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ABSTRACT

The present study attempts to expand current question categorization schemes to identify question types that discriminate good learners from their peers in collaborative problem-solving groups. The study also explores the effects of person and task variables on students' question-asking behaviors in an effort to identify those that facilitate mathematics problem solving. Forty-seven fifth graders from two independent urban schools that use cooperative-learning methods participated in the study. Students were asked to solve fraction problems in one set containing continuous problems and in another set consisting of discrete problems. A question-categorization scheme was devised to code student requests to each other for information or assistance. No significant differences were found in the numbers of questions asked by students of high, low, or average ability. Although this appears contradictory to some previous results, it may be that including question types that were not exclusively help seeking explains the discrepancy. Overall, results indicate that type of task interacts with student characteristics and the setting to affect performance and students' peer-directed questions. Prior experience with cooperative-learning groups appears to have affected problem-solving and questioning performance. Two figures present study findings. (Contains 73 references.) (SLD)

THE EFFECTS OF KNOWLEDGE AND TASK ON STUDENTS' PEER-DIRECTED QUESTIONS IN MODIFIED COOPERATIVE LEARNING GROUPS

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"Those who learn are those who can ask" (Cooper, Marquis, & Ayers-Lopez, 1982). For decades, the role that questions play in learning has been the focus of research and debate (for literature reviews see Dillon, 1982; Fahey, 1942; Gall, 1970). Historically, studies of the relationship between questions and academic achievement have focused on the ways in which teachers' questions constrain or facilitate learning (Blosser, 1973; Merwin & Schneider, 1973; Olmo, 1975; Sadker & Cooper, 1974). During the past decade, however, peer-directed questions, especially those occurring in small, cooperative work groups, have been studied in an attempt to identify question types that affect achievement outcomes.

Within this framework, questioning is viewed as a social problem solving strategy since it allows students to perform tasks that they may be unable to complete alone. In essence, this is a Vygotskian perspective claiming that a student, in collaboration with either more capable peers or adults, can solve problems that are more difficult or complex than those he or she could solve independently. Vygotsky (1978) defines this feature of learning as "the zone of proximal development which is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Since a student's questions are part of these problem solving interactions, one would expect that a student's ability to seek help or to ask questions of peers would impact upon his or her problem solving performance.

Studies in help-seeking, sociolinguistics, and cooperative learning have found that on-task, listener-targeted, instrumental (process) questions facilitate successful communication and promote achievement in cooperative work settings (Wilkinson, Lindow, & Chiang, 1985; Nelson-LeGall, 1986; Webb, 1983). In fact, help-seeking researchers (Nelson-LeGall, 1986; Nelson-LeGall, Gumerman, Scott-Jones, 1983) differentiate two types of questions (also called help-seeking bids) that affect achievement: executive requests and instrumental requests. Executive questions are dependency oriented in that an individual either requests the solution to the problem or to have a more advanced learner solve it for him. In contrast, instrumental questions are mastery oriented in that an individual asks others to clarify the processes involved in arriving at a solution. Instrumental help-seekers usually request only the amount and type of assistance needed to allow them to solve a problem independently. Positive achievement effects for instrumental help-seeking are evident (Nelson-LeGall, 1986; Nelson-LeGall, Gumerman, Scott-Jones, 1983).

These preliminary findings suggest that further differentiation of question types is needed to help delineate those questions that enhance learning. The present study attempts to expand current question categorization schemes to identify question types that discriminate good learners from their peers in collaborative problem solving groups. Furthermore, the study explores the effects of person and task variables on students' question-asking behaviors in an effort to identify those that facilitate problem solving.

The effects of learner characteristics on questioning behaviors in cooperative work groups have been the subject of considerable research. For example, Nelson-LeGall (1987) and van der Meij (1988) have found that variables such as age and academic ability level affect the numbers and types of questions students ask their peers. Edwards and Lewis (1979), Nelson-LeGall and Glor-Scheib (1985; 1986), and Nelson-LeGall and Gumerman (1984) found that fifth graders engage in significantly more peer help-seeking than third and first graders. As a result, the present study was conducted with fifth graders in the expectation that peer-directed questioning would be maximized. Nelson-LeGall (1987), Nelson-LeGall and Glor-Scheib (1985), and Swing and Peterson (1982) studied the help-seeking bids of high, average, and low ability elementary school students to determine students' preference for instrumental versus executive help. They found that fifth and sixth graders prefer instrumental over executive help significantly more than do younger elementary aged students. Moreover, high ability students in both mathematics and reading demonstrated a preference for instrumental help, whereas their low ability counterparts preferred executive help. To explain these findings, Nelson-LeGall and her colleagues (1983) proposed that young and low ability students may not be effective help-seekers because they may not only lack the skills to recognize their need to elicit help, but also they may fail to seek the type of help (e.g., instrumental help) that is most conducive to learning. With regard to average ability students, Nelson-LeGall and Glor-Scheib (1985) found that, in mathematics, average ability students seek help less than both low and high ability students. One explanation for this finding has been suggested by Dembo and McAuliffe (1987) and Nelson-LeGall and Glor-Scheib (1985) who reported that the help-seeking bids of average ability students are ignored or rejected more often than those initiated by low and high achievers.

There is conflicting evidence concerning the frequency with which students seek help from their peers. The work of Nelson-LeGall (1987), Nelson-LeGall, DeCooke, and Jones (1989), and Nelson-LeGall and Glor-Scheib (1985) demonstrates that low ability students request more help than high ability students who, in turn, seek more help than average students. In contrast, other studies (Karabenick & Knapp, 1988; Newman & Goldin, 1990) found that when students seek help from adults, low achievers make fewer requests than average or high achievers. Weiner, Russell, and Lerman (1978, 1979) and Newman (1990) suggest that low achievers make fewer requests due to their feelings of embarrassment and dependency over the fact that help is needed. The social context in which help-seeking occurs therefore appears to affect the help-seeking rates of low achievers.

The effects of task variables on peer-directed questions have only been examined generally. Nelson-LeGall and Glor-Scheib (1985) and van der Meij (1988) studied the way in which help-seeking behaviors vary with the activity structure (e.g., instruction versus seatwork) in the classroom. Both studies documented that students make more requests of their peers during seatwork activities. A review of the literature indicates that researchers have paid little attention to the effect of the type of academic task on the frequency and form of questions. The effects of task on questioning are important to study because, according to Baker and Brown (1984, cited in Nelson-LeGall, 1986, p. 70), "individuals' knowledge about the compatibility between themselves as learners and the learning situation plays an important role in effective problem solving."

Within the context of mathematics, the present study attempts to closely examine the way in which learner and task variables interact to affect the frequency and form of students' peer-directed questions. With regard to learner characteristics, the study examines the way in which students' prior mathematics knowledge (defined as mathematics ability in the help-seeking and cooperative learning literature) affects their peer-directed questions. Research, especially in memory, has shown that students' knowledge interacts with strategy usage which, in turn, affects performance (Alexander & Judy, 1988; Gay, 1986; Ornstein & Naus, 1985; Schauble, 1990; Voss, Greene, Post, & Penner, 1983). Since questioning is viewed as a problem solving strategy, it was expected that students' knowledge would affect the frequency and form of their questions.

Two types of fraction tasks were utilized in the present study to explore the effect of an academic task on questioning behaviors. Research (Berrnan & Friederwitzer, 1983; Driscoll, 1984; Kieren, 1980) indicates that learning fractions is difficult due to the complex relationships among the meanings and representations of fractions and basic arithmetic operations. For fifth graders who are beginning to develop a fuller conceptual understanding of fractions and to perform operations with them, fraction tasks are relatively novel. Thus, it was expected that the novelty of fractions would increase the likelihood that questions would be generated as students solved problems. Previous studies (Bjorkland & Bernholtz, 1986; DeLoache, 1980; DeLoache, Cassidy, & Brown, 1985; Shantz, 1978) have demonstrated that the novelty of the task affects the strategic processes employed by students in problem solving situations.

