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ABSTRACT

This study focused on social and cooperative behavior in traditional science classrooms. Students in 30 junior and senior high school science classes were observed in terms of the amount of time spent on task, or time spent concentrating on the lesson. The physical organization of the classroom, the instructional style of the teacher, and the subject taught (biology, general science, chemistry, and earth science) were taken into consideration by the observers. Helping behavior, as distinguished from social or cooperative behavior, was most frequently observed in biology classrooms, predictably in laboratory work. Students apparently interpreted the laboratory situation as legitimate for helping or working with each other. Helping instances centered mainly on requests for information such as definitions of terms or clarification of the assignment. Cooperation and interaction between students was rarely found during lectures, although social interactions did occur during these periods. A discussion is presented on the value of cooperative interaction between students and its effect on academic achievement, particularly in the science classroom. (JD)

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The present study focused on student-student interaction in the classroom, a domain Johnson (1980) justly considered neglected in educational research, despite its significance. Empirical data as well as naturalistic observation indicate that student-student interaction is a commonplace of life in the classroom. However, little research is available as to the characteristics and quality of these interactions.

Educators may unthinkingly view all student-student interactions as "off-task," merely social-verbal exchanges; and, therefore, disruptive to classroom learning. However, the present study showed that a significant proportion of student-student interactions may be "on-task" and in fact significant in furthering and facilitating learning. Such facilitation may occur through peer discussion and exchange of information, helping and assisting one another, and clarifying content and concepts.

Indeed teachers and researchers interested in cooperative learning emphasize student-student interaction as possibly the most significant vehicle leading to cognitive and social gains. (Sharan 1980, Slavin 1981).

The present study focused on social and cooperative behaviors that emerge naturally in traditional classrooms although most of the research in cooperative learning has treated "cooperation" as an independent variable, implemented in innovative classrooms and examined as a causal intervention through measuring cognitive and social outcomes as dependent variables. See for example reports of the Jigsaw classroom (Aronson & Goode, 1980), STAD (Slavin 1978 & 1980), Group Investigation (Sharan and Hertz-Lazarowitz 1980) and group discussion (Johnson 1980).

Believing that student-student behaviors are not productively viewed as comprising a solitary dimension, we suggest that they are tied to other dimensions of the classroom. Hertz-Lazarowitz, Sharan and Hare (in press) described four instructional dimensions which function in classrooms in varying patterns: a) the physical organization of the classroom, b) instructional style and communication pattern between teacher and students, c) student-student behaviors in the cognitive and social realms, and d) the structure of the learning task. The authors claim that a predictable inter-relationship and interdependence exist among these four structures in a conservative/traditional classroom. In general, the physical organization is aimed at maximizing isolation of students (sitting in rows), the teacher is the center of activities and usually communicates with the class as a whole, student-student interactions are minimized, and the learning task is typically to be accomplished by each individual for himself or herself, without reference to possible mutual interests of a group of pupils. The four

dimensions just mentioned can be used to analyze so-called "open" classrooms, "cooperative" classrooms, and other settings for learning.

The term "cooperation" was defined a number of years ago by Deutsch (1949). The nature of the goal was emphasized by him as the salient feature distinguishing cooperative and competitive behaviors. In a recent publication Bar-Tal and Geser (1980) redefined it as

> An activity in which a task is performed by two or more individuals (a) employing common means in a coordinate manner, to attain indvidual goals or (b) striving in a coordinate manner toward attaining a goal. (p. 214)

Bar-Tal and Geser also define four conditions under which cooperation can take place in the classroom: Compulsory, suggested, unsolicited and forbidden. The conditions refer to the manipulation of conditions and atmosphere for cooperation by the teacher in structuring the learning task. Bar-Tal and Geser's important contribution to the definition of cooperation in the classroom was based in part, on definitions of the nature of the learning task in reference to its social-cognitive features (Steiner 1972; Sharan, Hertz-Lazarowitz 1978; Sharan and Hertz-Lazarowitz 1980).

Accurate observation of classrooms demands careful consideration of the four dimensions introduced earlier, viz., the physical, the instructional style/ communication patterns, student-student behaviors, and the structure of the learning task. In the present study social behaviors of students were treated as dependent variables, while the other dimensions were perceived as independent variables, namely, the physical

organization of the classroom, the instructional mode, the teacher's communication (as defined by his or her discipline management), and the nature of the learning task. In the authors' judgment, only through this multi-dimensional view of the classroom can one accurately (or at least more accurately) observe different social interaction behavior among students.

