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Equity and status in group collaboration: learning through explanations depends on task characteristics

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Abstract. Although many instructors use collaborative group work as one tool in their repertoire, much research remains to be done on how learning occurs within collaborative learning environments. The present study contributes to this goal by finding that giving explanations during collaborative group work contributes to learning on single-answer group tasks, while task-related participation contributes to learning on variable-answer group tasks. Furthermore, the present study found that European–American students showed higher achievement than African–American students after working on a single-answer group task. Importantly, this race-based difference in achievement was tied to a race-based difference in giving explanations. These results reveal modest, but important support for the hypothesis that variable-answer group tasks provide a more equitable environment for participation than single-answer group tasks.

1. Introduction

In studies of students working and learning in groups, different task types have been emphasized. For example, Cohen and her colleagues (Cohen, 1994; Cohen, Lotan, Scarloss, & Arellano, 1999) have found that variable-answer tasks including group goals produce an environment, where learning through participation takes place. Consequently, their research tends to utilize variable-answer tasks, such as measuring circumferences of animals' stomachs. Groups not only have to decide on ways to take measurements, they also have to decide the location of each 'stomach'. Other researchers within the field of collaborative group work, however, have found that learning takes place when groups engage in single-answer tasks, where elaborate explanations are generated and prompt answers follow any questions that arise within the group work (Webb, 1991; Webb & Palincsar, 1996).

While most of this research has centered on interactions within groups, little research has directly investigated the relationship between task structure and collaborative group interactions. The goal of the study presented in this article was to shed light on the influence that task structure has on group dynamics that affect achievement. First, this study examined whether giving explanations during group work affects learning equally on single-answer and variable-answer tasks. Second, as equity in learning is of extreme importance within group collaboration

(Webb, Nemer, Chizhik, & Sugrue, 1998), the present research study investigated whether variable-answer and single-answer group tasks may differently influence race and gender status effects when popularity and student achievement are controlled. Research findings have consistently demonstrated that status treatments (e.g., teachers' assigning competence to low-status students in work groups) help to establish equity in group interactions (Cohen, 1994; Cohen et al., 1999). The focus of the present study, however, is to examine whether the structure of group tasks alone is connected to status effects related to group members' participation that has been shown to predict learning (Cohen, 1994; Webb & Palincsar, 1996).

This article first describes the importance of participation (e.g., giving explanations) within group work for learning. Second, it presents theory and research on the importance of group members' status for participation within collaborative groups. Lastly, before describing the present study, the introduction provides theoretical and empirical connections between group members' status and structure of collaborative group tasks. The remainder of the article will then describe methods, results, and interpretation of the findings with implications for education.

1.1. LANGUAGE, THOUGHT, AND GROUP WORK

The Vygotskian (1962) conception of cognitive development includes the notion that language affords individuals a means of developing their ideas. Language is a tool with which people organize and reorganize their knowledge. Environments that provide such opportunities for discourse, such as group work, can foster social learning as participants find ways to explain their thoughts and actions to each other.

As Vygotsky (1962) provided a theory for the connection of thought to language, a large body of empirical research supports the notion that when one explains concepts through the use of discourse, those concepts become solidified in students' minds (Webb, 1991; Webb & Palincsar, 1996). In particular, this research suggests that the level of detail within explanations influences such learning. Webb (1991) cites the hypothesis of Bargh and Schul (1980) that 'actively teaching (or explaining) to someone else may encourage the explainer to reorganize or clarify the material in new ways' (p. 368). This notion of clarification of concepts for the explainer fits well with Vygotsky's ideas on thought being mediated and conceptualized through language.

In the research on collaborative group work, however, there exists a discrepancy regarding the specific participation variables that lead to learning gains. While Webb (1991) concludes from her review of research that the overall rate of task-related participation does not significantly relate to learning, Cohen (1994) reports a significant relationship between task-related participation and learning. Cohen (1994) suggests that this discrepancy may be due to a difference in task structures used within Webb's research and within her own. In particular, Cohen notes that her research uses group tasks that do not have clear answers and suggests that these

types of tasks promote more task-related student interaction than do tasks with clearly correct answers that Webb tends to use. For example, in Webb's work students were asked to explain why one electrical circuit had a brighter light bulb than another circuit (Webb et al., 1998). Cohen's explanation for the discrepancy in results may be valid since Webb (1991) reports that giving elaborate explanations and receiving prompt answers to questions within collaborative groups leads to learning gains while other forms of interactions (e.g., giving and receiving unelaborated answers, receiving explanations, asking questions and receiving no response), which occur at a higher rate, seem to be unrelated or detrimental to learning. Moreover, most reported research has been conducted on middle-school populations conducting school-related tasks. Since previous research shows discrepancies in the participation variables that may facilitate learning, it is important to analyze the relationships between different types of participation variables and achievement.

1.2. STATUS IN GROUP PARTICIPATION

The previously cited research helps to establish that verbal participation in small groups facilitates internalization of ideas and clarifies concepts for the individual. Cohen (1994) reviewed research showing that the relative status of an individual within a group may determine the individual's level of participation in collaborative tasks. Dembo and McAuliffe (1987), for example, conducted a study wherein they created bogus status characteristics for their participants and found that individuals with 'higher' status participated more and had more influence on the decisions of the group than students with 'lower' status.