The fraction tasks used in the present study are based upon the measure or part/whole interpretation of fractions since this interpretation is emphasized in formal instruction. The part/whole subconstruct (Behr, et al., 1983) can be represented with manipulatives using two models: continuous and discrete. A single object partitioned into parts would define a fraction that is represented using a continuous part/whole model (also referred to as the area model). "Under this meaning, a whole is sliced into n slices, each slice is encoded as 1/n, and if one refers to several (k) slices it is encoded as k/n" (Nesher, 1985, cited in Ohlsson, 1988, p. 55). The discrete part/whole model (also referred to as the set model) "involves the need to perceive a set of discrete objects as a unit, one entity" (Behr, Wachsmuth, & Post, 1988, p. 2). Thus, a discrete representation of 1/5 might be five circles, one of which would be shaded.

These types of problems were used in the present study because research has suggested that solving continuous and discrete model problems requires different "schemes." Nik Pa (1989) proposes that the schemes involved in solving continuous fraction problems are qualitatively different than those needed to solve discrete fraction problems. To accurately solve fraction problems using these models, students must attend to different features of the representation. For the continuous model, students need to focus on the size and shape of the parts. Number of items is the critical element for fractions representing the discrete model (Behr, Wachsmuth, & Post, 1988). Because this study asks students to solve part/whole fraction problems using both the continuous and discrete models, it examines how the type of task (continuous versus discrete) affects the kinds of questions students ask each other.

Although studies are beginning to examine the effects of learner and task characteristics on students' question-asking behaviors, existing research has not investigated the impact of both types of variables in a single study. Thus, the present study was designed to explore the ways in which students' general mathematics knowledge and the type of fraction task interact to affect the frequency and form of students' peer-directed questions. Research questions that are addressed include the following: Do questioning frequencies differ among low, average, and high students and between tasks? Do high mathematics knowledge students ask qualitatively different questions than average and low knowledge students? Do students' questions qualitatively differ when they are working on different types of tasks?

Method

Subjects

Forty-seven fifth graders from two independent urban schools that used cooperative learning methods participated in the study. Both schools serve individuals from ethnically diverse, middle to upper middle socio-economic backgrounds. At each school, students were randomly assigned to three member, cooperative problem solving groups that were heterogeneous in terms of their general mathematics knowledge. Each group was comprised of a "low," "average," and "high" student in general mathematics knowledge which was determined by a) teacher rating and b) his/her combined performance (as measured by a percentile rank) on the Mathematics Computation and Concepts subtests of the Educational Records Bureau (ERB) Comprehensive Testing Program II. The ERB tests were administered in April, 1990, when students were in the fourth grade. The mean percentile rank of the high, average, and low knowledge groups were 87.26 (SD = 8.42), 56.57 (SD = 16.23), and 32.12 (SD = 11.87), respectively. It is important to note, however, that the mean percentile rank of the low knowledge group, 32.12, falls within the average range. Thus, the performance of "low" general mathematics knowledge students was **relatively low** compared to the performance of "average" and "high" knowledge subjects as defined by this study. When compared to the overall population of students in the United States who were administered the ERB tests, these "low" students were performing in the average range which is important for generalizability of the results of the study. Twenty-three of the students were male and 24 were female.

Materials and Procedure

Students were asked to solve two sets of fraction problems, one set containing continuous problems and the other set consisting of discrete problems. Problems were adapted from those created by McBride and Lamb (1986) and Lesh and Hamilton (1981). Three types of problems were included within both the continuous and discrete fraction problem sets: (a) identifying part of the "unit" (e.g., 1/2 of a circle, 1/2 of a set of objects), (b) determining equivalent fractions (e.g., "How many 1/6 does it take to make 4/12?"), and (c) comparing or ordering fractions (e.g., "Order the fractions from smallest to largest: 5/7, 2/8, 3/4"). These problem types were chosen because students' performance on these problems is considered a measure of their quantitative notion of rational numbers (Behr, Wachsmuth, & Post, 1985). Moreover, these types of fraction problems are appropriate for fifth graders. Behr, Wachsmuth, Post, and Lesh (1984) document that students, by late fourth grade, have developed the ability to judge the order and equivalence of fractions, although they may experience some difficulty applying their knowledge to new situations.

Manipulatives were made available to all students as they worked on each problem set because research (Behr et al., 1984; Lesh & Hamilton, 1981; Payne, 1976) suggests that students tend to rely on manipulatives or visual aids when solving fraction problems and using manipulatives or pictorial representations of fractions improves achievement. For the continuous task, students were given fraction tiles (Jenkins & McLean, 1985). Egg cartons and m & m's were made available for students to create sets of objects as they solved discrete problems. The ways in which manipulatives could be used were overviewed for the students before they began each task. Students were videotaped as they worked on both problem sets.

Question Categorization Scheme

A question categorization scheme was devised to code students' requests. This scheme extends the frameworks utilized by Nelson-LeGall (1981), Christian and Tripp (1978) and Good, Slavings, Harel, and Emerson (1987). An explanation and example of each question type is found in Table 1.

TABLE 1

Question Categorization Scheme

Question Type	Definition
1. Management Question	question referring to the management of problem solving activities (includes references to location of fraction tiles, requests for pencils, erasers, materials) (e.g., What problem are you working on? Where are the tiles? Can I borrow your eraser?)
2. General Procedure Question	question referring to general

activities required to complete tasks (includes references to drawing, using a ruler, making lines straight) (e.g., Can we draw a picture to show the answer? Do the lines have to be even? Do we have to draw a picture?)

3. General Request for Help — non-specific request for assistance (includes implicit non-specific requests for help such as "I don't understand this.") (e.g., Will you help me?)

4. Request for an Answer — request for an answer to a specific problem (e.g., What's the answer to number 8?)

5. Request for a Process — question referring to a process needed to solve a problem (these questions ask "how" and require an explanation. They may be vague, such as "How do I draw the picture?) (e.g., How do you reduce it then?)

6. Vocabulary Question — request for a vocabulary definition or term (e.g., What is a ratio again? Bringing a fraction down is called what?)

7. Clarification Question

a. Clarification of Another's Difficulty — request for more information in order to clarify the nature of another's difficulty with a problem (e.g., What don't you get?)

b. Clarification of A Peer's Statement or Question with a Question that Requests More Information — request for more information in order to understand a peer's question or statement (question asks a peer to refine his statement or question) (e.g., After a peer asks if others can divide, someone asks: Divide what? Fractions?)

8. Confirmation Question

a. Confirmation of One's Own Answer — request made to confirm that one's

	answer is correct (e.g., 5/4 would be 1 1/4, right?)
b. Confirmation of Another's Answer	request made to confirm that an answer offered by a peer is correct (e.g., You said 2/3?)
c. Confirmation of a Process	request made to confirm that a math process/procedure is correct (e.g., Reduce it, then? So you shade it in here?)
9. Teacher-like Question	question posed to a peer when a student assumes a teaching role (includes questions that monitor if a peer understands an explanation or response, also includes offers of assistance in the form of questions) (e.g., Do you need help on that one? Which one would you think would be the biggest fraction here? Did you get it?)
10. Self Question	question a student asks and answers himself as he is problem solving (e.g., 5/7 or 6/7? Oh, that's easy...6/7 is bigger.)
11. Lack of Understanding Question	
a. Lack of Understanding of Another's Statement	question that reflects a lack of understanding of another's statement (question does not offer any more information and does not directly request clarification) (e.g., What did you say? What are you talking about?)
b. Lack of Understanding of a Task Problem	question that reflects a lack of understanding of a specific problem in the set (e.g., 5/9 of the rectangle, what does that mean?)
12. Request for Explanation/ Defense	request for another to explain and defend his chosen course of action or answer (always includes the word "why" in the question) (e.g., Why did you reduce it?)
13. Inaccuracy Question	question that suggests a peer's

response is inaccurate (e.g., Are you sure it's 5/9? It is? 2/3? It can't be that.)

14. Request for Information — question that requests information needed to help one solve a problem. (Here the person does not directly ask for the answer to a problem. Rather, he asks for specific information that will help him solve the problem. (e.g., What is the least common denominator of 7 and 8? What is 4/12 reduced?)

15. Request for Meaning — request for what a math symbol or fraction tile represents (e.g., What fraction are the green tiles? What is 5/4?)

16. Opinion Question — request for an opinion of one's work that is not a direct request for an answer (e.g., Does this look like a circle to you?)