Investigating the occurrence and nature of social and cooperative behaviors, the present study had three goals within the organizing construct of the four classroom dimensions: 1) to conduct a series of naturalistic observations in secondary schools resulting in basic data on social behaviors of students; 2) to test for the effect of three variables on social behaviors, viz., science subject, mode of instruction, and discipline in the classroom; 3) to conceptualize and describe cooperative and helping behaviors, accounting for the teacher's role in eliciting or hindering the occurrence of these behaviors as he or she used different goal structures in connection with the prescribed learning tasks.

Method

Subjects. Thirty science classrooms in six junior high schools and one high school in the Provo, Utah area, were observed over a period of three weeks. All classes were taught during this period by science student teachers from Brigham Young University as part of their normal field experience in teacher education.

One hundred and fifty-nine observations were conducted, resulting in a total of 2,650 observed student behaviors.

Trained observers coded the social behaviors, the conditions under which they took place, and the cognitive level of the interactions. Inter-observer reliability among pairs of observers was .94 and among all observers, .96.

Observation Schedule

The observation instrument included two parts: a) background information, and b) social behaviors of students in the classroom. The background information consisted of the following independent variables:

1. The subject matter taught in class at the time the observation took place. Classes were observed in four science subjects: General Science, Biology, Chemistry, and Earth Science.

2. Mode of Instruction. Observations revealed five major instructional modes: laboratory, lecture, individual work, films and games, and tests.

3. Discipline. Observed classes were evaluated for low, average and high discipline levels. Agreement among three judges was .91.

It will be noted that the three variables described above are three of the factors or dimensions characteristic of classrooms in general, according to an earlier discussion in this paper. The fourth dimension, physical organization, was not deemed to have sufficient impact as an isolated independent variable, and instead is taken into account through its influence as a part of the educational setting within Subject Matter and Mode of Instruction.

The social behaviors of students, following the theoretical approach to the social-cooperative mode of learning explicated by Johnson and Johnson (1978) and Sharan and Hertz-Lazarowitz (1980), were categorized as follows:

1. Non-interaction
2. Social event: off-task student-student verbal interaction
3. Cooperation: sharing of means or working together on a task, a process, and/or a product
4. Helping: an interaction featuring an explanation, clarification, or exchange of information whether requested or not

Data Collection

Each class was observed at least twice a week for the whole period. In each period three observational cycles were completed. After waiting a few minutes for instruction to begin, the observer randomly selected a starting point on the seating chart for his or her first cycle and observed fifteen to eighteen students. The observer approached the target student, observing him or her for thirty seconds, recording the type of behavior, then proceeded to the next student in the row, following the same observational pattern. Each cycle lasted about 10-12 minutes. A five minute interval was inserted between cycles, enabling observers to divide a class period into its beginning, middle and final phases.

Observers classified student behavior according to the categories described earlier. Whenever a social interaction occurred the observer listened to the verbal exchange and made his or her judgment as to the nature of the interaction. In the judgment of the investigators (and the observers), the time required for classes--both pupils and student teachers--to adjust to the presence of observers was minimal and distortion of the particular class routine was not noted.

Each cycle of observations was a unit for analysis, and each behavior frequency per cycle was recorded. All frequencies, means, and standard deviations are classroom measures and not student measures. Preliminary comparison of data from the high school and the junior high schools revealed no significant differences on any of the dependent variables, thus data from both school levels were analyzed together.

Analysis and Results

A multivariate analysis of variance (Manova) for the four dependent measures of student behaviors (non-interaction, social event, cooperation, and helping) was conducted for each of the three independent variables (science subjects, instructional modes, and classroom discipline level). The Manova yielded over-all significant differences for each of the independent variables and for the interactions.

For science subject, $F(12,315) = 4.08$; for instruction modes, $F(16,364) = 7.23$; for discipline level, $F(8,238) = 3.56$.

