GROUP SIZE, GROUP STRUCTURE AND STUDENT INTERACTION IN CHILDREN'S
COMPUTER LEARNING

by

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(ABSTRACT)

The achievement of students who participated in a computer-assisted instruction unit on social studies directionality skills was examined in relation to group size. Also analyzed were students' interaction in small groups and the structure of those groups.

Sixty-six second-grade students in solo, pair, or triad treatment conditions were given a pretest and equivalent-form posttest. The computer task concerned cardinal and intermediate directions, which students applied in a computer tic-tactoe game.

Interaction among the students was recorded by audiotape and observer notes. The coding protocol contained the four major categories: giving help, receiving no explanations, receiving explanations, and procedural assistance. Verbatim records of twenty-five randomly chosen students were coded, tallied, and analyzed. For students in pairs or triads (n=55), group structure was analyzed for cooperation, competition, dominance, "odd-man
out" phenomenon, and how the group developed over time.

Students made significant gains in their social studies knowledge. Analysis of covariance, with the pretest as the covariate, showed no significant relationship between achievement and group size; achievement and sex; or achievement and ability. For triads, but not for pairs, students in mixed-ability groups had significantly greater gains in achievement than students in uniform-ability groups; this is consistent with prior research.

Procedural help was the most frequent type of student interaction. There was no significant relationship between achievement and any of the four major categories of interaction. This is in contrast to the work of Webb (1982a, 1982b, 1982c, 1983, 1985). Because these students were much younger, they probably could not generate effective explanations.

Of the twenty-two groups, sixteen were characterized by cooperation and three by competition. Neither ability nor sex was related to cooperation. Ability had no bearing on competition, but boys were more likely to compete. Cooperative interaction was least at the beginning of the session, increased during the middle, and slightly decreased at the end of the computer session.

Administrators can utilize the conclusion that
students learned in small groups equally as well as when they were alone. Small groups were useful for C.A.I. in that students mastered the content, appeared motivated, and participated actively.
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CHAPTER ONE
INTRODUCTION

For many years, educators have been trying out the use of small groups for classroom learning. Positive results for cooperative learning in groups have been reported on both cognitive and affective aspects of learning.

The introduction of the computer into the classroom has made the work related to instructional groups even more relevant since, in many instances, more than one student at a time must access a terminal.

Need for the Study

The need for the study can be explained by a brief synopsis of work done in three fields of study: (a) small group learning, (b) computer-assisted instruction, and (c) certain variables of individual differences. A more detailed review of literature will be presented in chapter two of the dissertation.

Cooperative Small Group Learning

Researchers have looked at how small group cooperative
learning has affected achievement (Sharan, 1980; Slavin, 1980). For almost all types of tasks, cooperative small group learning proved more successful than traditional, competitive-type learning (Johnson & Johnson, 1978).

Recently, researchers have been exploring exactly what makes cooperative learning more successful (Johnson & Johnson, 1985). That is, they have been trying to pinpoint what ingredient makes learning more likely to occur. Students in small groups are more likely to interact than students who are in large classroom groups. It is the nature of the students' interaction which is significant, according to evidence which is beginning to accumulate. Most studies have found a positive relationship between giving help and achievement (Peterson & Janicki, 1979; Webb 1980). Webb (1980, 1982a, 1982b, 1982c, 1984b, 1985) found that students who seek help and receive explanations have the best achievement; she also provided the evidence that students who seek help and do not receive any assistance have the poorest achievement. There is a need to examine whether the relationship between specific types of group interaction and achievement exists when the task is computer-assisted instruction and when the population is primary elementary students.

Webb (1980, 1982a, 1982b, 1984b, 1984c) originally worked with mathematics skills. In a study of LOGO
computer learning (1985), she found that many of the relationships found in non-computer settings did not transfer to the computer setting. The present study—a social studies tutorial rather than computer programming instruction—sought to examine interaction in small groups of students learning a skill via a computer. This is a common use of the computer in the classroom but it is not discussed by Webb or other researchers in the field of small group learning.

A few studies have addressed how small groups versus individuals learn on a computer. Karweit and Livingston (1969) looked at sixth graders of high ability who played a computer game alone, in pairs, or in triads. Although there was a tendency for the boys to play the game faster than the girls, there was no statistically significant difference in the learning as measured by the posttest. Trowbridge and Durnin (1983) put seventh and eighth graders in solo, pair, triad, or quad computer learning situations. They concluded that four students in a group was not efficient. Consequently, the study done for this report utilized only solo, pair, or triad treatment conditions. It was an extension of Karweit and Livingston's early research and Trowbridge and Durnin's later research because it looked at younger children, a different lesson content, and a broader examination of the student characteristics of
ability and gender.

In a study of college students who used the computer for physics instruction, students in small groups sometimes achieved academic results which were superior to those for students in a control group. On the occasions when the students in small groups had inferior academic performance, those groups had shown a significant deterioration in social structure, as measured by a sociogram (Gerrell, 1972). The present study was designed to examine more extensively than Gerrell did the dynamics of group interaction. The amount of competition or cooperation, the patterns of leadership, and the help-seeking strategies of the group members were observed, coded, tallied, and related to achievement.

There is a need to connect the extant literature about grouping for instruction and cooperative learning with the new technology being used in classrooms across the country. Especially in light of the educational policy decisions being made about the ideal student-to-computer ratio, there is a pressing need to see which tasks are being done by which configuration of students on the computer, and how those students interact. Administrators of school policy need any information about the ideal student-to-computer ratio. Moreover, researchers in the field of cooperative small group learning will be interested to know if their
findings generalize to learning via computer-assisted instruction. There is, therefore, both a scholarly and a practical necessity for finding out about student groups for computer learning.

C.A.I.

Using meta-analysis, James Kulik and others (1980) have drawn conclusions about the achievement of secondary and college level students who used computer-assisted instruction (C.A.I.). He found that the typical student in a computer-based class scored at the 60th percentile on achievement exams, while typical conventionally-taught students scored at the 50th percentile. Burns and Boseman (1981) found (also via meta-analysis but with a smaller group of studies) that for elementary students the advantage of using C.A.I. for mathematics was even greater.

Thus, there is some data about C.A.I. in the math field and, for the most part, on the secondary and college level. There is a need to add to the body of knowledge about C.A.I. at the elementary level and in fields other than mathematics. The above-mentioned studies were also most concerned with comparing C.A.I. with conventional teaching. There is a need to see C.A.I as an adjunct to conventional instruction, not necessarily as a replacement for it; that is more in accord with how schools are
presently using it (M. Koontz, personal communication, July 21, 1984). Consequently, research which looks at C.A.I. as part of the regular instructional system—as the study reported here did—is useful. Both researchers and educators in the field are interested in this type of C.A.I. information because it more closely resembles the way computers are presently used in classrooms.

**Certain Variables of Individual Differences and Computer Learning**

As a relatively new tool for instruction, the computer offers promises and pitfalls. Educators must proceed cautiously. The more information collected about how students learn on the computer the better will be the policy making of administrators and the utilization of computers by teachers in the field. Thus, any other variables which can be analyzed for their effect on student achievement in computer learning will be helpful. Therefore, the study was designed to analyze other secondary variables beyond the major one of group size.

One of those variables was gender. An evaluation of the Stanford C.A.I. Program in Initial Reading indicated that this type of instruction was relatively more effective for boys than for girls (Fletcher & Atkinson, 1972). In two studies of computer games (Malone, 1980; Mitchell,
1983), there were differences in the achievement and attitudes of males and females. Gains made in a high school computer literacy course were also different for boys and girls (Lockheed et al., 1983). Thus, there is a continuing need to examine the variable of sex in studies of computer learning in order to broaden our understanding of whether there are sex differences in instructional settings.

Computer learning has branched out to include children of all ability levels. For example, there have been reports of successful use of computer games with brain-damaged individuals, (Lynch, 1983). Berkowitz and Szabo (1977) found significant interactions between grouping (whether the subjects were working alone or in pairs on a computer task) and ability level of the subjects. In the conventional classroom, as well, the computer must meet the needs of students who have a variety of abilities. Thus, another variable which reasonably may be included in studies of computer learning is ability.

The variables of sex, ability, age, and ethnic origin have been studied or controlled for while examining what makes learning happen in small groups. Some significant differences have been discovered in the variables of sex and ability (Lockheed & Harris, 1984; Peterson & Janicki, 1979; Peterson et al., 1981; Slavin, et al, 1985; Webb,
There is a need for further study of the influence of sex and/or ability on the achievement of students, especially younger students, who worked alone or in small groups.