Expectation-states theory (Berger, Rosenholtz, & Zelditch, 1980; Wagner & Berger, 1993) can explain why status affects participation within collaborative groups. This theory defines status as 'a preferred characteristic' that elicits a 'power-prestige order' (Berger et al., 1980, p. 480). For instance, in some classrooms grades may determine status as achieving higher grades may provide prestige and power for students. The theory also suggests that individuals working within groups develop expectations of future performance of the group members from previous performance and that initial expectations are determined based on 'statuses that are significant in the larger society' (Berger et al., 1980, p. 480).

The relative status of individuals within groups has been found to influence individuals' participation in collaborative group-work. As was mentioned earlier, Cohen (1994) reports that the overall amount of task-related discourse is related to group members' status. Others have found similar results (Kimble, Yoshikawa, & Zehr, 1981; King, 1993). In addition, status based on gender and race has been found to have an influence on decisions that are adopted by the collaborative group (Lockheed, Harris, & Nemceff, 1983; Cohen & Lotan, 1995).

It is important to note that 'diffuse' status characteristics such as race and gender are often used to produce performance expectancies on many unrelated tasks, although it may be irrational to do so (Berger et al., 1980; Wagner & Berger,

1993). For instance, Cohen (1982) found that perceived reading ability is tied into race such that those individuals who are of minority status are perceived to have lower reading ability than those of majority status. One possible explanation that is provided for this phenomenon of poor expectations of minorities is that the historical oppression of minorities in America causes students to stencil racist beliefs within the society onto their peers in desegregated classrooms on a wide variety of subjects (Rosenholtz & Cohen, 1983).

1.3. THE LINK BETWEEN TASK AND STATUS

Cohen (1994) identifies two dimensions of collaborative group work tasks that impact group interactions: (a) number of solutions (variable-answer or single-answer) and (b) cooperation (true-group or individual-helping). Single-answer tasks have a single, correct answer while variable-answer tasks provide opportunities for many correct answers with a variety of pathways to reach the correct solutions. She suggests that problems that have identifiable correct answers could often be accomplished by single individuals and that any interaction that takes place would be in the form of group members helping each other understand concepts without elements of a deeper level of discourse about hypotheses, strategies, and speculations. She suggests that such deeper level interactions are more useful on variable-answer tasks where all group members must contribute for success than on tasks with 'right answers' where help seeking and understanding of explanations are more useful processes.

Cohen's delineation of the types of collaborative group tasks suggests that different types of tasks may form different collaborative environments for the students. For example, variable-answer tasks may allow for a lot of interaction on any group decision as there are no correct answers. With each step of the solution being open to question, more access could be provided for each group member to give input, thereby increasing and possibly equalizing verbal participation of all group members. On a single-answer task, however, once a perceived correct suggestion has been offered, then the group has to move on without much discussion. Such group interactions could allow for a single person to dominate by being the first to make all the suggestions. On variable-answer tasks, however, all group members could make their own valid suggestions in any order, thereby opening access for all students. Moreover, Voss and Post (1988) found that variable-answer tasks elicit knowledge from a wide subject domain, thereby increasing the possibility that many individuals would be able to contribute to the solution of a variable-answer task. Such a notion is supported by Cohen's research that was previously mentioned.

The notion that variable-answer tasks create conditions for equitable exchanges in participation among group members can be supported by Allport's (1954) suggestion that prejudice diminishes when individuals interact in a non-superficial manner. In other words, when individuals work together on projects that require co-construction of knowledge, then their prejudices may be substituted by ac-

tual knowledge about each other's skills and values. Do variable-answer tasks, then, allow for less superficial interaction than single-answer tasks? An affirmative answer to this question can be framed around Brabeck and Wood's (1990) notion that variable-answer tasks tend to provide more opportunity for conflicts and conflict resolution than single-answer tasks. Brabeck and Wood (1990) suggest that on variable-answer tasks, any or all group members could develop unique and plausible solutions.

Results from a previous study (Chizhik, 1999) suggest that task structure may, in fact, influence conditions that emerge as a result of intragroup diffuse status. This study revealed that a variable-answer task created an environment in which there were fewer diffuse status effects of gender than in the environment produced by a single-answer task. In particular, the findings revealed smaller differences between females and males in regard to who was perceived to have the best ideas on the variable-answer task than on the single-answer task. In addition, while males gave more explanations than females to their group members on the single-answer task, females gave more explanations than males to their group members on the variable-answer task. This set of findings suggests that gender differences, commonly found in various school activities, diminish when the tasks are more variable-answer than single-answer in nature.

Although the previous study (Chizhik, 1999) provides support for a relationship between task structure and diffuse status effects within collaborative groups, the research design confounded task structure with task content by using tasks that are different in both structure and content. In other words, it is unclear whether task content (i.e., the topics of each task) or task structure (i.e., variable-answer or single-answer) influenced status effects. In addition, the study did not use authentic tasks that may appear in actual classrooms. Results drawn from authentic instructional tasks can best be generalized to educational environments. Finally, the previous study did not investigate whether students' participation had an impact on achievement. The present study investigates the link between task structure and group participation without the limitations mentioned above.

1.4. RESEARCH QUESTIONS AND HYPOTHESES

First, this study inquires whether task structure influences the types of participation that contributes to learning. In particular, this research has an opportunity to confirm the hypothesis that on single-answer tasks giving explanations contributes to learning while on variable-answer tasks task-related participation is a factor for learning.

Second, this research examines whether student participation within collaborative groups, as influenced by diffuse status characteristics (race and gender) and task structure, has an effect on student learning. I hypothesize that differences in learning between European Americans and African Americans and between females and males will be greater when groups work on a single-answer mathematics task than when they work on a variable-answer mathematics task.