These F values are significant beyond the .001 level. Interaction effects for the following pairs of variables also were significant: For discipline by subject (DxS), $F(16,364) = 5.43$; for discipline by instruction (DxI), $F(32,440) = 3.48$; for subject by instructional mode (SxI), $F(48,460) = 2.39$. The three way interaction (DxSxI) was also significant: $F(12,315) = 5.11$. A series of univariate analyses of variance (Anova) yielded further main effects and interactions for each dependent variable, as described below.

Table 1 presents a general description of the behaviors observed in the classrooms. The bulk of the student behaviors were non-interactive in student-student terms. (Student-teacher interactions were considered non-interactive for purposes of the research.) Fifty-eight percent of the total behaviors coded was of such a nature. However, 42% was social interaction behavior. Social Events were twice as frequent as cooperative and helping behaviors combined. Of interest is the fact that the mean (per 10-12 minute cycle) of non-interactive behaviors (9.64) was more than four times as high as the mean for pro-social (Cooperation plus Helping) behaviors (2.19).

(Insert Table 1 About Here)

Table 2 presents the sums, means and standard deviations for the four possible behaviors by the four science subjects taught. The Anovas yielded main effects for subjects on two of the four behaviors. Non-interactive behavior ($F = 2.80$) and Cooperation

(F = 4.50) varied significantly among the science subjects taught. Helping and Social Events were not significantly different among the four subjects. Biology elicited a high mean of non-interactive behavior and, at the same time, high means in Cooperation and Helping.

(Insert Table 2 About Here)

Table 3 depicts the frequencies, row percentages and column percentages in a chi square analysis to illustrate the distribution of the five instructional modes observed in each of the four science subjects. As can be seen, a non-balanced distribution exists among the five instructional modes. Lectures were encountered almost twice as frequently (31% vs. 16+%) as lab work. Individual work accounted for 21.4% of the instructional configurations, films and games 12%, and tests 19.5%. One would expect a greater percentage of lab activities in science subjects. The Table also indicates that General Science was dominated by an individualistic instructional mode, that Biology featured lectures (30%) and testing (42%), and that lectures and individual work predominated in Chemistry (total of almost 70%). Earth Science was the most balanced science subject in terms of distribution of instructional modes. The chi square for this analysis was signficant at the .001 level: $X^2 = 42.34$. The X^2 indicates the great gap between expected distribution of instructional modes by science subjects and the observed reality in the classroom.

(Insert Table 3 About Here).

Table 4 presents the sums, means and standard deviations of the four behaviors observed among students in the five instructional modes. Three of the behaviors were found to be significantly different among the instructional modes. Analyses of variance yielded F values of 9.64 for Non-interaction, 1.72 (not significant) for off-task Social Events, 20.52 for Cooperation, and 2.60 for Helping.

(Insert Table 4 About Here)

Student-student helping behavior was surprisingly frequent in test situations. The highest mean for Cooperation is within the laboratory mode of instruction, while the highest mean for Helping is within the "individual" work mode. Although we think it reasonable to assume that lecture and tests would be high on the Non-interaction measure, the data clearly demonstrate that a considerable number of Social Events occurred within even the most controlled instructional modes. Since social events will occur among students in any setting apparently, perhaps teachers ought to ask themselves, What kind of social interaction would be most productive during a given instructional activity? The investigators believe the potential gains in classroom atmosphere (and even student academic performance) resulting from the fostering of pro-social interactions make such fostering worthwhile.

The Anova for main effects of discipline on the four behaviors did not yield significant differences. However, all the second order interactions were significant for Cooperation. These interactions generally indicated that classes evaluated as either high or low in discipline were similar in eliciting relatively high means of cooperative behaviors. The classes assessed as average in discipline were low in eliciting Cooperation. For example, Biology and Chemistry classes with low level discipline showed means of 3.37 (SD = .79) and 2.76 (SD = 1.44) respectively. General Science and Earth Science classes with high discipline registered high mean scores also for cooperation: 3.04 (SD = 1.34) and 2.67 (SD = .58), respectively. The mean scores of Cooperation in the "average" discipline level were as small as .82 for Biology and .56 for Chemistry. The interaction for Subject by Discipline was significant at the .001, with an F value of 3.71.

The DxI interaction (F = 6.33, significant at .001 level) followed the above pattern, showing Cooperation to be generally higher in the labs with either "low" or "high" discipline--means of 8.07 for labs with "high" discipline and 7.20 for labs with "low" discipline. The mean of Cooperation in labs with "average" discipline was remarkably lower (1.40).