Summary

There is an established need to extend the research in several fields which all touch on computer learning: cooperative small group learning, computer-assisted instruction (C.A.I.), and certain variables of individual differences which may explain or moderate students' performance while learning via a computer. The study reported addressed all three needs. The present study, grounded in the work of Webb and others, was focused on the question: What makes learning happen in small groups? It was rooted also in the timely examination of the use of computers in the classroom. The study sought to answer some specific questions about computer-assisted instruction and sought to explore in a more holistic way certain aspects of student interaction in small groups. It was designed to reveal new information useful to both researchers and school practitioners.

The major questions of interest were these:
Research Questions

In computer learning for second grade social studies...
I. What factors affect achievement?
   a. What is the relationship between group size and achievement?
   b. Are other variables important for achievement? (sex, reading ability)
   c. Is there a relationship between help-seeking strategies and achievement?
II. How do the groups function?
   1. What help-seeking strategies do students use?
      a. How frequently do students ask for help and receive help?
      b. Do students ask for help more frequently on lesson content or on how to use the computer?
      c. Is there a relationship between help-seeking strategies and group size?
   2. Are there differences in group structure for groups of two and groups of three? (factors such as leadership, conflict)
Definitions of Terms

**Achievement.** The percentage of correct answers on the posttest.

**Class.** A teacher (one of three) to which a student was assigned.

**Competition.** Interaction characterized by students seeking to gain advantage at the expense of others.

**Cooperation.** Interaction characterized by sharing the keyboard, encouraging peers to work on the task, helping peers with content or procedure difficulties, and joint problem-solving.

**Gain.** The percentage of correct answers on the posttest minus the percentage of correct answers on the pretest.

**Group Size.** Whether students access the computer terminal alone, in pairs, or in triads.

**Group Composition.** The functional reading ability levels of the members of a group.
Preferred Group Size. On a pretest or posttest, a student's answer to the question: "When working on a computer, would rather work alone, with one other person, or with two other people?"

Help-Seeking Strategies. For the purpose of this study, source of information refers to whether a student asks for help from the computer by pressing the "H" function, from the teacher/observer, or from a peer; type of task refers to whether a student asks for help on the substantive (content) aspect of the task or whether a student asks for help on the procedural (how to use the computer, how to do the task, or how to read the text) aspect of the task.

Reading Ability. For the purpose of this study, the student's reading group placement.
Limitations of the Study

This study was limited in several ways. For almost all students in the study, the computer was an exciting and novel educational tool. Thus, there was little variability in the subjects' motivation.

It should be noted that the relationships established in this study apply only to the variables as defined here and for the content similar to that examined here. The results may or may not be generalized to other types of content or populations.
CHAPTER TWO
REVIEW OF LITERATURE

The ideas for this study were grounded in the theories of two major fields of research. Thus, the literature review was divided into two major sections: (a) small group learning (which is sometimes termed cooperative or collaborative learning), and (b) computer learning.

Learning in Small Groups: Cooperative or Collaborative Learning

In the growing field of research on how students learn in small groups, two general topics were relevant to this research study: (1) defining a group, and (2) achievement and small group learning. Defining a group contained the subheadings of: (a) definition and attributes of a group, (b) group goals, and (c) how a group develops. The latter topic of achievement and small group learning included: (a) type of task, (b) student characteristics, such as ability and sex; and (c) student interaction.

Defining a Group

What Is A Group?

A collection of interacting persons who have some degree of reciprocal influence over one another
constitutes a group, according to Schmuck and Schmuck (1971). A differentiation can be made between peer work groups and teacher-led groups. The focus of the study in this report was peer work groups. Distinctions can also be made between completely cooperative groups and groups where helping is obligated or permitted or where peer tutoring is prescribed (Stodolsky, 1984).

A group's interaction can be described via five dimensions:

1. affective/non-affective. How freely do group members express the emotions involved in the interaction?

2. self-collective. Does the interaction intend to satisfy group motives or personal motives?

3. universalism/particularism. How consistently and uniformly are persons in similar roles defined by one another in the interaction?

4. achievement/ascription. How do group members gain status? For example, do they gain status by their performance or by some inherent characteristic?

5. specificity/diffuseness. How much of the interaction is focused on the content of the assigned task as opposed to focused on other subjects? (Parsons, 1951; Schmuck and Schmuck, 1971)

Group Goals

Industrial groups as well as classroom groups have
both individual/group goals and task/social goals (Schmuck and Schmuck, 1971, p.8). The more goals a group accomplishes, the more successful that group is considered to be. Sometimes there are conflicts between the different types of goals, but at other times it is possible to achieve the goals of both the individuals and the group, as well as to fulfill task and social needs. The matrix below illustrates the two dichotomies of group goals.

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<tr>
<th></th>
<th>Individual</th>
<th>Group</th>
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<tbody>
<tr>
<td><strong>Task</strong></td>
<td>Each person learns the skill.</td>
<td>All group members learn skill so they can play game together.</td>
</tr>
<tr>
<td><strong>Social-</strong></td>
<td>Each person expresses emotion, e.g. asking for help. Each person feels accepted, supported, helpful.</td>
<td>All discuss procedure (Whose turn?) Group cohesiveness &amp; sense of accomplishment (We won!).</td>
</tr>
</tbody>
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**How A Group Develops**

Although Schmuck and Schmuck (1971) address their theories mostly to large classroom groups which are extant
over a long period of time, their theories about group development can apply to small groups and groups which exist for shorter periods of time. Following are the four stages of group development identified by these researchers. These periods of group growth are not only sequential but also cyclical.

1. Inclusion and membership.
2. Establishing shared influence and collaborative decision-making.
3. Pursuing individual and academic goals.
4. Self-renewal: adapting to changes--setting new goals.

Webb (personal communication, July 29, 1985) noted that no work has been done in examining how small groups develop over time and research on this topic would be very useful.

Achievement and Small Group Learning

Researchers have examined the performance of students in small groups. Of chief interest has been whether those students showed achievement on the assigned academic tasks. Significant findings indicate that the type of task has a bearing on achievement as do such student characteristics as sex and ability. Research is beginning, also, to correlate achievement and the type of student interaction in small groups.
Type of Task

Researchers have looked at how small group cooperative learning has affected achievement. For example, Slavin categorized twenty-eight primary field projects and analyzed the differing academic achievement results. He concluded that the type of task—both the content subject and the level of cognitive processing required—needs to be matched with the type of cooperative learning and/or grouping for instruction (1980).

In the same field of study, Johnson and Johnson (1978) found that non-cooperative (competitive) learning structures promoted greater quantity of output in simple, mechanical, previously-mastered tasks. But for almost all other types of achievement, cooperative learning was more successful.

Bossert, Barnett, and Filby (1984) strongly urge that the type of task should determine what children should be assigned to what groups. That is, the size, composition, and work roles within and among groups should stem from the type of instructional task or technology.

Student Characteristics

Student characteristics have a significant impact on what occurs in small groups (Hallinan, 1984). For example, the role of student status has been cited as a significant variable in group interaction (Cohen, 1984). Thus, not only should student characteristics be controlled for in research
studies but they should be examined as part of the process of group interaction and group development over time. Two student characteristics, sex and ability, have received a significant amount of attention by researchers exploring small group interaction.

**Sex.** One status characteristic which has been shown to influence small group interaction is sex. This is true among children as young as five years of age and is true of adults (Lockheed & Harris, 1984). In a meta-analysis of 64 sets of small-group data, Lockheed and others (1983) found that men usually assumed the leadership positions in mixed-sex groups. An earlier review of research on mixed-sex discussion groups led Lockheed and Hall (1976) to conclude that, in mixed groups, men were more verbally active and more influential than women.

Recently, Webb (1984b) found that, in a study of small group mathematics learning for grades seven and eight, males had greater achievement than females even though females and males had similar ability. When inspecting the verbal interaction in the small groups, she found that nearly two-thirds of the females' requests for explanations went unanswered, whereas only one third of the males' requests for explanations went unanswered. Similarly, the females had many more unanswered procedural questions. Although the quantity of verbalizations was similar for males and
females, there was a difference between the types of verbalizations. Webb concluded that male students experienced most of the interaction that was beneficial for achievement (receiving explanations) while female students experienced most of the interaction that was detrimental for achievement (receiving no explanations).

**Ability.** The most common use of small group instruction is for reading instruction in elementary classrooms. For the most part, though, these groups are teacher-led rather than cooperative peer groups. Traditionally, these groups have been homogeneous; that is, teachers often put higher ability students in one group, medium ability students in one group, and lower ability students in a third group. A comparison of the different research studies is made difficult because precision is lacking in defining exactly what is meant by homogeneous or heterogeneous grouping (Good & Marshall, 1984). Yet observational studies provide evidence that traditional homogeneous grouping results in a poorer educational experience for lower ability students. For example, Eder (1981) found that the most immature, inattentive students were assigned to low ability groups.