2. Method

2.1. PARTICIPANTS AND GROUP ASSIGNMENT

Forty-eight ninth-grade students from eight classrooms within two urban high schools in southern California participated in this study. The student populations at both schools are similar in ethnic composition: about 45% European–American, 20% Latino/a, 15% African–American, 15% Asian–American, and the other 5% from other ethnic backgrounds. Students in both schools are generally middle class with only 15% receiving free or reduced-price lunches.

Participants for this study were selected from a larger sample of 264 students who agreed to participate in the present study. Due to the constraints of the research design for selecting participants (including ethnicity, gender, relative mathematics and reading achievement, relative popularity, and friendships), the pool of possible participants yielded 12 groups of four, or 48 actual participants. Each group included an African–American female, an African–American male, a European–American female, and a European–American male. This research limited the participating sample to two ethnicities to maintain an attainable scope. The particular ethnic groups were included without explicit reasons to exclude particular minority groups.

To make the present experiment authentic, group members knew each other from having had at least one mathematics class together. In addition, within each group, participants had similar popularity within their class (within one quartile) as determined by teachers as well as participants indicating with whom they wanted or did not want to work. It is important to control for popularity because it can function as a status variable (Cohen & Lotan, 1995) and may confound the status effects of race and gender, the focus of this study.

It is also important for students within each group to have homogeneous academic status to prevent the confounding of diffuse status differences. Unfortunately, the school district where these data were collected did not allow students to be asked about each other's academic status; consequently, in this study, group members had similar reading and mathematics achievement: they were within one quartile of each other as measured by their mathematics grades and ranking by their teachers. In addition, group members were within one scoring level of each other on the mathematics pretest administered by the researcher. Although students within each group had similar academic achievement, not all groups were the same on academic achievement: eight groups were medium-achieving, two groups were low-achieving, and two groups were high-achieving.

Finally, the group members were acquainted with each other without having strong feelings (friendship or dislike) toward one another (as reported by their teachers and the participants themselves). Having friends within groups provides another variable that may confound the impact of task structure on intragroup interactions (Azmitia & Montgomery, 1993). After satisfying the criteria mentioned above, students were randomly assigned to collaborative groups.

2.2. DESIGN AND PROCEDURE

This study was conducted in three phases. Phase one consisted of a pretest, phase two consisted of collaborative group work, and phase three consisted of a posttest. Two to 3 weeks after the administration of individual pretests, each group was videotaped in a private area of the school while carrying out its group task: (a) six groups completed a single-answer mathematics task and (b) six groups completed a variable-answer mathematics task. Group tasks were randomly assigned to the 12 groups. Before the groups engaged in their tasks they were told that they must do their tasks as a group and to come up with a single solution for the entire group. In addition, the group members were told to make sure that everyone in the group agreed with, accepted, and understood the final answer. (All groups were able to agree on a single answer.) Finally, the group members were told that they would be given similar tasks to do on their own in about 1 week. The purpose of giving these guidelines and information to the participants was to encourage them to work as a group to accomplish the tasks and to learn from each other. No formal instruction on collaboration was provided to participants. One to 2 weeks after the group work, each student completed an independent posttest that was similar to the pretest as mentioned earlier. Both the pretest and the posttest consisted of tasks that are parallel forms of the group tasks.

2.3. MEASURES AND TASKS

2.3.1. *Questionnaires*

Mathematics teachers were asked to fill out a questionnaire in which they estimated the quartile of each student on class popularity and mathematics ability. In addition, the teachers noted the race and gender of each student. These results were used, in combination with the pretest, to select the 48 participants and to assign them to 12 groups that were each homogeneous in academic achievement and class popularity.

Students filled out a questionnaire listing five students with whom they would like to work and three with whom they would not. This information was used to assign students to groups that were homogeneous with regard to relative student popularity within their class as well as making sure that friendship among students did not confound results of the study.

2.3.2. *Tasks*

To focus this research on status issues, this study uses tasks drawn from mathematics, a content area that poses a particular challenge to cooperative group work since mathematics is often stereotyped as a European–American male field (Carey, Fennema, Carpenter, & Franke, 1995). A large body of research suggests that diffuse status characteristics are prominent in mathematics (e.g., Oakes, 1990; Secada, 1992; Catsambis, 1994; Seegers & Boekaerts, 1996; Oakes & Lipton, 1999). All tasks were modified versions of open-ended mathematics questions from

a performance assessment used within schools in the area where this study was conducted.

The single-answer task required groups to calculate the volume of a swimming pool with given dimensions. The variable-answer task required groups of participants to design a swimming pool and to estimate its volume. Groups were provided with the following guidelines: (a) the pool must *not* have any curves, (b) the pool must have at least one shallow end *and* at least one deep end, and (c) the pool must have at least one incline plane. These guidelines assured that groups would have to calculate the volume of a triangular prism, which was the learning objective for the students. For the single-answer group task, students were given dimensions of a swimming pool and asked to calculate its volume. The diagram of the pool included a deep end and a shallow end with an incline plane connecting the two. The focus was for students to agree on how to calculate the volume of a triangular prism that was included within the swimming pool.

In order to establish students' knowledge of volume calculation, students completed a pretest where they were provided with dimensions of a single triangular prism and were asked to calculate its volume; on the posttest students were provided with the dimensions of a barn (within which was included a triangular prism) and were asked to calculate its volume. The assessments also asked participants to explain how they solved the volume problems to assist in inferring participants' level of understanding.