17. Off-task Question

a. Off-task-math related — question that refers to math but that has nothing to do with problem solution (e.g., What math group are you in?)

b. Off-task-non-math related — question does not refer to the fraction tasks or the problem solving process (e.g., Could we make little guns out of the rulers? Do you take me for an idiot? What was that noise?)

In order to determine inter-rater agreement, questions from one third of the study's transcripts were coded independently by a second rater for the purposes of reliability. A reliability coefficient of .89 was obtained indicating acceptable reliability for the question categorization scheme.

Results

Questioning Frequencies

Students' questioning frequencies were analyzed in a Knowledge X Task analysis of variance with knowledge (containing three levels: low, average, and high) as the between-subjects factor and task (containing two levels: continuous and discrete) as the within-subjects factor. A significant main effect of task was found, $F(1, 44) = 25.36$, $p < .001$. An examination of the means for each task indicates that students asked significantly fewer questions on the discrete task (M = 10.8) than on the continuous task (M = 16.83). No effect for group was found which is contrary to the hypothesis that low knowledge students would ask more questions than high achievers, who would make more requests than average students. No significant interactions between knowledge group and task were found. All students, regardless of knowledge level, asked similar numbers of questions in each task condition.

The Effects of Knowledge and Task on Students' Questions

Three separate question type analyses were performed which were based on different groupings of the 22 question types: 1) question types grouped conceptually based on hypotheses generated by research findings and the results of a prior pilot study, 2) question types asked most frequently by high and low students under each task condition, and 3) question types grouped according to Nelson-LeGall's categorization of executive and instrumental questions.

Conceptual Analyses

Based on findings from the literature and a prior pilot study, two question categories, "monitor" and "help-manage," were created to distinguish the questioning performance of high students from low students. The "monitor" category includes teacher-like questions, self questions, and requests for specific information that help students to solve problems independently, whereas the "help-manage" category consists of questions that clarify another student's difficulty and that manage problem solving activities. To differentiate the questioning behavior of low students from high students, two question categories, "no-strategy" and "lack-of-understanding," were also devised. The "no-strategy" category includes requests for answers and questions that asked for confirmation of another student's answer. Questions that suggested a lack of understanding of the task problems or of another's statement comprised the "lack-of-understanding" category. Separate Knowledge X Question Category analyses of variance were performed for each task condition.

Continuous task - high knowledge students. A significant main effect for group was evident, $F(2, 44) = 18.83$, $p < .001$. A priori linear contrasts indicate significant differences between the high and low students, $t(45) = 6.02$, $p < .0005$, the high and average students, $t(45) = 4.12$, $p < .0005$, and the average and low students, $t(45) = 1.78$, $p < .05$. Thus, high students asked significantly more "monitor" and "help-manage" questions than low and average students which supports the study's hypotheses. An additional finding was that average students asked significantly more "monitor" and "help-manage" questions than low students.

Discrete task - high knowledge students. A similar analysis was performed for the discrete task for both knowledge variables. However, a third conceptual category, "explanation," was added because the results of a prior pilot study indicated that high students, while solving discrete problems, asked for explanations of another student's answer and often questioned the accuracy of another's response. A significant Group x Question Category interaction was present ($F(4, 88) = 2.98$, $p < .02$). Simple interaction effects were calculated using Satterthwaite's (Winer, 1962) correction for the repeated measures variable's MS_{error} and its degrees of freedom. As expected, the results demonstrate a significant difference between groups for the "monitor" question category, with high students asking more of these questions than their average and low peers ($F(2, 130) = 10.85$, $p < .05$). On the other hand, no significant differences between groups were found for the "help-manage" and "explanation" question categories which refutes the study's hypothesis that high students would ask more of these questions than their low peers.

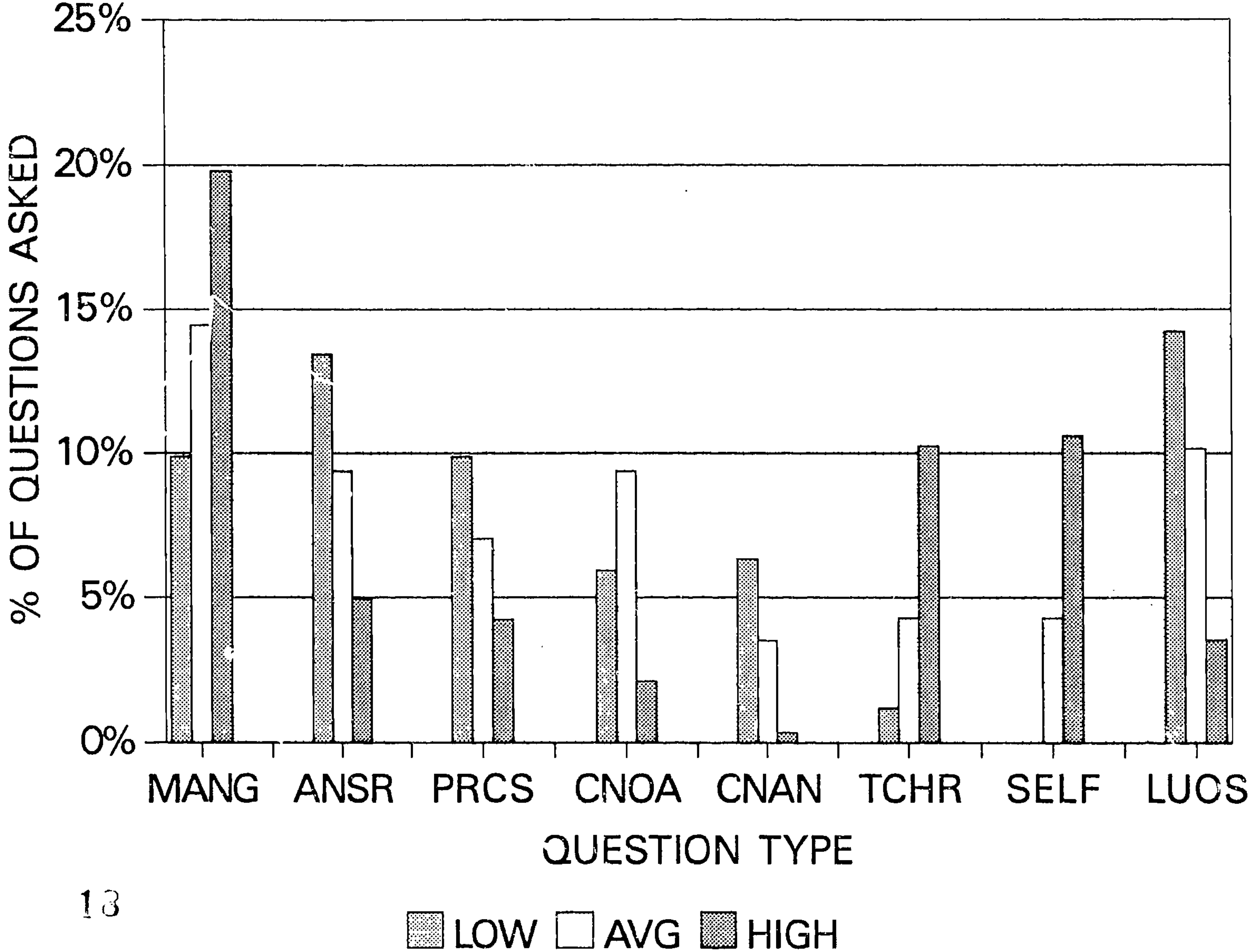
Simple effect calculations also demonstrated significant differences between the numbers of "monitor," "help-manage," and "explanation" questions asked, with high knowledge students asking more "monitor" questions than "help-manage" or "explanation" questions ($F(2, 88) = 5.07$, $p < .05$). No significant differences were found between the numbers of questions asked per question category for the average and low knowledge students.