The subject by instructional mode interaction was affected by the unbalanced distribution of the modes by subject, shown in Table 3. However, the mean of cooperative behaviors was markedly higher in the lab instructional mode. (See Table 4.) The F value for this interaction was 3.44, $p < .05$.

Finally, the three-way interaction of discipline by subject by instructional mode was significant for cooperation: $F(12,315) = 4.05$, $p < .01$. This three-way interaction confirmed the detailed descriptions summarized above.

Discussion

The findings clearly demonstrate that student-student interactions are a significant factor in science classroom life. While 58% of students' behaviors were defined as non-interactive, nearly half (42%) were interactive in nature. Of those interactive behaviors, two-thirds were off-task (Social Events) and one-third were on-task (Cooperation and Helping). One should remember that the data were collected in traditional classrooms where on-task cooperation was only rarely encouraged. Behaviors such as listening to the teacher and doing on-task individual work were far more prevalent, often being demanded by the teachers.

The finding that a majority of interactive behaviors were off-task social events must attract our attention and consideration. The implication is that since they were not channeled into learning activities they might correlate negatively with academic gains (Slavin 1981). If student-student interactions reflect a natural human need, we should seriously seek ways to channel those behaviors into the learning experience. The assumption that learning-neutral or learning-negative social events are found principally in low discipline classrooms is negated by the finding of the present study that the frequency of such events is similar in both low

and high discipline classrooms. In fact, interaction effects proved to be significant only for cooperative behavior with all independent measures, supporting the surprising finding that non-interactive and social events did not differ across discipline level. Such a finding supports the generalization that in all classrooms a noticeable portion of student interaction is in the form of social events not related to the learning task.

The present study was conducted in science classrooms because we anticipated a variety of instructional modes, physical organization and learning tasks. Most of the classes, however, used the most typical organizational structure--rows of pupils. Five main instructional approaches were observed in the six classrooms visited. Unfortunately all of them shared either an individualistic goal structure, a collective goal structure (lectures, movies), or a competitive goal structure (tests). (For the concept of goal structure, see Johnson and Johnson 1975.) Only the labs and games featured a cooperative goal structure, but these activities were not common, although one might expect science teaching to promote them. The frequency of use of instructional modes was balanced across subjects generally, but unbalanced within each content area (see Table 3).

Sometimes, specifically in lab activities, dyads or triads of students would gather to perform an experiment or other assigned task. In these settings, not surprisingly, cooperative behaviors were observed frequently. Cooperation

occurred typically when the teacher structured learning tasks requiring mutual effort in means or goals. An example would be where students worked togther to build a clay model of a cell--forming the clay (the means) to make specific parts of the cell, then working together to assemble the cell while exchanging verbal messages, thus cooperating through process to create a cooperative product.

Helping behavior, as distinguished from cooperative behavior, was most frequent in Biology classrooms, predictably in labs and individual work (see Table 4). Helping instances centered mainly on requests for information such as definitions of terms, clarification of the assignment, or explaining science principles. Most of the Helping was achieved through peer verbal interaction, e.g., explanations.

In our view, the principal conclusion to be drawn from the study, relative to the issue of pro-social student-student interactions, is that while cooperation and helping did not predominate by any means in the observed naturalistic classrooms, the behaviors were found in all settings and substantially so in labs and individual work. Apparently students interpreted these situations as legitimate ones for helping or working with one another. Cooperation and helping were rarely found in the lecture, though social events were as frequent as in other modes. In other words, the centralization of the teaching mode does not decrease off-task social interactions, but does affect adversely pro-social, on-task interactions. This finding possibly would undergo a significant modification

if students were told that cooperation was allowed, or even better, if they were taught how to cooperate relative to achievement of the learning task.

Finally, the present study did not correlate the dependent variables with academic achievement, so it is beyond the scope of the present paper to make suggestions, or to explore implications in that realm. The data from research on cooperation suggests that cooperation in the process of learning is positively correlated with academic acheivement, and that cooperative classrooms perform at higher levels than non-cooperative classrooms (Sharan 1980, Sharan and Hertz-Lazarowitz 1980, Slavin 1981, Johnson and Johnson, 1975). Since most of the cited studies were done in elementary schools with integrated cooperative techniques, it is still an open research question as to what happens in secondary schools with regard to pro-social interaction within a "non-cooperative" classroom. The present study begins to provide the data necessary to answer that question.