The pretest and posttest were scored using rubrics (i.e., scoring guides) developed specifically for this research study that are based on rubrics developed by the Long Beach Unified School District. The rubrics used in this study were developed using guidelines suggested by Herman, Aschbacher, and Winters (1992). Problem solving of all assessments was separated into five performance levels. All scores, therefore, could range from zero to five. A score of 'five' was assigned when participants correctly multiplied length, width, and height and, then, divided the product by two to determine the volume of a triangular prism. A 'four' was assigned when participants multiplied correctly, but did not divide the product by two. A 'three' was assigned when participants only multiplied two sides of the prism (as if to find the area). A 'two' was assigned when participants used multiplication, but did not multiply any of the sides of the triangular prism. A 'one' was assigned when participants only used addition (that did not transfer to multiplication) to solve the problem. A 'zero' was assigned when participants did not use mathematics or left the answer blank.

Anchor assessments were selected from the sample to assist in exemplifying each level, thereby establishing a rubric that can be reliably transferred and taught (as was done in training the scorers). Two researchers scored all pretests and posttests. The inter-rater reliability for giving exactly the same performance level was .94. The inter-rater reliability for being within one performance level was 1.00.

2.3.3. *Video Coding*

The 12 group video tapes were transcribed and coded in their entirety. A second coder coded 15 random minutes of each group's interactions with the inter-rater reliability being .93. Each group task lasted between 35 and 45 min; duration was not influenced by task structure. The codes analyzed for this study include: (a) idea accepted by the group, (b) gives explanation, (c) receives explanation, and (d) number of on-task turn-constructional units (Sacks, Schegloff, & Jefferson, 1974), used as a measure of task-related participation; non-task-related discourse was not coded. A group member received a code of 'idea accepted by the group' when the group writes down a suggestion that the group member made or contributed to. Each time that a group member gave an elaborated explanation as to how to determine an answer, she or he received a code of 'gives explanation' and group members to whom the explanation was aimed received a code of 'received explanation'. This may have been in response to a question or not. For example, in one group student A gives an explanation to student B upon a request:

B – 'Wait how would our base, I don't get it how would our base be 27'.

A – 'Okay nine and three. You multiply those two'.

To calculate the number of turn-constructional units for every participant (as a measure of overall participation), we added up all statements made by each person at the end of which it would be appropriate for another group member to make a statement (Sacks, Schegloff, & Jefferson, 1974). A single turn may consist of several turn-constructional units and, likewise, a single turn-constructional unit may be broken-up by utterances from other group members. For example, the following turn consists of two turn-constructional units, 'Let me see this. Put this 4 meter over here, then it would add another box down here'?

3. Results

3.1. RELATIONSHIP BETWEEN PARTICIPATION AND ACHIEVEMENT

To examine the impact of task-structure on achievement, analyses were conducted to determine whether any participation variables predicted learning outcomes and whether such relationships differed depending on task structure. Scores from the pretest and posttest as well as amounts of various participations per minute are presented in Table I. Partial correlations were calculated between participation variables and the posttest scores for the two types of group tasks (single-answer and variable-answer) while using the pretest scores as a covariate. Due to the participant-selection process there were no race or gender differences on the pretest. These partial correlations can also test the hypothesis that on single-answer group tasks giving explanations relates to achievement while on variable-answer group tasks task-related participation relates to achievement. Partial and

Table I. Means for pretest, posttest, and participations per minute, separated by race, gender, and task

	Pretest	Posttest	Ideas accepted	Gives explanations	Receives explanations	Task-related participation
Males						
Single-answer task groups	1.36	1.82	0.09	0.15	0.03	2.63
	(1.43)	(1.47)	(0.23)	(0.26)	(0.07)	(2.51)
Variable-answer task groups	1.87	2.72	0.05	0.17	0.08	2.62
	(0.90)	(1.81)	(0.07)	(0.17)	(0.09)	(2.08)
Females						
Single-answer task groups	1.64	2.96	0.03	0.12	0.05	1.95
	(1.37)	(1.65)	(0.07)	(0.33)	(0.08)	(1.41)
Variable-answer task groups	1.98	3.00	0.05	0.12	0.06	2.26
	(0.74)	(1.71)	(0.07)	(0.22)	(0.10)	(1.68)
African–Americans						
Single-answer task groups	1.47	1.73	0.02	0.08	0.03	1.73
	(1.37)	(0.90)	(0.06)	(0.25)	(0.07)	(1.83)
Variable-answer task groups	1.78	3.17	0.05	0.09	0.06	2.10
	(0.71)	(1.64)	(0.06)	(0.12)	(0.09)	(1.74)
European–Americans						
Single-answer task groups	1.54	3.00	0.10	0.19	0.05	2.85
	(1.44)	(1.95)	(0.23)	(0.33)	(0.08)	(2.12)
Variable-answer task groups	2.06	2.55	0.06	0.20	0.08	2.79
	(0.91)	(1.83)	(0.07)	(0.24)	(0.10)	(1.98)
Total						
Single-answer task groups	1.51	2.41	0.06	0.14	0.04	2.29
	(1.38)	(1.64)	(0.17)	(0.29)	(0.07)	(2.02)
Variable-answer task groups	1.92	2.86	0.05	0.14	0.07	2.44
	(0.81)	(1.73)	(0.06)	(0.19)	(0.09)	(1.86)

Note. Standard deviations are in parentheses.

zero-order correlations between participation variables and the posttest scores appear in Table II.