Other studies have looked at homogeneous and heterogeneous cooperative peer groups. Webb (1980 & 1982b) found that students of medium ability tend to be left out of
the interaction when they are in groups which include high
and low ability students. Mixed ability groups with high-
and medium-ability students or with medium- and low-ability
students had higher achievement than uniform-ability groups
(Webb, 1982a).

Ability has been shown to relate positively to giving
explanations in small group learning (Peterson & Janicki,
1979; Peterson et al., 1981; Webb, 1982b). That is, more
able students are more likely to be able to explain part of
a lesson to their peers.

Webb and Cullinan (1983) found that the amount of
interaction in a group did not relate to the students' ability
levels. Yet, one type of interaction in a group could be predicted by the group composition: when students were all of the same ability level, it was more likely that they did not respond to their peers' questions. Students in mixed ability groups were more likely to receive responses to their questions.

**Student Interaction in Small Groups**

Over the last twenty years research has been accumulating about the relationship between small group learning and students' achievement gain. In the last five years, though, there has been a growing interest in examining the theoretical foundation for this phenomena. That is, researchers are no longer satisfied in looking only
at the end product, but have begun to develop hypotheses about the advantages and disadvantages of small group learning, and have begun to examine the actual student interaction which occurs in small groups.

One underlying idea is that debate among children about the content of a lesson spurs thought. An individual's mental processing can be enhanced by the interaction which occurs in a cooperative small group (Stodolsky, 1984).

Group Size. Trowbridge and Durnin's (1983) study of seventh and eighth graders doing a C.A.I. science task was based on the premise that small group interaction increases cognitive processing. Of students who were either alone or in groups of two, three, or four, Trowbridge and Durnin found that there was no significant difference among the four treatment conditions on a paper and pencil posttest nor on a delayed posttest. In analyzing the type and amount of interaction in the groups, observers rated the groups as a whole from videotapes for "tenor of the session" (cooperative, competitive, or tutorial), "success with material" (error frequency and response quality), and "engagement" (attentiveness and off-task behavior). From this qualitative analysis, the following conclusions were drawn.

1. Students working in pairs or quads were more likely to cooperate with each other by carrying on
more extended conversations with each other relevant to the content of the instruction.

2. Students working in triads were more likely to compete with one another than students working in pairs or quads.

3. Students working in pairs were more likely to give or receive tutorial assistance than students in triads or quads.

4. Members of quads had relatively little access to the keyboard and frequently displayed instances of off-task behavior and social exclusion. Groups of four seem to be too large for effective use of these kinds of materials; groups of three are as good as pairs in terms of level of interactivity.

(Trowbridge & Durnin, 1983, p.10)

Furthermore, Trowbridge and Durnin supported their premise that peer interaction enhances the learning experience by pointing to their conclusion that the students who worked alone had a harder time answering task questions correctly on the first try. They did concede, though, that the students who worked alone were more likely to review their earlier work than those students who worked in groups.

Okey and Majer (1975) examined sixty college students who worked either alone, in pairs, or in groups of three or
The differences in achievement were not found to be significant but time on task was significant. When total achievement scores for the group were divided by the total time at the terminal, learning efficiency was found to increase with group size.

Findings that group size had no significant bearing on achievement were also found by Karweit and Livingston (1969). In that study, sixth-grade students were assigned to solo, pair, or triad conditions for using a computer simulation game about running a business.

Coding protocols for group interaction. The protocol used to examine the interaction of students in small groups varies according to the researcher. This has resulted in some conclusions from data which may seem conflicting but may truly be consistent. Thus, care must be taken to understand fully the categories of qualitative analysis when comparing studies of small group interaction.

Trowbridge and Durnin (1983) developed a coding scheme, with the two main categories of "verbal-cognitive" and "cooperative-social", for their study which involved seventh and eighth graders in a science task taught via computer-assisted instruction. Behaviors were categorized as follows:
Verbal-Cognitive

C1
- tells, directs others
- queries, asks for suggestion
- accepts suggestions
- responds to suggestions

C2
- interprets in one's own words
- explains, formulates reasons
- formulates question, answer
- formulates prediction
- evaluates using criteria
- disagrees with program

Cooperative-Social

S1
- neutral conversation, opinions
- disapproval, disagrees
- approval, agrees with another

S2
- shares keyboard
- takes turns
- gives help, assists another
- polls others, solicits votes
- delegates task to another
- encourages another.

(Trowbridge and Durnin, 1983, p.5)

Wilkinson and Calculator (1982) and Wilkinson and Spinelli (1983) described the requests and responses of their primary-aged students assigned to small groups by these characteristics: "designate" (one student was the designated listener), "on-task", "sincere" (certain preconditions for requests were met), "revision" (a request from the same speaker to the same listener was revised), "direct-form" (for requests for action, the imperative form; for requests for
Information, the wh-, yes no, or tag question), "appropriate response".

Webb (1982b, 1982c, 1984b, 1984c) and Webb & Cullinan (1983) tape recorded each small group for at least fifteen minutes. Each student's utterances were coded using the following general categories. In some of the studies, more detailed subcategories were also utilized. It is important to note that the categories were slightly modified as the purpose of Webb's work was altered.

1. gives explanation
2. receives explanation
3. receives no explanation
4. receives a response to a procedural question
5. gives short-answer feedback
6. performs calculations

(Webb, 1984c, p.215)

Each of these coding protocols had an internal logic and seemed to fit well with the particular population under study. In all cases the inter-rater reliability was high.

The good and the bad of verbal interaction. There is a clear conclusion which can be drawn from the data accumulated by some of the most prolific researchers: Verbal interaction among students working together influences their learning.

Specifically, giving explanations is beneficial for
learning; receiving explanations is sometimes beneficial. Receiving no explanation when requested is detrimental for learning (Webb, 1982a, 1982b, 1982c, 1983). Webb (1984a) reported that these conclusions about small group learning do not transfer to learning of LOGO, a computer language.

Giving explanations did not relate to achievement. Receiving explanations was positively related to achievement only when explanations followed errors; receiving explanations in response to questions was negatively related to achievement. Consistent with previous research, receiving no response to a question was negatively related to achievement. (Webb, 1984a, p.6)

In Webb's recent study of computer programming in small groups (1984a), students directed more questions to the instructor than to each other. Thus, these students—ages eleven through fourteen—tended to rely on the instructor for help. Unlike group work in non-computer settings, all of the questions raised by the students were answered. Webb points out that most of the questions raised were specific rather than general (and the general ones were directed to the instructor rather than a peer). Webb and Kenderski (1984) suggest that specific questions are more likely than general questions to elicit responses.

Although many of the phenomena found in non-computer
small groups can be seen in groups working around the computer, there are some differences. For example, Webb (1984a) mentions that the student who was typing often took the initiative in taking action. When that occurred, the other group members would make fewer suggestions about actions; most of their verbal suggestions would be about ideas.

Webb (1984a) reported that some students talked aloud while typing. She suggests that this behavior needs further analysis, as it may be related to learning.

In two studies that focused on much younger children, (Wilkinson and Calculator, 1982; Wilkinson and Spinelli, 1983) the data suggested that the behavior of the first graders (who were in peer-directed reading or math groups) was characterized by explicitness, directness, and assertiveness. This is in contrast to adults' more indirect patterns of language use in groups. These first, second, or third graders were very effective speakers because they obtained appropriate responses to their requests for action and information most of the time.

Section Summary
A theoretical foundation for the study of small groups has been established around the theme that, under certain conditions, learning is enhanced by peer interaction.
Supporting studies have established that specific types of interaction are beneficial or detrimental to learning. Yet, when some small group computer learning was examined, the results conflicted with previous conclusions made about small group interaction. The dissertation study reported in later chapters offered a different type of computer learning task which was examined within the theoretical tradition of collaborative learning.
Computer Learning

Computer-assisted instruction will be the major focus of the literature review on computer learning, with specific attention to the following issues: (a) a definition of C.A.I. (b) modes of C.A.I. (c) C.A.I. effectiveness, (d) sex and ability variables in C.A.I. achievement, (e) C.A.I. in the classroom, (f) the future of C.A.I., and (g) the social context of computer learning.

C.A.I.: What It Is

Computer-assisted instruction (C.A.I.) is instruction on some course content provided by a computer. The term is used synonymously with CBL (computer-based learning), CBI (computer-based instruction), and CAL (computer-assisted learning) in this study and by many other researchers (Chambers & Sprecher, 1983, p. 200).