Continuous and discrete tasks - low knowledge students. Although separate analyses were performed for each task condition, similar results were demonstrated. For each task, a significant main effect for group was found (Continuous Task $F(2, 44) = 4.79$, $p < .01$; Discrete Task $F(2, 44) = 5.49$, $p < .01$). A priori linear contrasts comparing the low and high students reveal that low students asked significantly more "no-strategy" and "lack-of-understanding" questions than high students (Continuous Task $t(45) = 3.09$, $p < .005$; Discrete Task $t(45) = 3.309$, $p < .005$). Results varied by task when average and high students were compared. On the continuous task, contrasts were significant for average and high students, with average students asking more "no-strategy" and "lack-of-understanding" questions than high students (Continuous Task $t(45) = 1.82$, $p < .05$). Interestingly, on the discrete task, comparisons between average and high students were not significant. In both task conditions, contrasts between average and low students were not significant. No effect for question category and no interactions between variables were found.

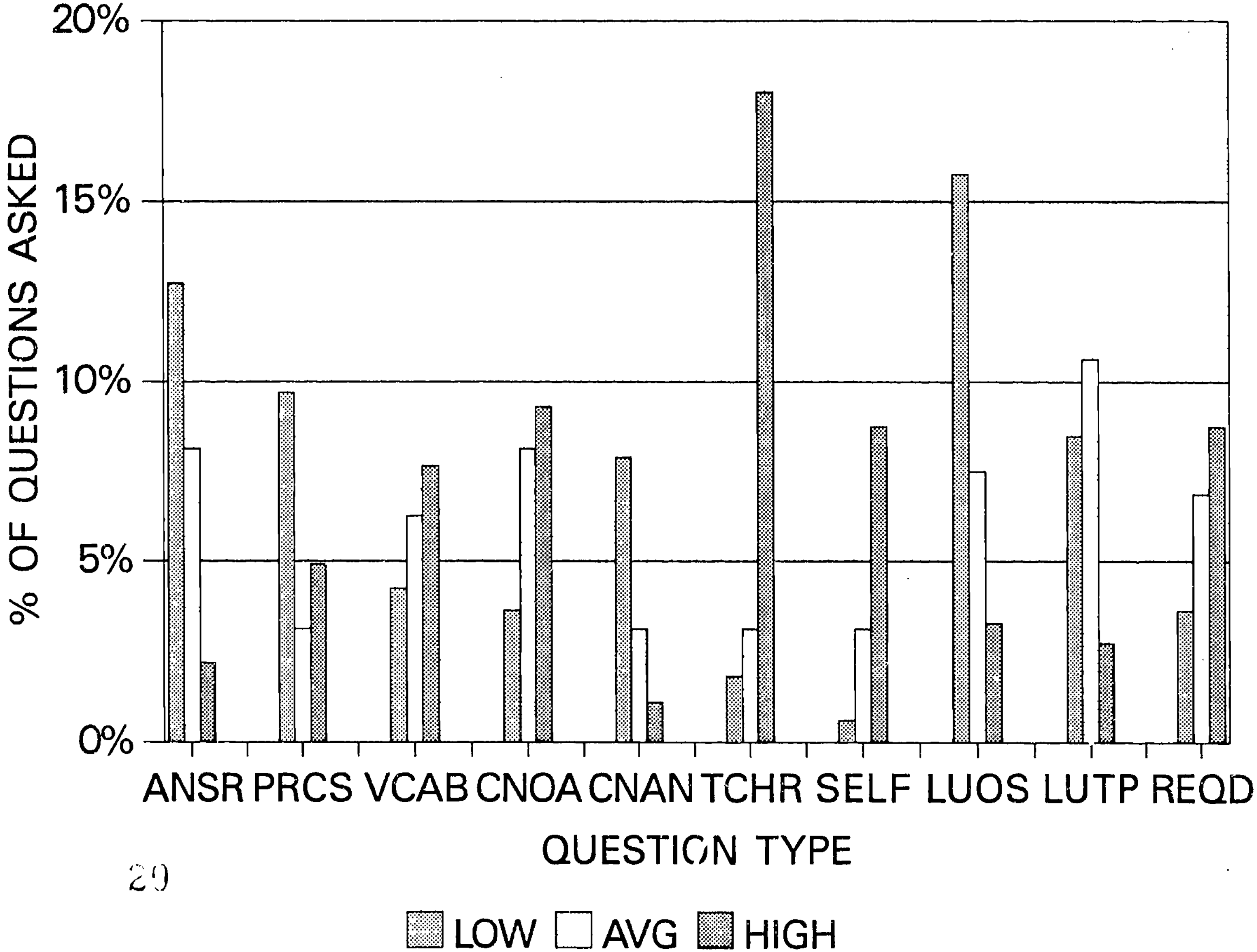
High and Low Students' Questioning Frequencies

A second set of analyses was performed on individual question types that appeared to differentiate high and low students. For each task, the percentage of questions asked by low, average, and high students was calculated for each of the twenty-two question types. Question types with the greatest differences in percentages for high and low students were entered into the analysis to determine if significant differences existed among groups (See Figures 1 and 2). These analyses were performed as a means of confirming the results of the conceptual analyses.

% OF QUEST. PER Q-TYPE FOR CONTINUOUS



% OF QUEST. PER Q-TYPE FOR DISCRETE



Continuous task - high knowledge students. In the first of these analyses, three question types, management (MANG), teacher-like (TCHR), and self (SELF) questions, were identified as potentially discriminating high students from their average and low counterparts on the continuous task. An analysis of variance shows a significant main effect for group, $F(2, 44) = 10.05$, $p < .01$. Post-hoc linear contrasts using the Scheffe procedure reveal that, on the continuous task, high students asked significantly more management, teacher-like, and self questions than low students ($F(2, 44) = 19.62$, $p < .05$) and average students ($F(2, 44) = 6.93$, $p < .05$). These results support the hypothesis that high students, in comparison to low students, would ask more management and self questions. No significant differences between low and average students were found for these question types. A significant main effect of question type was also found ($F(2, 88) = 11.04$, $p < .001$). Post-hoc linear contrasts with the Scheffe procedure indicate that, across knowledge groups, students asked significantly more management questions than teacher-like questions ($F(2, 88) = 17.22$, $p < .05$) and self questions ($F(2, 88) = 16.41$, $p < .05$).

Discrete task - high knowledge students. A similar analysis for the types of questions asked by high knowledge students was conducted for the discrete task. However, the percentage analysis indicated that different question types might distinguish high and low knowledge students. These question types included vocabulary (VCAB), teacher-like (TCHR), and self (SELF) questions, requests for explanations (REQD), and requests for confirmation of one's own answer (CNOA). The results of the analysis of variance indicate a significant main effect for group, $F(2, 44) = 5.6$, $p < .007$. Post-hoc linear contrasts with the Scheffe procedure reveal that high students asked significantly more vocabulary, confirmation of own answer, teacher-like, self, and explanation questions than low students, $F(2, 44) = 10.82$,

$p < .05$. Contrasts between high and average students and average and low students were not significant. Also, interactions or an effect for question type were not found. These results support the hypothesis that high general mathematics knowledge students would ask more self questions than low students.

Continuous task - low knowledge students. Another set of analyses was performed for question types that appeared to differentiate low students from their peers. For the continuous task, low students were identified as making requests for answers (ANSR), processes (PRCS), confirmation of another student's answer (CNAN), confirmation of one's own answer (CNOA), and asking questions that reflected a lack of understanding of another's statement (LUOS). Significant main effects for group, $F(2, 44) = 6.02$, $p < .01$, and question type, $F(4, 176) = 5.66$, $p < .01$, were found in the analysis of variance. Post-hoc Scheffe contrasts comparing the performance of low and high students indicate that low students asked significantly more answer, process, confirmation of another's answer, and lack of understanding of another's statement questions than high students, $F(2, 44) = 10.84$, $p < .05$. An additional finding was that average students, in comparison to high students, asked significantly more of these types of questions, $F(2, 44) = 6.56$, $p < .05$. Post-hoc contrasts using the Scheffe procedure demonstrate that students, across knowledge groups, asked for answers more frequently than they asked lack of understanding questions ($F(4, 176) = 16$, $p < .05$) or confirmation of another's answer questions ($F(4, 176) = 16$, $p < .05$).