For the two types of group tasks, pretest and posttest scores were moderately intercorrelated (single-answer task $r = .46$, $p < .05$; variable-answer task $r = .57$, $p < .01$).

On the variable-answer task 'task-related participation' significantly correlated with posttest scores ($r = .43$, $p < .05$) while on the single-answer task 'giving explanations' significantly predicted achievement when groups completed the single-answer task ($r = .44$, $p < .05$). These partial correlation results support the hypothesis that giving explanations relates to achievement when students work on single-answer group tasks while task-related participation relates to achievement when students work on variable-answer group tasks.

These results, however, can be misleading. Although giving explanations on variable-answer tasks did not significantly predict achievement ($r = .29$, $p > .05$),

Table II. Pearson partial and zero-order correlation coefficients between participation variables and posttest scores, using pretest scores as a covariate, separated by task ($N = 24$)

Participation variables	Learning outcomes (Posttest scores)	
	Single-answer task	Variable-answer task
Idea accepted by the group	.30 (.45*)	.19 (.21)
Gives explanation	.44* (.42*)	.29 (.32)
Receives explanation	−.23 (−.27)	.32 (.17)
Task-related participation	.06 (.10)	.43* (.40)

* $p < .05$.
Note. Zero-order correlations are in parentheses.

the difference between the two task types in correlations between giving explanations and achievement is not significant ($z = 0.71,\ p > .05$). Similarly, analyses detect only a tentative difference between single-answer and variable-answer tasks on correlations between task-related participation and achievement ($z = 1.76,\ p < .10$). A similar analysis of receiving explanations, however, reveals a significant difference between the two task types in correlations with achievement ($z = 2.61,\ p < .01$).

3.2. TASK EFFECTS ON STUDENT ACHIEVEMENT

To test whether task structure of the group tasks differently impacted achievement (posttest scores) of different gender/racial groups, an ANCOVA was calculated for achievement. The design for the ANCOVA had three crossed factors: task structure (single-answer and variable-answer) × race (African–American and European–American) × gender. Pretest score was the covariate.

For the hypotheses to be supported by the ANCOVA results, analyses should detect significant interaction effects between task structure and gender/race. Moreover, smaller achievement differences between racial and gender groups should appear for groups working on the variable-answer task than for those working on the single-answer task. If the hypothesis is reflected in the results, on the single-answer task, African–Americans and females should have lower achievement than European–Americans and males, respectively. On the variable-answer task, however, these differences should disappear.

The ANCOVA analyses revealed one significant task-structure by race interaction effect that partially supports the hypotheses that diffuse status differences on achievement are accentuated for students working on single-answer tasks, but not on variable-answer tasks. In particular, when groups worked on the single-answer task, European–Americans had higher posttest achievement than African–Americans, $F(1,39) = 5.94,\ p < .05$ (see Table III). When groups worked on the variable-answer task, however, this difference disappeared (see Figure 1). No such effects were detected for gender.

Table III. Analysis of covariance for posttest achievement

Source	df	*F*
Task structure	1	0.20
Gender	1	2.02
Race	1	0.22
Task structure × Gender	1	0.86
Task structure × Race	1	5.94*
Gender × Race	1	0.58
Task structure × Gender × Race	1	0.12
Within-group error	39	(2.04)
Covariate	β	*t*
Pretest score	0.48 (0.19)	3.69***

The first value enclosed in parentheses represents mean square error, while the second such value represents standard error.
* $p < .05$.
*** $p < .001$.

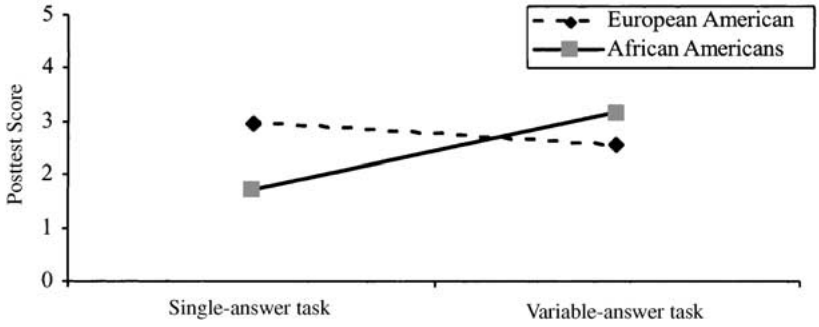

Figure 1. Mean posttest achievement on mathematics tasks, separated by task structure and race. Interaction of race and task structure on posttest achievement (controlling for pretest scores) is statistically significant, $p < .05$.

These results indicate that, although students worked in homogeneous-ability groups, their race impacted on their posttest-achievement when they completed the single-answer task, but not the variable-answer task. The next question that must be asked is, 'were there race-based status differences for giving explanations on the single-answer task that could explain race-based achievement differences from the previous section'?

3.3. RACE-BASED DIFFERENCES IN PARTICIPATION ON EACH GROUP TASK

3.3.1. *Single-answer Task*

To test for race effects on the participation variable that related to achievement on the single-answer task, a Mann–Whitney *U* non-parametric statistic was calculated. A *t*-test was not calculated because descriptive statistics indicate that the

European–American and African–American samples for 'giving explanations' on the single-answer task were not normally distributed, one of the assumptions for maintaining robustness when using parametric tests of significance. For this task, the African–American sample had kurtosis equal to 11.66 and skewness equal to 3.40 while the European–American sample had kurtosis equal to 8.05 and skewness equal to 2.74. This means that there was an even distribution among two-thirds of the participants who scored a one, two, or three on the posttest. The homogeneity of variance assumption, however, was upheld as the African–American sample had a variance equal to 0.062 ($M = 0.083$) and the European–American sample had a variance equal to 0.110 ($M = 0.188$). For the variable-answer task the normality and homogeneity assumptions were upheld. Non-parametric tests of significance do not make assumptions about normality of sample distributions and, therefore, would maintain robustness in the current case of non-normal samples.