A Brief Review of the C.A.I. Modes

C.A.I. is often divided into types of instructional modes. These C.A.I. modes illustrate both the use of the computer as an instructional media (from the perspective of the teacher) and the use of the computer as an educational tool (from the perspective of the student). Some disagreement exists as to just how many modes of instruction there are and exactly what they are (Howe &
From simplest to most complex, the modes of C.A.I. briefly explained here are: drill and practice, tutorial, problem solving, gaming, simulation, inquiry, and dialogue. This ordering of the C.A.I. types illustrates also the distinction between who has control over learning. The lower forms (drill and practice and tutorial) put the locus of control more with the computer, while the higher forms (problem solving, simulation, inquiry, and dialogue) put the student more in control of the learning situation. Computer games straddle the fence; depending on their format, they can either have the student in control or the computer in control.

**Drill and practice.** Drill and practice is the least complex form of C.A.I., both in what it requires of the student and in the time and effort needed to produce it. The program is written with the assumption that instruction has already occurred in some other format. Drill and practice programs ask students questions and give students feedback on the answers they input. Drill and practice, as well as any other mode of C.A.I., can and often does utilize design techniques such as immediate feedback and branching. Branching permits students who have no difficulties to proceed without encountering repetitive information; it lets students who do not grasp
the concept easily to obtain additional instruction.  

**Tutorial.** The tutorial is the second type of C.A.I. Unlike the drill and practice, the tutorial is often designed to present material that has not been previously taught to the student. The information is displayed in a straightforward way, similar to the way a textbook would present material. Yet, usually the material is broken down into smaller "bites" and, again, students are asked questions, expected to make responses, and given immediate feedback on their input.

**Problem-Solving.** The third type of C.A.I., problem solving, requires more or more intensive mental participation by the student. The computer presents a problem to the student, who then instructs the computer on how to solve the problem. In some packages, the student actually programs the computer. If the problem solution is incorrect or inadequate, it is rejected by the computer, and the student must provide additional instructions for solving the problem (Vasek, 1983, p.52).

**Computer games.** Computer games can be of all varieties. The game used in this study was a variation of Tictactoe. Malone designed target type games to learn math concepts (1980). Computer games can demand creativity or they can expect little cognitive processing but much eye-hand coordination. Video arcade games—although not
designed for educational purposes—can be shown to enhance parallel processing (being able to take in information from several sources simultaneously) (Greenfield, 1984). Computer games designed with specific educational goals often offer intrinsic motivation to learn an educationally-valued skill (Malone, 1980).

**Simulation.** Simulation re-creates real-life situations via a computer. Examples are an aircraft cockpit and a chemical laboratory. A student who uses a simulation interacts with the computer as though he were in that real-life situation. For example, the student may learn some of the real-life tasks of driving a car. The simulation may impose random, spontaneous, and/or catastrophic events which the student must react to. Thus, a simulation offers high-impact learning without the hazards of certain real-life situations. It also provides many aspects of a situation in a shorter time than real time. Another advantage is that it is often much more cost effective than providing real-life learning experience for many students.

**Inquiry.** The sixth type of C.A.I. is the inquiry mode. The computer contains a data bank of information which the student must utilize to solve a problem. An illustration is a computer program to assist a medical student in diagnosing diseases. The student
must ask certain questions and/or perform certain tests to first discover the symptoms; the student must then access a data bank of diseases to formulate a diagnosis.

**Dialogue.** Dialogue, also called Socratic dialogue (Vasek, 1983, p.54), is the final type of C.A.I. Using the student's native oral language, the computer has a dialogue with the student. The student is led through a series of questions until the student discovers on his own the principle or rule that is object of the lesson. This type of C.A.I. is still in the research stage (Vasek, 1983).

**Mixing ingredients.** Although an explanation of the different types of C.A.I. is useful, software developers are increasingly using more than one type of C.A.I. in one program. For example, some computer games contain problem-solving components (Malone, 1980). The C.A.I. which was used in this study was a tutorial, which included both extra drill and practice for some students, and a game.
C.A.I. Effectiveness

The results of C.A.I. research thus far have been less than definitive. Most of the studies before 1980 focused on subject matter or comparisons of C.A.I. to traditional instruction (Pence, 1980). Many research studies have reported conflicting or inconclusive results about the effectiveness of C.A.I. (Burns & Bozeman, 1981; Sasscer, 1982). Two sets of researchers, though, have attempted to rectify this by doing meta-analyses of the extant literature.

Burns and Bozeman (1981) examined forty C.A.I. research studies. They found that there was "a significant enhancement of learning in instructional environments supplemented by CAI." (p. 37).

Kulik and others (1980) focused on high school and college level C.A.I. and did a meta-analysis. They concluded that, while the typical conventionally-taught student scored at the 50th percentile, the typical C.A.I. student scored at the 60th percentile. Again the subject matter was mathematics.

Okey and Majer (1975) undertook a small but important study. They looked at sixty college students who worked either alone, in pairs, or in groups of three (or occasionally four) at a computer-assisted instruction terminal. The differences in achievement were not found to
be significant but time on task was significant. When total achievement scores for the group were divided by the total time at the terminal, learning efficiency was found to increase with group size. Others have also reported that, when using C.A.I., there was a reduction in the amount of time it takes to learn specific material (Chambers & Sprecher, 1983).

Few studies have addressed the connection between C.A.I. effectiveness and student characteristics (Pence, 1980).

**Sex and C.A.I. Achievement**

There have been some studies which indicate that boys and girls differ in computer learning achievement. For the most part, males have shown the greater gains.

The early Stanford C.A.I. Program in Initial Reading (Fletcher & Atkinson, 1972) indicated that children who supplemented their regular reading instruction with a C.A.I. word attack tutorial on a daily basis scored higher on an end-of-the-year posttest than those students who had not participated in the C.A.I. lessons. Boys made greater gains than girls "despite the almost universally expected superior performance of girls in conventional initial reading" (Fletcher & Atkinson, p.599). Among "disadvantaged" four and five year-olds, boys made greater gains than girls on a letter and word matching C.A.I.
task. The authors hypothesized that the boys felt more comfortable with making gross motor responses in lieu of verbal ones (Green, Henderson, & Richards, 1968).

At the high school level, Lockheed and others (1983) reported that girls gained less than expected while boys gained more than expected in computer literacy. In a study of college algebra students, low-anxious and male pairs learned faster on a C.A.I. unit than other pairs did (Reid & others, 1973).

**Ability and C.A.I. Achievement**

Studies of C.A.I. have more often focused on "disadvantaged" students than other students (Burns & Bozeman, 1981). For C.A.I., a meta-analysis of forty studies indicated that both highly achieving and educationally-disadvantaged students (as well as those students whose distinct ability levels had not been differentiated) benefitted from C.A.I. drill and practice mathematics lessons. Mathematics tutorial-type C.A.I. significantly enhanced the achievement of disadvantaged students and students whose ability was not specified. In contrast, the average ability students did not make significant gains as a result of drill and practice C.A.I. (Burns & Bozeman, 1981).

**C.A.I. in the Classroom**

Computer use in schools is evolving daily. Still, a
survey completed in March 1983 revealed that the student-to-computer ratio is still 150 to 1 for elementary schools and for secondary schools (Becker, 1983).

In an analysis of what courses had C.A.I. components, math was the leader with forty percent of the math being delivered via the computer in 1985. Science and Business each had approximately twenty percent and Social Studies less than ten percent of their course content delivered by C.A.I. in 1985 (Education Turnkey Systems, Inc.). Compared with other curriculum areas, there is little software for social studies, particularly skill-oriented software (Cohen, 1982).

Many comment on the primitive state of educational software development (Manion, 1985). Others, while encouraging the development of the higher-level types of C.A.I., point out that some lower level types of C.A.I. can be very helpful in the classroom setting as an adjunct—not a replacement for—traditional teacher instruction (Koontz, personal communication, July 21, 1984). One of the important questions for future research is "What are the most effective strategies for integrating C.A.I. with other instructional activities?" (Gleason, 1981, p.16)

The Future of C.A.I.

Many people in the time of the Wright Brothers were
thrilled with the invention of the airplane. Yet in no way could they envision the potential of that invention either in function (e.g. daily commuting by many business people) or structure (e.g. the design of the SST). An analogy can be drawn for the computer. "Probably the major problem with C.A.I. today is that the level at which it is now represented will be mistaken for its potential level." (Stolurow, 1968, p.7)

The structure of C.A.I. will change as new educational uses evolve. For example, computers can be used as mentors which process human speech or problem specific language (Molnar, 1980). As the structure of computer learning changes, how the computer functions in the classroom may also change. "New machines tend to generate new social arrangements." (Stodolsky, 1984)

The Social Context of Computer Learning

Computers have a direct impact on classroom learning by requiring specific cognitive processing skills and by delivering academic content in new ways. Computers also have an impact on the social context of the classroom.