Beyond the empirical questions, we face some value questions as well. Can science teaching survive without cooperation among students? Among researchers? Among lab workers? The practice of science (as distinct from the teaching of it) is preeminently a cooperative endeavor. Can the transmission of its principles, findings, etc., occur successfully without that same mode of effort? Many of the approaches to science education preach an "inquiry" method that engages students in an interactive process of inquiry and investigation

(Suchman and McCombs; Marek and Renner, 1979). According to our findings, the reality in secondary science classrooms has not, as yet, followed the preaching.

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Table 1

Student-Student Behavior in Science Classrooms
in Junior High Schools and High Schools
(N = 159 Observations)

(Means, Sums and Percentages)

Behaviors	Mean*	Sum	Percentage
Non-Interaction	9.64	1533	58
Social Events	4.69	747	28
Cooperation	1.13	180	7
Helping	1.06	170	6.5
Total		2650	100

*Range 1-17

Table 2

Sums, Means and SD's of Student Classroom Behaviors by Science Subjects (N = 159 Observations)

Behaviors	Measure	N=22 General Science	N=42 Biology	N=38 Chemistry	N=57 Earth Science	F Values
Non-Interaction (1533)	S*	212	464	379	478	
	M**	9.63	11.04	9.97	8.38	2.80*
	SD***	3.05	4.64	4.63	3.58	
Social Events (747)	S	133	143	164	307	
	M	6.04	3.40	4.31	5.38	1.84
	SD	2.71	2.54	3.12	2.61	
Cooperation (180)	S	9	63	38	70	
	M	.40	1.50	1.00	1.22	4.50*
	SD	1.09	2.43	2.32	2.30	
Helping (170)	S	28	60	32	50	
	M	1.27	1.42	.84	.87	1.74
	SD	1.37	1.86	1.28	1.10	.50

* F (df 3,122) $p < .01$
  F (12,315) = 4.08 $p < .001$

*S = sums
**M = means
***SD = standard deviations

Table 3

Frequencies and Percentages of Five Instructional Modes in Four Science Subjects (N = 159 Observations)

Science Subject	Lecture	Lab	Individual Work	Films & Games	Tests	Row Total
General Science	3a 13.6b 6.1c	1 4.5 3.8	12 54.5 35.3	4 18.2 21.1	2 9.1 6.5	22 13.8
Biology	15 35.7 30.6	8 19 30.8	3 7.1 8.8	3 7.1 15.8	13 31.0 41.9	42 26.4
Chemistry	20 52.6 40.8	4 10.5 15.4	9 23.7 26.5	3 7.9 15.8	2 5.3 6.5	38 24
Earth Science	11 19.3 22.4	13 22.8 50.0	10 17.5 29.4	9 15.8 47.4	14 24.6 45.2	37 35.8
Column Total	49 30.8	26 16.4	34 21.4	19 12	31 19.5	159 100

$X^2 = 42.34$ (df 12) $p < .001$

a) number of observations
b) row %
c) column %

Table 4

Sums, Means and SD of Students' Classroom Behavior by Modes of Instruction (N = 159 Observations)

Type of Behavior	Measure	Modes of Instruction: Lecture (N=49)	Lab (N=26)	Individual Work (N=34)	Films and Games (N=19)	Tests (N=31)	F
Non-Interaction (1533)	S*	596	122	271	170	374	
	M**	12.16	4.69	7.97	8.94	12.06	9.64*
	SD***	3.60	2.63	2.88	2.36	3.55	
Social Events (747)	S	205	121	189	115	117	
	M	4.18	4.65	5.55	6.05	3.77	1.72
	SD	2.78	2.88	2.91	2.41	2.86	
Cooperation (180)	S	18	123	17	16	6	
	M	.36	4.73	.50	.84	.19	20.52*
	SD	1.03	2.76	1.16	1.97	.79	
Helping (170)	S	24	40	67	13	26	
	M	.48	1.53	1.97	.68	.83	2.60*
	SD	.68	1.65	1.46	1.10	1.63	

F (4,122) P<.05
F (16,364) 7.23 p<.001

*S = sums
**M = means
***SD = standard deviation

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