The Mann–Whitney U procedure converts scores into ranks within each group and then calculates the statistic to determine significance of differences. The results revealed a statistically significant racial difference for the single-answer task (M rank = 15.08 for European Americans, M rank = 9.92 for African Americans; $U = 41.0$, $p < .05$), such that European Americans gave explanations more frequently than African Americans (see Figure 2). No significant racial difference, however, was detected for giving explanations on the variable-answer task when a t-test was calculated. This occurred despite a mean difference (European Americans, $M = 0.20$ explanations per minute; African Americans, $M = 0.09$ explanations per minute) that was similar to that on the single-answer task (European Americans, $M = 0.19$ explanations per minute; African Americans, $M = 0.08$ explanations per minute).

The combination of the results from Mann-Whitney, partial correlation, and ANCOVA analyses outlines a picture of how task characteristics, diffuse status

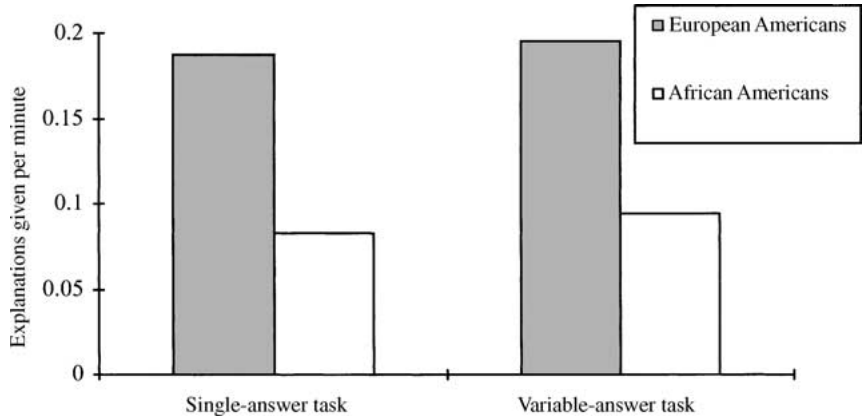

Figure 2. Giving explanations on mathematics tasks, separated by task structure and race.

characteristics, group participation, and achievement interrelate. Task characteristics establish an environment for group interactions that, in some cases, is susceptible to diffuse status effects. In particular, on the single-answer task, European–American group members (high status) gave significantly more explanations than African–American group members (low status). This difference, although present, was not statistically significant for the variable-answer task. As stated previously, this ethnic difference on the single-answer task could be due to higher status group members taking initial opportunities to contribute to group-task solutions. If there is only one solution, as is the case for single-answer tasks, then lower status group members may have fewer opportunities to give explanations than do higher status group members. This difference in giving explanations translates into differences in achievement, as on the single-answer group task, giving explanations relates to achievement.

3.3.2. *Variable-answer Task*

To test for any diffuse status effects on the two participation variables that relate to achievement on the variable-answer task (task-related participation and receiving explanations), two ANOVAs were carried out. The design of each ANOVA had two crossed factors: race (African–American and European–American) $\times$ gender (female and male). No significant results were revealed in these analyses.

3.4. A CLOSER LOOK AT THE RELATIONSHIP BETWEEN GIVING EXPLANATIONS AND ACHIEVEMENT

To further examine racial differences in giving explanations and how giving explanations can differently influence learning on single-answer and variable-answer tasks, it is helpful to take a look at two collaborative groups from this study. The first group completed the single-answer task while the second group completed the variable-answer task.

The group that completed the single-answer task had little knowledge of how to compute volume before working on the collaborative-group task. On the pretest, all group members incorrectly attempted to compute volume of a triangular prism solely by adding the lengths of its edges. After working on the single-answer task, three of the group members showed improvement in their understanding of volume computation. The two European–American group members demonstrated the greatest improvement when, on the posttest, they separated the barn into sections, calculated the volume of each section by partially-correctly multiplying the lengths of three sides, and added the calculated volumes of all the sections together to determine the volume of the entire barn. The African–American female in the group also showed improvement from her pretest by using multiplication to calculate volume. She, however, only multiplied the lengths of two sides at a time, and in actuality, only calculated the surface area of the barn. The African–American male in the group was the only group member to show no improvement from the pretest by continuing to only use addition to calculate volume.

The relationship between participation during group work and students' subsequent achievement on the posttest reflected the statistical analyses that were presented earlier. First, the European–American students were the only group members who produced explanations. In particular, the European–American male began the interaction by quickly suggesting, after reading the directions, 'all right then... it's four times 20, 20 times five is...' he continued to call out numbers that he was multiplying in a progressively quieter voice until he was mumbling to himself while the rest of the group was looking at what he was writing on his paper. To explain his work, the European–American male stated, 'I timesed it by a lot of numbers'. The other group members had limited access to the group work as there was little need for them to add to the work of the European–American male who completed the single-answer task with virtually no help from his group mates. As a result, group members ended up learning primarily from their silent work on the task and not through active group interactions.