Discrete task - low knowledge students. A second percentage analysis was performed for question types that seemed to differentiate low students on the discrete task. Five question types were identified: requests for answers (ANSR), requests for processes (PRCS), confirmation of another's answer (CNAN), and questions that indicated a lack of understanding of another's statements (LUOS) and a lack of understanding of task problems (LUTP). A significant main effect of group was revealed ($F(2, 44) = 4.62$, $p < .02$). Post-hoc linear contrasts with the Scheffe procedure were significant for low versus high students ($F(2, 44) = 9.18$, $p < .05$). As hypothesized, low students asked significantly more answer and lack of understanding of another's statement questions than their high peers. Compared to high students, low knowledge students also made significantly more requests for processes and confirmation of another's answer. Post-hoc Scheffe contrasts comparing low and average students were not significant which indicates that, overall, low and average students' questioning performances for these question types did not significantly differ. No effect for question type and no interactions were evident for both knowledge variables.

Nelson-LeGall Question Type Analyses

The final question type analyses were performed by categorizing the study's question types as either instrumental or executive (Nelson-LeGall, 1981). Because twelve of the study's question types could not be readily classified into either category, only ten question types were included in the analysis. The executive category is comprised of the answer, confirmation of another's answer, request for meaning, general request for help, and vocabulary question types. Requests for processes, explanations, general procedures, information, and management questions are included in the instrumental category. Although a main effect for group was not found, a significant Group x Question Type interaction was evident, $F(2, 44) = 7.41$, $p < .01$. Simple interaction effect calculations reveal that high and average students asked significantly more instrumental than executive questions, high students $F(1, 44) = 28.83$, $p < .05$, average students $F(1, 44) = 6.64$, $p < .05$. In contrast, low students asked similar numbers of executive and instrumental questions. These findings confirm the hypotheses that high and average students would ask greater numbers of instrumental than executive questions, whereas low students would not show a preference for instrumental questions.

A similar analysis was performed under the discrete task condition. However, no significant results were obtained for any of the variables. The results of these analyses and the ones performed for the continuous task condition suggest that Nelson-LeGall's two question categories may not be sensitive enough to identify subtle differences between the questioning behaviors of low, average, and high knowledge students.

Discussion

The Effect of Knowledge on Question Frequency

Prior to examining the qualitative differences in students questions, it was important to investigate whether or not differences existed in the numbers of questions asked by low, average, and high students. Based on the findings of help-seeking studies, it was hypothesized that low general mathematics knowledge students would ask more questions than high students who, in turn, would ask more questions than average students. Interestingly, the results of the study did not support this hypothesis; no significant differences were found between the numbers of questions asked by low, average, and high general mathematics knowledge students. These results differ from the findings of help-seeking studies which indicated that average students in mathematics sought less help from their peers than low and high ability students (Nelson-LeGall, 1987; Nelson-LeGall, DeCooke, & Jones, 1989; Nelson-LeGall & Glor-Scheib, 1985). The present study's findings also contradict those of adult help-seeking studies (Karabenick & Knapp, 1988; Newman & Goldin, 1990) which found that low achievers made fewer help-seeking requests than average and high achievers.

An explanation for the present study's contradictory findings may be found in the way in which questions were categorized. By including question types that were not exclusively help-seeking requests, this study utilized a more expansive question categorization scheme than presently exists in the help-seeking literature. Thus, differences in the overall number of requests made per general mathematics knowledge group may not have been evident given the greater number of question types that were examined in this study. The fact that low students in the present study were more like average students in other populations may also explain why significant differences between groups were not evident. Perhaps because students in the present study were "relatively low" in comparison to their average and high peers, the frequency with which they asked questions did not differ from their average and high peers.

Nevertheless, the finding that low, average, and high achievers ask similar numbers of questions is important because it indicates that differences in performance cannot be explained by the number of questions students asked. Rather, it appears to be the type and **quality** of students' questions that differentiates low, average and high knowledge students.

The Effects of Knowledge on Question Type

The results of the present study indicate that the types of questions students asked each other were differentially affected by their level of general mathematics knowledge. In addition, the type of task interacted with knowledge group to affect questioning performance. Results are discussed below by knowledge group.

High Knowledge Students

While solving both continuous and discrete problems, high general mathematics knowledge students asked significantly more teacher-like and self questions than low students. As expected, high knowledge students, across tasks, assumed a teaching role with their peers. Through teacher-like questions, high students helped to facilitate low and average students' ability to arrive at answers. These results confirm the findings of cooperative learning and social interaction studies (Perlmutter et al., 1989; Swing & Peterson, 1982; Webb, 1980, 1982a, 1984) which demonstrated that high knowledge students offered explanations and gave assistance to their lower ability peers when working in small heterogeneous groups. In addition, this study's findings also concur with results from memory studies which concluded that a well developed knowledge base facilitates more sophisticated strategy use (Ornstein & Naus, 1985; Tarkin, Myers, & Ornstein, 1985). Finally, the results of expert/novice studies (Chi, Bassok, Lewis, Reimann, 1987; Voss, Greene, et al., 1983) which demonstrated that students high in conceptual knowledge (e.g., experts) engage in self-questioning to determine their weaknesses before selecting problem solving strategies are confirmed by this study's findings for high knowledge students.

Task effects were evident for other question types. High knowledge students asked significantly more management questions than their peers on the continuous task, but not on the discrete task. It was expected that high students would ask more management questions than their peers because research on the effects of social-cognitive interaction (Perlmutter et al., 1989) indicated that more capable students managed the group's problem solving attempts by setting goals, delegating responsibilities, and prioritizing. Nevertheless, this did not occur on the discrete task. The implications of task differences for strategy selection and high students' overall questioning behavior on the discrete task may explain this contradictory finding.

Research in fraction problem solving has suggested that students access different problem solving schemata when solving continuous and discrete fraction problems (Behr et al., 1988; Hiebert & Tonnessen, 1978; Nik Pa, 1989). Nik Pa (1989) argues that these problem specific cognitive schemes influence strategy selection; that is, students select qualitatively different strategies to solve discrete and continuous problems because of the schemata that are activated. These findings imply that students in the present study asked different types of questions because of the problem solving processes that were accessed.

An analysis of high knowledge students' overall questioning behaviors on the discrete task lends further support to the hypothesis that students asked qualitatively different questions on each task because task specific cognitive schemes were employed. An examination of the frequencies for particular question types reveals that high students frequently asked their peers for confirmation of their own answers, a questioning behavior which did not occur on the continuous task. Since high knowledge students asked more confirmation questions, they appeared less confident about their responses for discrete problems. It can be hypothesized that because high students were unsure of the accuracy of their responses for discrete problems, they had less time to manage the problem solving activities of the group through the use of management questions.

Low Knowledge Students

Low knowledge students performed similarly across tasks. Compared to high students, low knowledge students requested more answers, processes, and confirmation of another's answer. Furthermore, low students asked more questions reflecting a lack of understanding of another's statement or of the task. Differences between low and high students in the number of requests for answers confirm the findings of the help-seeking research (Nelson-

LeGall et al., 1983) which indicated that low students failed to seek the type of help (e.g. or ask the type of question) that is most conducive to learning. Findings from the help-seeking literature are further supported by the present study's results which demonstrated that low general mathematics knowledge students did not show the preference for asking instrumental or explanation type questions as was true for high and average students. Instead, low students made more executive requests or requests for answers.

Average Knowledge Students

Since the help-seeking and cooperative learning literatures were not definitive with regard to the types of questions average students asked, few specific predictions were made. Overall, the results of the present study indicate that the questioning performances of average students vacillated between what was expected for high and low students.

On the continuous task average students asked fewer "hi-level" and "help-manage" questions than their high peers, but asked more of these types of questions than their low peers. This finding is unsurprising given the fact that in the classroom average students, by definition, tend to perform at levels intermediate between high and low students. While solving discrete problems, average students asked the same number of help-manage and explanation questions as their high and low peers. The implications of this finding is that average students appeared to be capable of managing problem solving activities and asking for explanations of problem solving processes. The present study also demonstrated that average knowledge students asked significantly more instrumental (requests for hints and explanations) than executive type questions (requests for answers) on the continuous task. This same result was found for high students, but not for low students. This finding implies that average students were capable of asking "higher-level" questions.