From observations of an afterschool computer club, Levin and Kareev (1980) suggest that there is a tie between the level of challenge that a computer task
presents and the amount of social and academic support the student doing that task solicits. For example, children seem to prefer to be near peers and adult experts when first working on the computer, but as they become more adept on a particular computer program they seem to prefer to work alone or with just one other student.

In looking at achievement and social support, Lockheed and others (1983) reported that students who asked more questions gained relatively more during a computer literacy course than students who asked fewer questions of the teacher.

All educators should be aware of subtle social shifts because of the computer. A "computer culture" (Molnar, 1983) may emphasize different values than the traditional classroom culture. For example, being precise and paying attention to detail is a high priority in doing input on a computer (Molnar, 1983). On the other hand, since in computer programming making mistakes is indicative of progress, those who make the most mistakes will be those who are the brightest. Thus, making errors during the process of building new content may become socially acceptable in the classroom (Soloway, 1983).

Another example involves the physical dynamic of the classroom. It may not be feasible to restrict all students to their desks if dictionaries and other
Reference materials are only located on the database of one computer terminal. This would mean that independent freedom of movement would be a necessity for students, reinforcing the construct that each student is responsible for his/her own learning.

Finally, an illustration which connects to the research in this dissertation: cooperative learning may become the norm rather than a rarity as computers are used in small groups which are not teacher-directed. According to Walla and Brubaker (1982), pairing students on the computer is advantageous for both time efficiency and for the peer assistance opportunity.

**Section Summary**

C.A.I. is a relatively new and swiftly changing field for educational research. As such, observers of the field often cannot agree on definitions. C.A.I. has been shown to be effective as compared to conventional teaching, but further research is needed to examine C.A.I. as an adjunct rather than an alternative to conventional teaching. Thus far, some information is available about student characteristics (such as sex and ability) but it is sparse. Most C.A.I. has been in math and related fields; there has been little research on C.A.I. in social studies. Projections are being made about how computers in the classroom will alter the social context of education.
Systematic research on the social aspects of computer learning is needed.

For scholars and for practitioners, there is a genuine and urgent interest in C.A.I. research. It is hoped that the results of this dissertation study will significantly contribute to the literature about computer learning.
CHAPTER THREE

METHODOLOGY

This study necessitated the use of both quantitative and qualitative measures. A description of the procedures includes information about the computer program which was used, the preliminary study, the sample, the test instrument, prior teaching and the treatment activity, and the script used by the researcher. The research design section recounts how the data was analyzed.

Procedures

The Compass Rose Tutorial

During 1982-83, Fairfax County Public Schools curriculum specialists advised this researcher that second graders would benefit from geography activities which could be programmed for computer-assisted instruction. Specifically, primary-aged students needed further instruction and practice on map directionality skills. Consequently, this researcher designed the Compass Rose Tutorial. Appendix A contains a listing of the computer program.

Preliminary Study

In the spring of 1984, a preliminary study was done with forty-five second grade students in two elementary
classrooms. Under the direction of the principal and assistant principal of the school and with the excellent cooperation of the two second grade teachers, each child was given a pretest and randomly assigned to solo, pair, or triad conditions for computer learning of map skills using the Compass Rose Tutorial. As a result of the data collected, the pretest was revised twice to increase validity. A parallel posttest was also prepared and tested on these pilot students. In a counter-balanced design, twenty-one students had equivalent pretests and posttests. The mean of the pretest was 2.75. The mean of the posttest was 5.3. This suggests that the computer-assisted instruction had some effect and the test was sensitive to that effect.

The preliminary study provided insight into how the individual or groups function as well as important feedback on the utility of the computer program. The Compass Rose Tutorial was improved in technical ways as a result of teacher and student comments. All students were well-motivated, but there were differences in group structure (such as amount of conflict and leadership patterns) and on help-seeking strategies.

Sample

The subjects were sixty-six second graders. They
represented a variety of ability levels, ethnic groups, and both sexes. Although the majority of students were native-born Americans, there was a multicultural flavor to the classes. Thirty-nine percent of the students said that they were from another country. Represented in the sample were children from the following countries: El Salvador, Korea, Afganistan, Vietnam, India, Turkey, Honduras, Guatemala, China, Nicaragua, and Malaysia. The sample included three intact classes of students at selected elementary schools in Fairfax County (Virginia) Public Schools. Fairfax County is a large, suburban school district outside of Washington, D.C.

Test Instrument/Reliability

Every subject was given a pretest and an equivalent form posttest. Each of the tests had a total of ten questions. Eight of the questions were used for assessment of achievement, and two of the questions concerned the subjects' preferences for computer learning and for working alone or in groups. Copies of the tests can be found in the Appendix section.

Internal consistency of the test items for each form was established using Cronbach's Alpha. This measure tells how each item relates to the total test. The following scores were obtained.
Pretest Form A only = .83  
Pretest Form B only = .80  
Posttest Form A only = .75  
Posttest Form B only = .80  

These are acceptable levels for an alpha analysis.

An item analysis was also done. This showed that most of the foils were good distractors and that all of the test items adequately discriminated.

Test-Retest reliability was established by giving each form of the test to a group of thirty-six second graders not involved in the study. They were given the pretest (half were given form A and half were given form B) and ten days later were given the alternate form for a posttest. These students did not receive the computer-assisted instruction treatment. The mean of the pretest was 4.1 and the mean of the posttest was 4.9; a dependent t-test confirmed that the difference between the pretest and the posttest was not significant. The Pearson Product Moment Correlation for the pretest with the posttest was .68, which is considered a moderate to high correlation (Hinkle, Wiersma, Jurs, 1979, p. 85).

Prior Teaching

The teacher of class #1 gave no instruction of the map skills to his students prior to the computer-assisted
instruction (C.A.I.) treatment. In classes #2 and #3 the C.A.I. was integrated into the teachers' regular instruction of the skills. There were two variations on the prior teaching:

1. Class #2 had one lesson of approximately forty-five minutes duration six weeks prior to the C.A.I. treatment.
2. Class #3 had twenty minute lessons for four days immediately preceding the C.A.I.

C.A.I.

All subjects were given the same computer program for the Atari 800 microcomputer. This program, the Compass Rose Tutorial, contained a unit of C.A.I. which was designed to teach two basic skills of social studies: cardinal and intermediate directions. Cardinal directions are north, south, east and west. Intermediate directions are northwest, northeast, southwest, southeast. A third skill, which is sometimes termed relative directions, was also presented. An example of a relative direction question was "Chris is at the blue square. He wants to travel to the green square. In what direction will he have to go?"

The final part of the computer program was a tictactoe game, which required the students to apply the skills they learned on the earlier part of the lesson.
Each game question had two parts: 1) A white square randomly appeared adjacent to the compass rose. Students had to indicate in what direction was the white square; 2) If the first part of the question was answered correctly, a tictactoe board appeared on the computer screen. By using the compass rose directions again, the student indicated where on the tictactoe board he/she wanted the X or O mark.

Since there was branching within the program, students who had more difficulty with the content, had somewhat more instruction and practice questions. Students were encouraged to work at their most comfortable pace. Thus, some students needed less than fifteen minutes and others spent more than fifty minutes on the C.A.I. unit.

A posttest, which was an equivalent form of the pretest, was given to each subject approximately one week after the computer learning unit was completed.

**Script**

At the beginning of each session, the observer asked the students: "Do you know how to use the computer?" If students had no knowledge, the observer explained that they would sometimes need to press the [start] or [return] keys, depending on what the screen said to do. The observer also pointed out the [delete back s] which would
be helpful if they inadvertently pressed an incorrect key and wanted to back up.

For groups of two or three, the observer said: "Today we only have one computer for the two (three) of you. How do you think that you can work together?" If there was no answer, the observer said: "Maybe you will want to take turns."

Research Design

The Quantitative Research

All subjects were randomly assigned to solo, pair, or triad small group conditions.

For the quantitative data, this study required a one-way analysis of covariance pretest/posttest design. The pretest and posttest were counterbalanced; that is, half of the students received Form A as a pretest and half received Form B as the pretest. The main independent variable was group size. Other independent variables were ability and sex. (The variable of class [which of three classrooms a student came from] was included in the multiple regression analysis for exploratory purposes.) The dependent variable was achievement as measured by student performance on the posttest.
The Qualitative Research

For the qualitative data, the researcher acted as observer of the subjects while they interacted with the computer and with each other. Audiotapes were also made of each entire session. The observer made note of the amount of time students spent on the computer-assisted instruction unit, as well as their correct and incorrect responses. She noted who and when they asked for help, any usual responses or behaviors, and who was dominant or submissive in a group. The observer attempted to limit the impact her presence had on the group interaction by physically distancing and limiting her verbal input and eye contact.