The group that completed the variable–answer task had a little more knowledge about computing volume than the group that was discussed above. On the pretest, all four group members of this second group incorrectly multiplied the lengths of two sides of the triangular prism to calculate the volume of the solid. They, unlike the first group, knew that multiplication is required for calculating volume. All group members demonstrated similar improvement after group work by multiplying the lengths of three sides of the solid on the posttest.

Although, as in the first group, only European–American group members gave explanations on the variable-answer task, all group members were intricately involved in deciding dimensions of their swimming pool. This collaborative decision led to the group working together on calculating the pool's volume with each of the group members mentioning a version of the formula to calculate volume sometime during the group work. As a result all group members working on the variable-answer task had the opportunity to learn and interact with calculating the volume within their group work.

As the single-answer task was not a true group task where all group members were necessary for successful completion of the task, group members' participation was limited to suggestions, explanations, and questions that they chose to pose to the rest of the group. The task, however, did not require any such interaction. Therefore, any learning that took place ended up being strongly related to giving explanations, the major form of high-level verbal interaction within the group that happened to be related to the ethnicity of group members. As a result, on the single-answer task, European–American group members learned more from group work than did their African–American group mates. On the variable-answer task, however, group members' were required to participate for successful completion of the task. As a result, all group members had an opportunity for high-level participation that was not solely dependent on the amount of explanations given. Therefore, all group members who worked on the variable-answer tasks demonstrated a similar amount of learning from their group work.

4. Discussion

4.1. OVERVIEW

This study's findings regarding the forms of participation that impact on learning help to explain conflicting findings in previous research on group work. Some previous research concluded that task-related participation contributes to achievement gains (e.g., Cohen, 1994), while other studies determined that giving explanations sometimes contributes to achievement gains but task-related participation does not (e.g., Webb, 1991). In particular, findings from this study indicate that task-related participation is related to learning only when groups complete variable-answer tasks (tasks similar to those used in Cohen's research), while giving explanations contributes to learning when students engage in single-answer tasks (tasks similar to those used in Webb's research). Findings also indicate that receiving explanations may facilitate learning on variable-answer tasks while impeding learning on single-answer tasks. Results, however, did not reveal status-based differences regarding receiving explanations.

The current study did find that race impacts on learning within groups. Racial differences for 'giving explanations' on the single-answer task were reflected in similar racial differences in achievement for these same groups. Specifically, when groups worked on the single-answer task, European–Americans gave more explanations than their African–American groupmates and showed higher achievement on the posttest (even when controlling for pretest scores). These findings, therefore, suggest that racial differences in achievement gains may stem from differences in the types of participation that predict learning outcomes.

In addition, the current study found no status effects linked to the gender of group members, regardless of task structure (single-answer or variable-answer tasks). For both single-answer and variable-answer tasks, gender was not a significant factor in verbal interaction or achievement. The paucity of findings could be a result of establishing collaborative groups with homogeneous mathematics achievement. This may especially be true since previous research reports that mathematics ability is often confounded with gender as well as race (Secada, 1992).

Finally, the present study strengthens the assertion that, at least in some cases, race affects the outcomes of collaborative group work. This study also adds to the body of research on collaborative group work by shedding some light on how group members' attributes, task structure, and specific forms of participation contribute to the quality of interaction and learning within collaborative groups.

4.2. RELATIONSHIP BETWEEN ACHIEVEMENT AND PARTICIPATION

It is important to examine whether task structure differentially impacts learning depending on participation (also accounting for race and gender). The findings from the present research indicate that when groups engaged on the single-answer task,

European Americans showed higher posttest achievement scores (while controlling for pretest scores) than did their African American counterparts. No race or gender effects were detected for the variable-answer task. Because this study also found that, on the single-answer task, European Americans gave more explanations than did African Americans, giving explanations seems to be the link to the differential achievement between races on the single-answer task. Such a link would be supported by Webb's (1991) findings that giving explanations predicts learning.

The race effects detected for 'giving explanations' partially support the hypothesis that variable-answer tasks provide a more equitable participation environment than do single-answer tasks. When the single-answer task was examined on its own in post-hoc analyses, European Americans gave more explanations than did African Americans; racial differences were not detected for the variable-answer task.

The impact of race on 'giving explanations' depended on task structure. On the single-answer task, European Americans gave more explanations than did their African–American groupmates. This was not the case for the variable-answer task. The hypothesis of this research – that variable-answer tasks provide a more equitable environment for group interactions than do single-answer tasks – is based on the notion that single-answer tasks provide fewer opportunities for each group member to contribute to the solution than do variable-answer tasks. Therefore, students with higher status are more likely to participate on single-answer tasks than are lower-status group members. Deferring to higher-status peers and limited participation on single-answer tasks provide a reasonable explanation for why European Americans gave more explanations than African Americans only on the single-answer task.

The present study found that giving explanations related to learning only on the single-answer task, thereby corroborating Webb's (1991) findings and demonstrating that in collaborative group work task characteristics play an important role for equity, both in group participation and in learning. As a result, it is possible to conclude that race has the greatest impact on group member achievement when examining 'giving explanations' on single-answer tasks.

The findings from the present research also indicate that different forms of participation interact with task type to impact on achievement. Examination of differences in the predictor variables of learning between the two types of tasks presents an interesting dichotomy, as was predicted in the beginning of this paper. That is, giving explanations is important for learning on single-answer tasks while task-related participation is important for learning on variable-answer tasks. This study, therefore, helps to explain the results of Webb (e.g., Webb, 1991), who, while using mostly single-answer tasks, has demonstrated that giving explanations contributes to achievement gains, and Cohen (e.g., Cohen, 1994), who, while using mostly variable-answer tasks, has demonstrated that general participation contributes to learning.