Nevertheless, on both tasks average general mathematics students often performed like low knowledge students by asking for answers, confirmation of another's answer, and lack of understanding questions. Although the means of the average students for each analysis of these question types were lower than the low students' means, differences were not significant. Thus, even though average students demonstrated that they were capable of asking "higher level" questions, they tended to ask "lower level" ones.

Results from studies in help-seeking and cooperative learning may help to explain the present study's findings for average students. Nelson-LeGall and Glor-Scheib (1985) and Dembo and McAuliffe (1987) found that in mathematics classes average students were less successful in their attempts to seek help from peers. It can be hypothesized that if average students' initial explanation or process questions were ignored, they might have resorted to asking for answers, directed their requests to teachers, or stopped asking questions altogether. In fact, Nelson-LeGall and Glor-Scheib (1985) found that although all students generally requested help more often from peers than from teachers, average-ability students were more likely than other students to seek help from teachers. It should be noted, however, that a sequential analysis of the types of questions asked by average students and the recipients of these requests is needed to confirm these hypotheses.

An alternative explanation may be that the heterogeneity of the cooperative groups influenced the questioning performance of average students. Webb (1980, 1982b, 1984) found that cooperative groups including three levels of ability put average students at a disadvantage. In these groups, high and low students assumed teacher-student roles respectively and average students tended to be left out of interactions. Webb (1984) also found that average students performed best in narrow range heterogeneous groups with high and medium-ability students or medium and low-ability students. Given these findings, average knowledge students might have asked "lower level" questions because the composition of the group precluded them from participation in interactions with high students who frequently assumed a teacher role. This contention is supported by Nelson-LeGall and Glor-Scheib's (1985) study which suggested that average students' "overreliance on adults may detract from students's positive interactions with peers" (p. 69). As a result, average students may experience social and academic isolation in small work groups which negatively impacts their performance (Nelson-LeGall & Glor-Scheib, 1985; Webb, 1980).

Type of Task

The type of task not only interacted with students' knowledge to affect the kinds of questions that were asked, but also affected the overall number of requests students made. The results of the study demonstrated that students asked fewer questions on the discrete task than on the continuous task. Why did students ask fewer questions on the discrete task? Was the discrete task easier than the continuous task? An examination of the types of questions asked by students on each task suggests that task difficulty may not be the issue.

Across knowledge groups, students did not request more answers on either the continuous or the discrete task. Nevertheless, when solving discrete problems, students did ask more vocabulary questions and questions that reflected a lack of understanding of task problems. Additionally, on the discrete task, students also tended to act as teachers more frequently than on the continuous task. On the other hand, when working on continuous problems, students made more requests for confirmation of processes and requests for the meaning of math symbols or fraction tiles. Students also asked more management questions on the continuous task than on the discrete task. All of these results demonstrate that students asked qualitatively different types of questions depending upon which task they were working.

Given these results, it can be hypothesized that the type of task affected the problem solving processes used by students. As mentioned previously, a number of researchers (Behr et al., 1988; Hiebert & Tonnessen, 1978; Hunting, 1986; Nik Pa, 1989) argue that solving continuous and discrete model problems requires different cognitive "schemes" which have implications for strategy selection. When kindergarten and first-grade students were asked to represent fractions such as 1/2, 1/3, 1/4, and 1/5 by dividing an area (e.g. a circle) or sharing a set of objects, Hiebert and Tonnessen (1978) found that students performed significantly better on discrete fraction problems than on continuous ones. They explained this finding by stating that solutions of continuous quantity tasks required well-developed anticipatory schemes in which students had to determine an answer before partitioning the region into equal parts. In contrast, discrete quantity problems could be solved by employing a counting strategy; thus, an anticipatory scheme for a final solution was unnecessary. Hiebert and Tonnessen (1978) remarked that the strategies for solving the discrete problems were markedly different from those employed on the continuous quantity task.

If these findings are applied to the present study, one can hypothesize that the type of problem activated different cognitive schemes which in turn affected the number and types of questions (e.g., strategies) students asked. For example, on the discrete task, since several problems could have been solved by counting, students might not have needed to ask questions which would have reduced the overall number of questions asked for the discrete task.

Other discrete quantity problems in the study did require students to use one set of objects to represent several fractions (e.g., 3/4 and 9/12), to compare fraction representations, and to use ratios to solve problems. Schuerger and Burke (1977) and Mitchell and Blume (1977) found that a lack of experience with discrete contexts made it difficult for students to divide a set of objects into thirds and fourths. Mitchell and Blume (1977) noticed that students incorrectly represented fractions for discrete problems because they formed groups that had the cardinality of the denominator of the given fraction. Thus, students overgeneralized their strategy knowledge of how to solve continuous problems, which requires an association between the denominator of a fraction and the number of units, to discrete contexts. Since a number of discrete problems in this study could not be readily solved with counting strategies and required students to construct multiple representations of sets of objects, it can be hypothesized that students asked more questions indicating "a lack of understanding of task problems" than on the continuous task. Moreover, high knowledge students assumed a teaching role by asking more teacher-like questions on the discrete task because other students experienced difficulty understanding the task problems. Finally, students probably made more requests for vocabulary information because ratio problems were included in the discrete task.

For continuous quantity problems, although the "whole" is defined by the given region, students needed to be aware of the relationships between the parts and the whole. Hunting and Korbosky (1984) analyzed two groups of 9 and 10 year old students' solution processes for fraction problems. Students received instruction based on either the continuous or discrete model. They found that students in the continuous group displayed unstable strategies for determining the sizes of units of fractions. The implications of these findings for this study are that students probably made more requests for confirmation of processes and requests for the meaning of fraction tiles because it was difficult for them to determine the size of each part and how to equally partition a continuous region, especially when students were asked to construct representations of equivalent fractions. Additionally, it is likely that students asked more management questions because greater coordination of group problem solving processes with the fraction tiles was needed for continuous problems.

Although fraction studies (Hiebert & Tonnessen, 1978; Hunting & Korbosky, 1984; Mitchell & Blume, 1977; Nik Pa, 1989; Schuerger & Burke, 1977) have highlighted the effects of task on students' problem solving performance, the variability in students' questioning performance due to task manipulations has not been directly examined. As a means of interpreting the study's findings, the results of studies investigating the larger scale effects of task on students' performance may be examined. For instance, studies in memory (Bjorkland & Bernholtz, 1986; DeLoache, 1980; DeLoache, Cassidy, & Brown, 1985; Shantz, 1978) demonstrate that the nature of the task affected students' memory performance.

DeLoache, Cassidy, & Brown (1985) found that one and a half and two year old students utilized sophisticated rehearsal and monitoring strategies which improved their memory performance when they were given a task that was carefully matched to their cognitive capabilities. Prior to this research, it was believed that young students were incapable of utilizing these strategies. The authors argued that students' performance improved because the demands of the task were suited to the youngsters. Additionally, DeLoache et al. (1985) claim that the task demands and the type of setting (in this case, familiar or unfamiliar) interacted to affect the students' strategic performance.

Bjorkland and Bernholtz (1986) found that students' recall of a list of typical and atypical items depended on their prior knowledge and the type of task. When students were asked to recall items from a self-generated list of typical and atypical items, good and poor readers performed similarly. Good readers outperformed poor readers in their recall of a list of atypical and typical items identified by adults. These results indicate that the characteristics of the task affected students' memory performance. These findings highlight the importance of task effects on students' performance by suggesting that the relative comparability of cognitive and task structures is closely related to students' strategic performance.

The implications of these research findings for the present study is that the type of task would be expected to affect students "strategic" questioning behavior. The results of the study support this contention; students' knowledge interacted with the type of task to produce quantitatively and qualitatively different questions.

Overall, the results of the present study underscore the need to use caution in choosing a single task to investigate students' questions since the type of task used interacts with student characteristics and the setting to affect performance. Thus, it is important to include different tasks or graded levels of a task (e.g., easy and difficult) to examine the nuances in students' questioning performance. Peverly (1991) contends "the use of single tasks can result in the significant underestimation and/or overestimation of the nature of skills ... (of students) in certain situations. To compensate for this, subjects might be compared on different tasks from the same domain" (pp. 74-75).