The question of how the groups function was analyzed via qualitative procedures. Using both the observer's notes and tape recordings, transcriptions were made of group interaction. Group interaction was coded by analyzing the types of interaction which occurred and devising appropriate categories based on the real-life data. The following help-seeking categories echo those used by Webb (1982a, 1982b, 1984a, 1984b, 1984c). As such there is a distinction made between a student response which is simply the answer to a question and a response that provides an explanation, which is a form of peer teaching.
Help-Seeking.

a. Receives an Explanation of Map Skills Content
   1. makes an error, receives an explanation
   2. asks for and receives an explanation

b. Gives Help for Map Skills Content
   1. gives an answer, but no explanation
   2. gives an answer with an explanation

c. Receives no Explanation of Map Skills Content
   1. makes an error, is not corrected
   2. makes an error, receives an answer without explanation
   3. asks for help, receives no help
   4. asks for help, receives an answer without explanation

d. For procedure—either how to use the computer or how to answer a question
   1. gives help
   2. asks for help, receives no help
   3. asks for help, receives help
   4. receives help

Cooperation and Competition

Analysis of the qualitative data indicated whether the students in groups were cooperative or competitive. At four points in the session (frame 1, frame 5, the beginning of the game, and the end of the game) student interaction was analyzed for competition, which was
defined as students seeking to gain advantage at the expense of others. At the same four points in the session, student interaction was examined for cooperation; that is, whether students shared the keyboard, encouraged peers to work on the task, helped peers with content or procedural obstacles, or solved problems jointly.

All of the transcripts of group interaction were coded by the observer. Another researcher independently coded three groups of three and three groups of two for cooperation, competition, and dominance at the four points of the session. The inter-rater reliability is reported in Chapter Four. A different researcher, but someone who had observed the computer program being used by one group of children, coded the transcripts of three groups of three and three groups of two for help-seeking, using the categories listed above. That inter-rater reliability is also reported in the results section.

**Dominance and Odd-Man Out**

Dominance and the odd-man out phenomenon were analyzed, also, from the qualitative data. Two questions were addressed:

a. Who is in charge at four key points in the session (frame 1, frame 5, the beginning of the game, and the end of the game).

b. In the groups of three, is one person usually
left out of the interaction?

**Interaction Index.**

Five groups of two and five groups of three were randomly selected to represent all twenty-two groups for the purposes of in-depth analysis of interaction. Thus, the verbal utterances of twenty-five students were transcribed in their entirety and coded according to the above categories. Tallies were then made of each category of behavior.

The results of both the quantitative and qualitative data are reported in Chapter Four.
CHAPTER FOUR
RESULTS

Both quantitative and qualitative methods were used in this study to address the following research questions.

In computer learning for second grade social studies...

I. What factors affect achievement?
   a. What is the relationship between group size and achievement?
   b. Are there other variables important for achievement? (sex, ability)

II. How do the groups function?
   1. What help-seeking strategies did students use?
      a. type of task (Does the subject ask for help on content or on how to use the computer?)
      b. source of information (Does the subject ask the computer, the observer, or a peer?)
      c. Is there a relationship between help-seeking strategies and group size?
   2. Are there differences between the structures of groups of two and groups of three? (factors such as leadership, conflict)
All of these questions are answered in this chapter. Furthermore, the data allowed for discovery of points not outlined by the original research questions.

The Quantitative Data

Following a pretest, the sixty-six subjects were given a unit of C.A.I. (computer-assisted instruction) which was designed to teach two skills of social studies: cardinal and intermediate directions. Cardinal directions are north, south, east and west. Intermediate directions are northwest, northeast, southwest, southeast. A third skill, which required the application of the previous two skills, was presented and termed "relative directions". An example of that skill was a story frame which read: "Let's say you are on the blue square and you want to travel to the green square. In which direction do you have to go?" The final part of the computer program was a tictactoe game, which required the students to apply the skills they learned on the earlier part of the lesson.

Students were encouraged to work at their most comfortable pace. Thus, some students needed less than fifteen minutes and others spent more than fifty minutes on the Compass Rose Tutorial. Approximately one week after the computer learning unit was completed, a posttest (which was an equivalent form of the pretest) was given to
each subject.

The data that lent itself to traditional quantitative analysis addressed the first major question: In computer learning for second grade social studies, what factors affect achievement?

**Students' Gains**

The children did learn the skill from the C.A.I. tutorial. A dependent t-test for examining the students' pretest scores compared to their posttest scores showed that they made gains which were significant at the .001 level. See Table 1. A distribution histogram (Figure 1) illustrated the number of students who achieved various scores on the pretest and on the posttest.
Table 1

Achievement of All Students

<table>
<thead>
<tr>
<th>Test</th>
<th>n</th>
<th>Mean</th>
<th>S.D.</th>
<th>S.E.</th>
<th>d.f.</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>66</td>
<td>4.24</td>
<td>3.15</td>
<td>.39</td>
<td>65</td>
<td>3.6*</td>
</tr>
<tr>
<td>Post</td>
<td>66</td>
<td>5.48</td>
<td>3.19</td>
<td>.39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p=.001
Figure 1: Students' scores on the pretest and on the posttest.
The Relationships Between All of the Variables

All independent and dependent variables were correlated by calculating Pearson Product-Moment coefficients. Table 2 contains a matrix of all of those correlation coefficients. Principally, significant correlations clustered around the variables of pretest, posttest, gain, and ability.
Table 2

Pearson Correlation Coefficients for All Variables

<table>
<thead>
<tr>
<th></th>
<th>Sex</th>
<th>Ability</th>
<th>Grpsize</th>
<th>Pre</th>
<th>Post</th>
<th>Class</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>.01</td>
<td>-.07</td>
<td>.22</td>
<td>.16</td>
<td>-.05</td>
<td>-.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p=.47</td>
<td>p=.28</td>
<td>*p=.04</td>
<td>p=.09</td>
<td>p=.35</td>
<td>p=.28</td>
<td></td>
</tr>
<tr>
<td>Ability</td>
<td>.23</td>
<td>.55</td>
<td>.46</td>
<td>.10</td>
<td>-.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*p=.03</td>
<td>*p=.000</td>
<td>*p=.000</td>
<td>p=.22</td>
<td>p=.24</td>
<td></td>
<td></td>
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<tr>
<td>Group</td>
<td>.22</td>
<td>.11</td>
<td>.15</td>
<td>-.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td>*p=.04</td>
<td>p=.20</td>
<td>p=.11</td>
<td>p=.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td></td>
<td>.61</td>
<td>.14</td>
<td>-.43</td>
<td></td>
<td>*p=.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*p=.000</td>
<td>p=.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td>-.16</td>
<td>.45</td>
<td></td>
<td>p=.09</td>
<td>*p=.000</td>
<td></td>
</tr>
<tr>
<td>Class</td>
<td></td>
<td>-.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p=.002</td>
</tr>
</tbody>
</table>
The Relationship Between Group Size and Achievement

The first specific question which this study addressed was the relationship between group size and achievement. The Pearson-Product Moment Correlation for group size and achievement (as measured on the posttest) indicated that there was no significant relationship between these variables. That is, although students as a total group gained, the correlation of .11 shows that group size did not relate to students' achievement.

An analysis of covariance, with the pretest as the covariate, again showed no significant relationship between group size and achievement. Table 3 illustrates the pretest and posttest means and standard deviations of the different group sizes.
Table 3

Means and Standard Deviations for Group Size

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>mean</th>
<th>S.D.</th>
<th>S.E.</th>
<th>d.f.</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solos/Pretest</td>
<td>11</td>
<td>3.8</td>
<td>2.5</td>
<td>.76</td>
<td>10</td>
<td>2.34*</td>
</tr>
<tr>
<td>Solos/Posttest</td>
<td>11</td>
<td>5.5</td>
<td>3.4</td>
<td>1.0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Pairs/Pretest</td>
<td>22</td>
<td>3.0</td>
<td>3.2</td>
<td>.68</td>
<td>21</td>
<td>2.60*</td>
</tr>
<tr>
<td>Pairs/Posttest</td>
<td>22</td>
<td>4.7</td>
<td>3.2</td>
<td>.69</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Triads/Pretest</td>
<td>33</td>
<td>5.1</td>
<td>3.1</td>
<td>.54</td>
<td>32</td>
<td>1.77</td>
</tr>
<tr>
<td>Triads/Posttest</td>
<td>33</td>
<td>6.0</td>
<td>3.1</td>
<td>.55</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
Other Variables and Achievement

This study examined the students’ gender and reading ability level in relation to achievement. Reading ability was identified as a "1", "2", or "3" by the student’s teacher, with the "3" being those students who were farthest along in reading ability.

