 -0.111	-0.100 -0.066	-0.061 -0.091
TOTAL	0.060 -0.046	0.106 -0.031	0.084 -0.038

GROUP 2 PRETEST BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	TOTAL
I	0.[illegible]	0.331	0.463
	[illegible]	[illegible].306	0.247
II	0.[illegible]	0.627	0.3[illegible]
	0.[illegible]	0.191	0.3[illegible]
TOTAL	0.38[illegible]	[illegible]	0.426
	0.3[illegible]	[illegible]	0.323

GROUP 2 POSTTEST BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	TOTAL
I	0.[illegible]0	[illegible].488	0.541
	0.[illegible]7	[illegible].157	0.143
II	0.[illegible]	.718	0.446
	[illegible]	.109	0.312
TOTAL	[illegible]	597	0.494
	[illegible]	[illegible].134	0.227

BLOCK CHANGE FOR GROUP 2. POSTTEST MINUS PRETEST.
ABOVE: POSITIVE PROPORTION CHANGE.
BELOW: NEGATIVE PROPORTION CHANGE.

	I	II	TOTAL
I	-[illegible]	0.157	0.078
	-[illegible].055	-[illegible].149	-0.104
II	0.024	[illegible].091	0.056
	-0.091	-[illegible]	-0.086
TOTAL	0.009	[illegible]	0.088
	-0.074	[illegible]	-0.096

GROUP 3 PRE[illegible] BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	[illegible]	TOTAL
I	0.9[illegible]0	[illegible]	0.702
	0.0[illegible]8	[illegible]8	0.148
II	0.3[illegible]0	0.[illegible]	0.[illegible]44
	0.4[illegible]7	0.[illegible]5	0.332
TOTAL	0.6[illegible]5	0.[illegible]	0.[illegible]78
	0.2[illegible]7	0.2[illegible]	[illegible]236

GROUP 3 POSTTEST. BLOC[illegible] [illegible]PORTIONS.
ABOVE: PROPORTION POS[illegible] BELOW: PROPORTION [illegible]GATIVE.

	I	II	[illegible]
I	0.900	0.[illegible]	[illegible]95
	0.048	0.200	[illegible]24
II	0.295	0.434	0.[illegible]60
	0.467	0.324	[illegible]01
TOTAL	0.598	0.571	0.[illegible]35
	0.257	0.252	0.[illegible]7

BLOCK CHANGE FOR GRO[illegible] POSTTEST MINUS PRETEST.
ABOVE: POSITIVE PROPORTION CHANGE.
BELOW: NEGATIVE PROPORTION CHANGE.

	I	II	TOTAL
I	0.000	0.185	[illegible].093
	0.000	-0.048	-[illegible]24
II	-0.015	-0.165	-0.[illegible]4
	0.000	0.148	0.[illegible]9
TOTAL	-0.007	0.023	[illegible].007
	0.000	0.044	[illegible]

GROUP 4 PRETEST. BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	TOTAL
I	0.551	0.545	0.548
	0.263	0.231	0.247
II	0.266	0.673	0.443
	0.371	0.082	0.245
TOTAL	0.415	0.601	0.500
	0.314	0.166	0.246

GROUP 4 POSTTEST. BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	TOTAL
I	0.468	0.497	0.482
	0.244	0.140	0.194
II	0.273	0.609	0.419
	0.357	0.091	0.241
TOTAL	0.375	0.545	0.453
	0.298	0.119	0.216

BLOCK CHANGE FOR GROUP 4. POSTTEST MINUS PRETEST.
ABOVE: POSITIVE PROPORTION CHANGE.
BELOW: NEGATIVE PROPORTION CHANGE.

	I	II	TOTAL
I	-0.083	-0.048	-0.066
	-0.019	-0.091	-0.053
II	0.007	-0.064	-0.024
	-0.014	0.009	-0.004
TOTAL	-0.040	-0.056	-0.047
	-0.016	-0.047	-0.030

GROUP 5 PRETEST. BLOCK PROPORTIONS
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	TOTAL
I	0.558	0.215	0.3[illegible]
	0.218	0.585	0.4[illegible]
II	0.451	0.481	0.46[illegible]
	0.241	0.286	0.26[illegible]
TOTAL	0.49[illegible]	0.353	0.421
	0.231	0.430	0.33[illegible]

GROUP 5 POSTTEST. BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	TOTAL
I	0.558	0.210	0.365
	0.282	0.590	0.453
II	0.482	0.457	0.469
	0.246	0.367	0.309
TOTAL	0.516	0.338	0.421
	0.262	0.474	0.376

BLOCK CHANGE FOR GROUP 5. POSTTEST MINUS PRETEST.
ABOVE: POSITIVE PROPORTION CHANGE.
BELOW: NEGATIVE PROPORTION CHANGE.

	I	II	TOTAL
I	0.000	-0.005	-0.003
	0.064	0.005	0.031
II	0.031	-0.024	0.002
	0.005	0.031	0.045
TOTAL	0.017	-0.015	0.000
	0.031	0.044	0.03[illegible]

GROUP 6 PRETEST. BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	TOTAL
I	[illegible]	0.060	[illegible]
	[illegible]	0.845	[illegible]
II	[illegible]	0.667	[illegible]
	[illegible]	0.214	[illegible]
TOTAL	[illegible]	0.262	0.39[illegible]
	[illegible]	0.535	[illegible]

GROUP 6 POSTTEST. BLOCK PROPORTIONS.
ABOVE: PROPORTION POSITIVE. BELOW: PROPORTION NEGATIVE.

	I	II	TOTAL
I	[illegible]	0.095	0.472
	0.106	0.786	0.370
II	0.274	0.567	0.405
	0.500	0.143	0.381
TOTAL	0.542	0.236	0.447
	0.259	0.571	0.374

BLOCK CHANGE FOR GROUP 6. POSTTEST MINUS PRETEST.
ABOVE: POSITIVE PROPORTION CHANGE.
BELOW: NEGATIVE PROPORTION CHANGE.

	I	II	TOTAL
I	0.04[illegible]	0.035	[illegible]
	-0.03[illegible]	-0.05[illegible]	[illegible]
II	[illegible]	0.00[illegible]	[illegible]
	[illegible]	-0.07[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]
	[illegible]	-0.054	-0.05[illegible]