It is important to mention that the task and knowledge variables interacted with the setting, a cooperative learning group, to affect students' peer-directed questions. The fact that students had prior experience working in heterogenous cooperative learning groups and had been encouraged throughout their schooling to work with peers in problem solving situations has implications for their questioning performance. Butler and Keder (1990), for example, investigated the group problem solving strategies of students from a traditional-competitive school and those from a school which emphasized cooperative values and activities. They found that students in the cooperative school were more likely to adopt collaborative problem solving strategies, whereas students from the traditional school utilized individual-competitive strategies. The authors contended that students' prior socialization impacted their group behaviors. The implications of these findings for students who participated in the present study is that their prior experience with cooperative learning groups affected their problem solving and questioning performance. In a traditional school environment, students may have directed fewer requests to their peers and may have asked different types of questions.

Future Research

Given the finding that low and high students ask qualitatively different questions, it is important to investigate the effect of these questions on students' achievement. The results of help-seeking and cooperative learning studies (Nelson-LeGall, 1986; Nelson-LeGall, Gumerman, & Scott-Jones, 1983; Webb, 1982a) suggest that instrumental help-seeking and offering explanations improved students' overall performance. However, future research needs to specify which types of questions lead to increases in achievement.

Further research is also needed to refine the question categorization scheme utilized in the study. Distinct categories of questions for low, average, and high students could be devised to help determine whether the linguistic features of the question or its specificity are related to student performance. Sociolinguistic studies (Wilkinson & Calculator, 1982; Wilkinson, Lindow, & Chiang, 1985) suggest that direct, specific, on-task questions are used by effective communicators. Combining the question categories used in this study with those from the sociolinguistic literature may help to distinguish other aspects of students' questioning performance that differentiate low, average, and high students. In addition, it is important to extend the study to a wider range of age levels (e.g., first through sixth graders) to examine the development of question-asking behaviors among peers. This information could be used to refine and extend the study's question categorization scheme.

Educational Implications

The results of the study demonstrate that task manipulations affected the types of questions students asked. One may hypothesize that students' achievement would also be affected. Thus, educators need to be cognizant of performance differences on particular types of tasks in mathematics, specifically on different types of fraction problems. When teaching fractions, instructors should expect that students will ask qualitatively different types of questions.

The results of this study further suggest that students can be effective teachers for their peers. Educators who espouse cooperative learning methods should encourage students to assume a teaching role by prompting other with questions, explaining concepts and procedures, and modelling processes which are behaviors that have been linked to higher achievement. Additionally, research (King, 1990) has demonstrated that teaching students to reciprocally question their peers in small groups led to increases in understanding and performance. Although King's study was conducted with undergraduates, this technique may be useful to use with elementary school students to promote the positive effects of peer-directed teaching.

Finally, the present study confirms the findings in the cooperative learning literature which demonstrated that cooperative learning methods are appropriate for mathematics classes (Davidson, 1985; Slavin, 1983, 1985). The present study extends these findings by suggesting that students who have had prior experience with cooperative work groups do not necessarily need specific rewards for collaborative problem solving to occur. To summarize, the results of the present study demonstrate that students' peer-directed questions in cooperative work groups are affected by their general mathematics knowledge and the type of task. Future research is needed to clarify the effects of these variables on student achievement. Nevertheless, educators need to be aware of the effects of these variables when examining student performance.

References

Alexander, P. A., & Judy, J. E. (1988). The interaction of domain-specific and strategic knowledge in academic performance. Review of Educational Research, 58 (4), 375-404.

Behr, M. J., Lesh, R., Post, T. R., & Silver, E. A. (1983). Rational number concepts. In R. Lesh & M. Landau (Eds.), Acquisition of mathematics concepts and processes (pp. 92-126). New York: Academic Press.

Behr, M. J., Wachsmuth, I., & Post, T. R. (1985). Construct a sum: A measure of children's understanding of fraction size. Journal for Research in Mathematics Education, 16 (2), 120-131.

Behr, M. J., Wachsmuth, I., & Post, T. R. (1988). Rational number learning aids: Transfer from continuous models to discrete models. Focus on Learning Problems in Mathematics, 10 (4), 1-18.

Behr, M. J., Wachsmuth, I., Post, T. R., & Lesh, R. (1984). Order and equivalence of rational numbers: A clinical teaching experiment. Journal for Research in Mathematics Education, 15 (5), 323-341.

Berman, B., & Friederwitzer, F. J. (1983). Teaching fractions without numbers. School Science and Mathematics, 83 (1), 77-82.

Blosser, P. E. (1973). Handbook of effective questioning techniques. Worthington, Ohio: Education Association.

Bjorkland, D. F. & Bernholtz, J. E. (1986). The role of knowledge base in the memory performance of good and poor readers. Journal of Experimental Child Psychology, 41, 367-393.

Butler, R. & Kedar, A. (1990). Effects of intergroup competition and school philosophy on student perceptions, group processes, and performance. Contemporary Educational Psychology, 15, 301-318.

Chi, M. T. H., Bassok, M., Lewis, M. W., Reimann, P., & Glaser, R. (1987). Self-explanations: How students study and use examples in learning to solve problems (Tech. Rep. No. 9). Pittsburgh, PA: Learning Research and Development Center, University of Pittsburgh.

Christian, D. & Tripp, R. (1978). Teachers' perceptions and children's language use. In Children's functional language and education in the early years. Final Report to Carnegie Corporation.

Cooper, C. R., Marquis, A., & Ayers-Lopez, S. (1982). Peer learning in the classroom:

Tracing developmental patterns and consequences of children's spontaneous interactions. In L. Wilkinson (Ed). Communicating in the classroom (pp. 69-84). New York: Academic Press.

Davidson, N. (1985). Small-group learning and teaching in mathematics. In R. Slavin et al. (Eds.), Learning to cooperate, cooperating to learn (pp. 211-230). New York: Plenum Press.

DeLoache, J. S. (1980). Naturalistic studies of memory for object location in very young children. In M. Perlmutter (Ed.), New directions for child development: Children's memory (No. 10, pp. 17-32). San Francisco: Jossey-Bass.

DeLoache, J. S., Cassidy, D. J., & Brown, A. L. (1985). Precursors of mnemonic strategies in very young children's memory. Child Development, 56, 125-137.

Dembo, M. H., & McAuliffe, T. J. (1987). Effects of perceived ability and grade status on social interaction and influence in cooperative groups. Journal of Educational Psychology, 79 (4), 415-423.

Dillon, J. T. (1982). The multidisciplinary study of questioning. Journal of Educational Psychology, 74 (2), 147-165.

Driscoll, M. (1984). What research says. Arithmetic Teacher, 31 (6), 34-36, 46.

Edwards, C., & Lewis, M. (1979). Young children's concepts of social relations: Social functions and social objects. In M. Lewis & L. Rosenblum (Eds.), The child and its family. New York: Plenum.

Fahey, G. L. (1942). The questioning activity of children. Journal of Genetic Psychology, 60, 337-357.

Gall, M. D. (1970). The use of questions in teaching. Review of Educational Research, 40, 707-721.

Gay, G. (1986). Interaction of learner control and prior understanding in computer-assisted video instruction. Journal of Educational Psychology, 78, 225-227.

Good, T. L., Slavings, R. L., Harel, K., & Emerson, H. (1987). Student passivity: A study of question asking in K-12 classrooms. Sociology of Education, 60, 181-199.

Hiebert, J., & Tonnessen, L. H. (1978). Development of the fraction concept in two physical contexts: An exploratory investigation. Journal for Research in Mathematics Education, 9, 374-378.

Hunting, R. P. (1986). Rachel's schemes for constructing fraction knowledge. Educational Studies in Mathematics, 17, 49-66.

Hunting, R. P., & Korbosky, R. K. (1984). Continuous versus discrete quantity contexts for learning fractions. Final report to the Academic Staff Development Committee, Division of Arts, Education, and Social Science, Western Australian Institute of Technology.

Jenkins, L., & McLean, P. (1985). A manipulative fraction program: Fraction tiles. Hayward, CA: Activity Resources Co.

Karabenick, S. A., & Knapp, J. R. (1988). Help seeking and the need for academic assistance. ' urnal of Educational Psychology, 80 (3), 406-408.