**Ability and achievement.** The ANCOVA showed no significant interaction between group size and ability, though there were suggestions of some patterns. For example, low ability students did better in groups than alone; medium ability students did better alone than in groups; and high ability students did better either alone or in groups of three, but did most poorly when working in pairs. It should be emphasized that these trends were not strong enough to result in a statistically significant interaction between group size and ability.

The Pearson Correlation Coefficient showed evidence of the high correlation between ability and achievement as measured by the posttest. Included in Table #2 is also the correlation between the ability score and the pretest score, in which there was also a significant relationship.
Table #4

Means for Ability by Group Size on the Posttest

<table>
<thead>
<tr>
<th>Group Size</th>
<th>1</th>
<th>2</th>
<th>3*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.17</td>
<td>8.67</td>
<td>8.00</td>
</tr>
<tr>
<td></td>
<td>(n=6)</td>
<td>(n=3)</td>
<td>(n=2)</td>
</tr>
<tr>
<td>2</td>
<td>3.25</td>
<td>7.17</td>
<td>5.20</td>
</tr>
<tr>
<td></td>
<td>(n=12)</td>
<td>(n=6)</td>
<td>(n=5)</td>
</tr>
<tr>
<td>3</td>
<td>4.10</td>
<td>6.20</td>
<td>7.31</td>
</tr>
<tr>
<td></td>
<td>(n=10)</td>
<td>(n=10)</td>
<td>(n=13)</td>
</tr>
</tbody>
</table>

*Ability was defined as reading ability as determined by the classroom teacher; "3" indicates those furthest along in reading ability.
Group composition and achievement. For triads but not for pairs, students in mixed-ability groups had significantly greater achievement gains than students in uniform-ability groups \((t=3.34, \ p<.01)\). For students who were in pairs, there was no difference in gain scores between those who were assigned to uniform-ability groups and those assigned to mixed ability groups \((t=.95, \ df=20)\).

Sex and achievement. When coding for sex, "1" was a girl and "2" was a boy. The Pearson Correlation indicated that there was a relationship between sex and the pretest (that is, boys did better on the pretest), although on the posttest the relationship was not significant. Thus, whether one is a girl or boy does not seem to affect achievement as measured by the posttest.

Using the pretest as a covariate when calculating an analysis of covariance confirmed that there was no significant relationship between sex and achievement.

Classroom assignment and achievement. Although the study was not designed to test the variable of "classroom assignment", Table #2 illustrates that classroom assignment was significantly correlated with achievement gain. Thus, on a post hoc basis classroom assignment of the students was examined further.

The students in this study came from three different classrooms with three different teachers. Furthermore, the
teachers integrated the C.A.I. lesson in different ways; that is, there was a difference in the amounts of prior teaching among the three classes.

Teacher#1 did no introduction of the map skills unit; Class #1 pretest scores reflect this. The students of Teacher #1 started low but made significant achievement gains. Yet they ended up with a mean on the posttest which was two points lower than the mean of Class #2. See Figure #2.

Class #2 had minimal prior teaching of the skill. Teacher #2 gave one forty-five minute introductory lesson one month prior to the experimental treatment. The students in Class #2 showed just about as much growth in achievement as Class #1 and ended up with the greatest mastery of the skill, as measured by the posttest. See Figure #2.

Class #3, which had the most prior teaching (four twenty-minute sessions during the week immediately preceding the treatment), showed no growth. Since that class started with relatively high pretest scores, they had less room to grow: a "ceiling effect" probably limited the amount of gain the students made. That restricted range would also tend to lower correlations.
<table>
<thead>
<tr>
<th>All Students</th>
<th>Class #1</th>
<th>Class #2</th>
<th>Class #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Amount of prior teaching)</td>
<td>none</td>
<td>moderate</td>
<td>most</td>
</tr>
<tr>
<td>n=66</td>
<td>n=23</td>
<td>n=25</td>
<td>n=18</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>x</td>
<td>^</td>
</tr>
<tr>
<td>4</td>
<td>x</td>
<td>x</td>
<td>^</td>
</tr>
<tr>
<td>mean</td>
<td>3</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>scores</td>
<td>2</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>1</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>0</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>pre post</th>
<th>pre post</th>
<th>pre post</th>
<th>pre post</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2</td>
<td>5.4</td>
<td>2.8</td>
<td>4.8</td>
</tr>
<tr>
<td>t=3.61</td>
<td>t=3.4</td>
<td>t=4.41</td>
<td>t=-.51</td>
</tr>
<tr>
<td>p=.001</td>
<td>p=.002</td>
<td>p=.0001</td>
<td></td>
</tr>
</tbody>
</table>

Figure #2:
Achievement gains among different prior teaching treatments.
**Group Size Preference**

The subjects in this study had some experience working in reading groups and occasionally were asked to work cooperatively in small groups for social studies or science lessons. Most had never worked on a computer before this lesson.

On both the pretest and the posttest, students circled their preference for group size. The test item read:

When I am learning on a computer, I would rather

1. work alone.

2. work with one other person.

3. work with two other people.

For each student, a calculation was made of change from the pretest to the posttest. There was no significant change in the students' preference for group size. Sixty-six percent of the students did not alter their group size preference. Fourteen percent of the students preferred a smaller group on the posttest than on the pretest; Twenty percent of the students preferred a larger group when asked on the posttest versus when asked on the pretest.
The Qualitative Data

Students were randomly assigned to treatment conditions of solo, pair, or triad. Thus, the groups which were formed included a variety of ability levels and both sexes. Verbal and nonverbal interaction was recorded by the observer; audiotapes provided confirmation of the verbal interaction data. The question which the qualitative analysis addressed was "How do the groups function?" The two subordinate research questions were "What help-seeking strategies did students use?" and "Are there differences between the structures of groups of two and groups of three? (factors such as leadership, conflict).

Help-seeking Strategies

All of the verbal interaction was transcribed, coded, and tallied. The coding schema which was used is listed below. For the later calculations, the subcategories were collapsed. Under the category of "Procedure" were any behaviors not related to the social studies subject matter. Thus, "Procedure" included receiving (or asking for or giving assistance on) how to read the text, how to use the computer keyboard, how to spell a word, and how to proceed on doing a task.

FOR MAP SKILLS CONTENT: RECEIVES AN EXPLANATION

1. makes an error, receives an explanation
2. asks for and receives an explanation

FOR MAP SKILLS CONTENT: GIVES HELP
1. gives only an answer
2. gives an explanation with an answer

FOR MAP SKILLS CONTENT: RECEIVES NO EXPLANATION
1. makes error or does nothing, is not corrected
2. makes error or does nothing, receives answer without explanation
3. asks for help, receives no help
4. asks for help, receives only the answer but no explanation
5. makes error, receives computer feedback only ("That is not right. Try again.")

FOR PROCEDURE--EITHER ON HOW TO USE THE COMPUTER OR HOW TO ANSWER A QUESTION (including spelling or word recognition)
1. gives help
2. asks for help, receives no help
3. asks for help, receives help (including his/her own problem-solving)
4. receives help without requesting it.

**Inter-Rater Reliability**

Two educators, who were not involved in the study, were asked to code six transcripts, three of groups of two and three of groups of three. One of the educators coded verbalizations according to the above coding protocol.
The percentage of agreement between the two raters was 83%, which was computed by dividing the total number of agreements between the raters by the total number of instances rated.

Using the same computational scheme, inter-rater reliability was also determined for groups' characteristics. Another educator coded the groups for who was the dominant group member (it could be no one), and for whether a group was cooperative or competitive. The judging took place at four specific points in the C.A.I. session. The percentage of agreement between the two raters was 81%.

**Type of Task**

Does the subject ask for help on content or on how to use the computer?

Of eighteen students randomly selected to be tallied, there were slightly more verbalizations about procedure than about content. It should be remembered that spelling, word recognition, as well as questions about how to do the tasks were all part of what was tallied as "procedure".

**Source of Information**

Did students more often seek help from the computer, from an observer, or from a peer? That question was colored by the amount of observer input which was given. In two of the pairs, there was substantial observer
In one of those pairs, the intervention was necessary because neither student had sufficient reading ability to do the C.A.I. The other pair which required substantial observer intervention was unusual in that the students had difficulty keeping their attention on the task. For several of the solos limitations in reading ability necessitated considerable observer intervention, also. In groups of three, though, the observer never had to intervene in a leadership role.