4.3. IMPLICATIONS FOR EDUCATION

The important findings of the present research suggest that teachers and others in educational settings should be aware of the effects that diffuse status characteristics (in this case, race) may have on collaborative groups. As this and previous research demonstrate that type and amount of participation are important for cognitive gains, equity in participation should be carefully observed and maintained.

Further, as task type interacts with some diffuse status characteristics, talking with teachers about this interaction will help them to adjust their teaching techniques. The current research study suggests that variable-answer tasks may, in some cases, provide a more equitable environment than single-answer tasks. In particular, the current study suggests that variable-answer tasks provide an environment in which lower-status group members may receive more attention and be taken more seriously than when working on single-answer tasks. Teachers, however, should also be made aware that establishing variable-answer collaborative-group environments does not guarantee status equity. The program of Complex Instruction, for example, suggests several status treatments (e.g., teachers' assigning competence to low-status group members) to help establish equity within collaborative work groups (Cohen & Lotan, 1995; Lotan, 1997).

Although results from the present study suggest that racial equity in achievement is more likely when groups work on variable-answer tasks than on single-answer tasks, there are many pedagogical reasons for using both task types. Single-answer tasks, for example, have been shown to increase learning in peer tutoring situations (Fuchs, Fuchs, Mathes, & Simmons, 1997). Fuchs et al. (1997) found that proteges participating in peer tutoring showed higher achievement gains than the control group. Importantly, these results did not differ depending on whether the proteges were learning disabled, low performing, or average in achievement. Furthermore, Fuchs et al. (1997) suggest that peer tutoring equalized achievement within diverse classrooms, whether that diversity stems from ability level, ethnicity, gender, or socio-economic status.

As with single-answer tasks, there are pedagogically sound uses for variable-answer tasks. Variable-answer tasks, for example, are prominent in many diverse work environments and, if one desires authentic educational practices, then tasks within schools should resemble those outside the classroom. Moreover, Cohen (1994) suggests that the group processes attributable to variable-answer tasks seem most effective in helping students reach a deeper level of understanding.

To help deal with status issues that may arise during a collaborative group task, Lotan (1997) suggests using interventions infused with Complex Instruction strategies. Complex Instruction interventions include (a) informing groups that multiple skills are required to complete their task and that every group member has some of these skills while no group member has all the skills and (b) assigning competencies to low-status students as they demonstrate skills that are important for the group to be successful in their task. In addition, other researchers have suggested teaching students how to ask and answer questions during group work

as a way to facilitate productive and equitable discourse (King, 1994; Fuchs, Fuchs, Hamlett, & Karns, 1998).

4.4. LIMITATIONS OF THE PRESENT STUDY AND SUGGESTIONS FOR FURTHER RESEARCH

The results from the present study should be viewed as an attempt to tease out social patterns that are influenced by task type while, in their own right, influencing learning. In social science research, however, patterns of interaction depend on the individual actions of each participant. In the case of the present research, for example, an individual may have influence over interactions within an entire group. Moreover, although the present study utilizes over 10 h of interactions across 12 work groups, the modest findings warrant further research to confirm the trends reported in this paper.

As this is one of the first studies on the interaction between task characteristics and diffuse status effects, many facets remain unexplored. First, researchers should test the generalizability of this study's results not only within mathematics, but also across content areas (e.g., science, social science, and language arts) as well as across various populations. Furthermore, an investigation of the role academic status plays within and across groups as well as the interaction of academic status with race and gender should be pursued by a researcher who employs a study design that includes groups with multiple ability levels across race and gender. For example, would a high-academic-status African–American female show more participation than a low-academic-status European–American male? In addition, researchers should analyze the influence that other aspects of collaborative tasks have on various types of diffuse status effects. Possible aspects to explore include: role assignment in tasks, race and gender composition of groups, and the influence of hands-on components for both a single and multiple users. Another line of research could investigate diffuse status effects within multicultural groups as well as across bilingual and multilingual tasks.

Besides focusing research on manipulation of group interaction, future studies that assess achievement impacted by collaborative groups completing variable-answer tasks could use variable-answer tasks to measure achievement. The present study, for example, limited the information gathered by pretests and posttests by not using variable-answer tasks in measuring achievement. Future studies can include both single-answer and variable-answer assessments while insuring independence of each measure.

Finally, the race-specific findings from the present study should not be used to stereotype individual students based on their race. Racial differences in the present research (as in most other research that examines such diffuse status characteristics) arise from the hegemony within American culture. This hegemony has established social constructs of race and gender as well as oppression rooted in these social constructs (Fordham, 1993; Ogbu, 1994; Ladson-Billings, 1996; Montagu, 1997). Individual differences, although often affected by the social con-

struction of race and gender, are shaped by many cultural factors beyond these diffuse status characteristics, including social class. In particular, the present study questions whether students' relative mathematics achievement impacts intra-group participation on mathematics tasks as much as students' race and gender. Moreover, this study suggests that achievement differences may have confounded race and gender participation effects in previous research and that diffuse status characteristics may not influence participation to the extent reported in previous research. In the future, researchers who examine differences in participation should measure students' achievement and academic status to insure that any reported differences are attributable to respective experimental variables.

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