Kieren, T. E. (1975 . On the mathematical, cognitive, and instructional foundations of rational numbers. In R. Lesh (Ed.), Number and measurement: Papers from a research workshop (pp. 101-144). Columbus, OH: ERIC/SMEAC.

Kieren, T. E. (1980). The rational number construct-its elements and mechanisms. In T. E. Kieren (Ed.), Recent research on number learning (pp. 125-149). Columbus, OH: ERIC/AMEAC.

King, A. (1990). Enhancing peer interaction and learning in the classroom through reciprocal questioning. American Educational Research Journal, 27 (4), 664-687.

Lesh, R., & Hamilton, E. (1981). The rational number project testing program. Paper presented at the American Educational Research Association Annual Meeting, Los Angeles, CA, April.

McBride, J. W., & Lamb, C. E. (1986). Using concrete materials to teach basic fraction concepts. School Science and Mathematics, 86 (6), 480-488.

Merwin, W. C., & Schneider, D. O. (1973). The use of self instructional modules in the training of social studies teachers to employ higher cognitive level questioning strategies. Journal of Educational Research, 67, 13-18.

Mitchell, C. & Blume, G. (1977). A preliminary investigation of the use of a game to identify children's use of language relevant to fractions and children's knowledge of the concept of fractions. In M. Burke, N. Hiber, & T. Romberg. The teaching of initial fraction concepts. Wisconsin R & D Center for Cognitive Learning Working Paper N. 218. Madison: The University of Wisconsin.

Nelson-LeGall, S. (1981). Help-seeking: an understudied problem-solving skill in children. Developmental Review, 1, 224-246.

Nelson-LeGall, S. (1986). Help-seeking behavior in learning. In E. W. Gordon (Ed.), Review of Research in Education, (Vol. 12, pp. 55-90). Washington, DC: American Educational Research Association.

Nelson-LeGall, S. (1987). Nece ary and unnecessary help-seeking in children. Journal of Genetic Psychology, 148, 53-62.

Nelson-LeGall, S., DeCooke, P. A., & Jones, E. (1989). Children's self-perceptions of competence and help seeking. Journal of Genetic Psychology, 150 (4), 457-459.

Nelson-LeGall, S., & Glor-Scheib, S. (1985). Help seeking in elementary classrooms: An observational study. Contemporary Educational Psychology, 10, 58-71.

Nelson-LeGall, S., & Glor-Scheib, S. (1986). Academic help-seeking and peer relations in school. Contemporary Educational Psychology, 11, 187-193.

Nelson-LeGall, S., & Gumerman, R. (1984). Children's perceptions of helpers and helper motivation. Journal of Applied Developmental Psychology, 5, 1-12.

Nelson-LeGall, S., Gumerman, R., & Scott-Jones, D. (1983). Instrumental help-seeking and everyday problem-solving: A developmental perspective. In B. DePaulo, A. Nadler, & J. Fisher (Eds.), New directions in helping: Vol. 2. help-seeking (pp. 265-283). New York: Academic Press.

Newman, R. S. (1990). Children's help-seeking in the classroom: The role of motivational factors and attitudes. Review of Educational Psychology, 82 (1), 71-80.

Newman, R. S., & Goldin, L. (1990). Children's reluctance to seek help with schoolwork. Journal of Educational Psychology, 82, 92-100.

Nik Pa, N. A. (1989). Research on children's conceptions of fractions. Focus on Learning Problems in Mathematics, 11 (3), 3-25.

Ohlsson, S. (1988). Mathematical meaning and applicational meaning in the semantics of fractions and related concepts. In J. Hiebert & M. Behr (Eds.), Number concepts and operations in the middle grades, (Vol. 2). Hillsdale, NJ: Lawrence Erlbaum Assoc.

Olmo, B. G. (1975). Teaching students to ask questions. Language Arts, 2, 1116-1119.

Ornstein, P. A., & Naus, M. J. (1985). Effects of the knowledge base on children's memory strategies. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 19, pp. 113-148). New York: Academic Press.

Payne, J. N. (1976). Review of research on fractions. In R. A. Lesh & D. A. Bradbard (Eds.), Number and measurement: Papers from a research workshop (pp. 145-188). Columbus, OH: ERIC Information Analysis Center for Science, Mathematics and Environmental Education.

Perlmutter, M., Behrend, S. D., Kuo, F., & Muller, A. (1989). Social influences on children's problem solving. Developmental Psychology, 25 (5), 744-754.

Peverly, S. T. (1991). Problems with the knowledge-based explanation of memory and development. Review of Educational Research, 61 (1), /1-93.

Sadker, M., & Cooper, J. (1974). Increasing student higher-order questions. Elementary English, 51, 502-507.

Schauble, L. (1990). Belief revision in children: The role of prior knowledge and strategies for generating evidence. Journal of Experimental Child Psychology, 49, 31-57.

Schuerger, M. A., & Burke, M. (1977). Children's ability to recognize certain fractional partitionings of wholes using set and region interpretations. In M. Burke, N. Hiber, & T. Romberg (Eds.), The teaching of initial fraction concepts. Wisconsin R & D Center for Cognitive Learning Working Paper No. 218. Madison: The University of Wisconsin.

Shantz, M. (1978). The relationship between cognitive processes and the development of communication skills. In B. Keasey (Ed.), Nebraska symposium on motivation (pp. 1-42). Lincoln: University of Nebraska Press.

Slavin, R. (1983). Cooperative learning. New York: Longman.

Slavin, R. (1985). Team-assisted individualization: Combining cooperative learning and individualized instruction in mathematics. In R. Slavin et al. (Eds.), Learning to cooperate, cooperating to learn (pp.177-209). New York: Plenum Press.

Swing, S. R. & Peterson, P. L. (1982). The relationship of student ability and small-group interaction to student achievement. American Educational Research Journal, 19 (2), 259-274.

Tarkin, B., Myers, N. A., & Ornstein, P. A. (1985). The effects of stimulus meaningfulness on children's spontaneous rehearsal strategies. Unpublished manuscript.

van der Meij, H. (1988). Constraints on question asking in classrooms. Journal of Educational Psychology, 80 (3), 401-405.

Voss, J. F., Greene, T. R., Post, T. A., & Penner, B. C. (1983). Problem solving skill in the social sciences. In G. Bower (Ed.), The psychology of learning and motivation (Vol. 17, pp. 165-213). New York: Academic Press.

Vygotsky, L. S. (1978). Mind in society. Cambridge, MA: Harvard University Press.

Webb, N. M. (1980). Group processes and learning in an interacting group. Quarterly Newsletter of the Laboratory of Comparative Human Cognition, 2, 10-15.

Webb, N. M. (1982a). Group composition, group interaction, and achievement in cooperative small groups. Journal of Educational Psychology, 74 (5), 475-484.

Webb, N. M. (1982b). Peer interaction and learning in cooperative small groups. Journal of Educational Psychology, 74 (5), 642-655.

Webb, N. M. (1983). Predicting learning from student interaction: Defining the interaction variables. Educational Psychologist, 18 (1) 33-41.

Webb, N. M. (1984). Stability of small group interaction and achievement over time. Journal of Educational Psychology, 76 (2), 211-224.

Weiner, B., Russell, D., & Lerman, D. (1978). Affective consequences of causal ascriptions. In J. H. Harvey, W. J. Ickes, & R. F. Kidd (Eds.), New directions in attribution research (Vol. 2,pp. 59-88). Hillsdale, NJ: Erlbaum.

Weiner, B., Russell, D., & Lerman, D. (1979). The cognition-emotion process in achievement-related contexts. Journal of Personality and Social Psychology, 37, 1211-1220.

Wilkinson, L. C., & Calculator, S. (1982). Requests and responses in peer-directed reading groups. American Educational Research Journal, 19 (1), 107-120.

Wilkinson, L. C., Lindow, J., & Chiang, C. (1985). Sex differences and sex-segregation in students' small-group communication. In. L.C. Wilkinson, & C. B. Marrett (Eds.), Gender influences in classroom interaction (pp. 185-207). Orlando, FL: Academic Press, Inc.

Winer, B. J. (1962). Statistical Principles in Experimental Design. New York: McGraw-Hill.