In those few groups where the observer had to intervene in order to get the group functioning, students subsequently looked to the observer to answer their questions. In all other groups the students asked the observer for help infrequently. Soliciting help from the computer HELP function was even more rare. The vast majority of students in groups sought help from their peers.

Obviously, students who did the C.A.I. alone did not have the option of seeking peer assistance. They sought help from the observer rather than from the computer in most instances.

**Help-Seeking and Group Size**

An examination of the tallies of type of help given or received revealed that there was no significant difference between groups of two and three in either the
amount or type of help sought or received.

**Other Results of the Qualitative Data**

**Dominance/Odd Man Out**

To see if one student was consistently dominant or consistently left out of the group interaction, the data were analyzed at four specific points in the C.A.I. session. If the same person controlled the group three-quarters of the time, that individual was called dominant. In eight of the twenty-two groups one student was dominant.

In all of those cases, the dominant group member had the highest ability level in the group.

Where one child was dominant in a mixed-sex-group, it was usually a boy who was dominant.

Sometimes, in groups of three, one person was consistently left out. This was true in four of the eleven groups. In one group, the "odd man out" was a poor reader, who was formally labelled "learning-disabled"; perhaps the other girls considered her inferior because of this. This girl, as well one other "odd man out" made great efforts to be included in the group interaction; neither achieved status as an equal in the group. Two other "odd men out" were accepted by their groups to some degree at various points in the session.
Cooperation/Competition

The data were analyzed at four specific points as to whether the students displayed cooperation or competition. If there was clear cooperation or competition during three of the four ratings, the group was labelled cooperative or competitive. Typically, the dynamic of the groups changed over the course of the session.

Cooperation was illustrated by joint problem-solving, such as asking each other questions or giving information related to the C.A.I. task. For example:

S: "I think I know. Southern."
T: "East!"
S: "South. S."
T: "We're going to be wrong."
S: "No, S, because it is down here."
T: "Oh."

Neither the ability level nor the sex of the students had a bearing on whether they cooperated.

Sometimes cooperative behavior manifested in "private" consultations on what would be the best answer or course or action; in those instances verbal interaction could not be recorded but the whispering behavior was noted. In an extreme example, one group of two girls whispered the entire session in an obviously pleasing and effective session in which the high ability student did much "teaching" of the skill to the low ability
English-Second-Language student. According to the teacher, prior to the C.A.I. small group these two girls had not interacted. Cooperative problem-solving and peer teaching in small groups will be discussed further in Chapter Five.

Behaviors which led to labelling a group as competitive were pushing, punching or other hostile physical actions to gain control of the keyboard, repeated negative criticisms ("Can't you read?" "You turkey."), and disregarding other group members when working on the task.

Only in groups of three was there sustained competitive behavior. In all three of the groups which were labelled competitive, there were students of both sexes and the competition only occurred between the two males. Ability level had no bearing on whether a group was competitive. In two of the three competitive groups cooperation was also obvious three-quarters of the time. Thus, cooperation and competition can occur simultaneously.

In the one group of two where competition was overt during the game, there was one very vocal high ability boy and one assertive low ability girl. The girl was not intimidated by the reading ability nor by the critical remarks of her peer. In a different pair, the students
wouldn't relate to each other at all. That group was not labelled competitive because competition requires interaction. In Chapter Five there will be further discussion of the various aspects of competition.

The Differences Between Groups of Two and Groups of Three

The Groups of Two

There were eleven groups of two and their compositions can be found in Table 5. Cooperation was a hallmark in six of the eleven groups. Competition, though present at certain isolated times, was not sustained in any of the pairs.

The Groups of Three

Table 5 also describes the compositions of the eleven groups of three. Ten of the eleven groups were cooperative and three of the eleven were competitive, with two groups having both characteristics.
Table 5.

Group Composition, Dominance, Cooperation, or Competition

<table>
<thead>
<tr>
<th>Group</th>
<th>Size</th>
<th>Sex</th>
<th>Ability</th>
<th>Dominance</th>
<th>Coop</th>
<th>Compet.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>m,n</td>
<td>2,3</td>
<td>m2</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>m,f</td>
<td>3,1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>f,f</td>
<td>1,3</td>
<td>f1</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>m,f</td>
<td>3,3</td>
<td></td>
<td></td>
<td></td>
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<td>5</td>
<td>2</td>
<td>f,f</td>
<td>3,3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>f,m</td>
<td>3,1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>f,m</td>
<td>2,2</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>f,f</td>
<td>2,3</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>f,m</td>
<td>3,1</td>
<td>m1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>f,m</td>
<td>2,2</td>
<td>m2</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>m,m</td>
<td>3,3</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>f,f,m</td>
<td>3,3,3</td>
<td>f3</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>f,m,m</td>
<td>3,2,1</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>m,m,m</td>
<td>1,1,2</td>
<td></td>
<td></td>
<td>x</td>
</tr>
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<td>15</td>
<td>3</td>
<td>f,f,m</td>
<td>1,1,2</td>
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<td>x</td>
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<td>17</td>
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<td>m,f,m</td>
<td>1,3,3</td>
<td>m1</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>18</td>
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<td>f,m,f</td>
<td>3,3,1</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>m,f,m</td>
<td>2,2,2</td>
<td>m2</td>
<td>x</td>
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</tr>
<tr>
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<td>m,m,m</td>
<td>2,2,2</td>
<td></td>
<td></td>
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<td>1,3,1</td>
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<td>x</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>f,m,m</td>
<td>1,1,1</td>
<td>m1</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
The Development of Groups

A group was classified as cooperative, competitive or dominated by one student if three-quarters of the time it was thus characterized. Some groups could not be classified as wholly cooperative, competitive, or with one dominant individual, yet there was evidence of those qualities at different points in the C.A.I. session. Consequently, each group was examined for how it changed over the course of the lesson. At the beginning of the session there were the least number of groups interacting cooperatively; that was when students were just becoming acquainted with the group members, the computer, the room, and the task. In the middle of the session there was the greatest frequency of cooperative interaction. At the end of the session, during the tictactoe game, the number of groups displaying cooperation decreased. Even though the game was competitive in nature, the amount of competition did not increase. Furthermore, there was no difference between groups of two and groups of three in the pattern of group development.

Student Opinion of the Computer/Motivation

On both the pretest and the posttest, students rated their feelings about computers by choosing to circle one
of the following foils.

1. They are boring.
2. They are O.K.
3. They are a lot of fun.
4. I'm not sure.

A calculation of frequencies showed that there was no significant change in the opinions of the students about the computer as a result of the treatment. On the pretest and on the posttest the vast majority of students thought computers were a lot of fun. See Table 6.

Table 6

<table>
<thead>
<tr>
<th>Foils</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. They are boring.</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>2. They are O.K.</td>
<td>5.3</td>
<td>9.2</td>
</tr>
<tr>
<td>3. They are a lot of fun.</td>
<td>63.2</td>
<td>68.4</td>
</tr>
<tr>
<td>4. I'm not sure.</td>
<td>15.8</td>
<td>6.6</td>
</tr>
<tr>
<td>Filled in no answer</td>
<td>13.2</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Qualitative methods revealed that of sixty-six students only three were lacking in motivation to do the C.A.I. task. For the most part, students were highly motivated; many chose to miss recess in order to work on
the computer.

Summary

Although there was overall achievement gains for students, there was no significant relationships between group size and achievement, sex and achievement, and ability and achievement. Post hoc analysis of group composition and classroom assignment did reveal significant findings.

Cooperation was pervasive in almost all the triads and common also in the pairs. Neither ability level nor sex had a bearing on whether students cooperated. Whenever one student dominated a group, though, in mixed-sex groups it was a boy and in mixed-ability groups it was the student with the highest ability level.
CHAPTER FIVE
STUDY SUMMARY

This study had two purposes: (a) One purpose was to examine the achievement of students who participated in a computer-assisted instruction unit on social studies directionality skills; and (b) the other purpose was to study the interaction of students in small groups who were assigned a computer task.

Findings

Students' Achievement on the C.A.I. Task

Students' gains. This study found that students did indeed make significant gains in their knowledge of social studies directionality skills. The C.A.I. was effective as a tutorial. This was a teacher-designed program of a relatively simple format. Three cumulative skills were presented and practice was offered in a branching design. The key to the program was that the culminating activity, a tictactoe game, required application of the first two directionality skills. It was clear from the researcher's observations that some students did not fully process the social studies skills until they were required to use them in the tictactoe game.

Group size and achievement. The major finding of
this study addressed the question of the relationship between
group size and achievement for C.A.I. The data reported here
are similar to those of other researchers (Trowbridge &
Durnin, 1983; Okey & Majer, 1975; Karweit & Livingston,
1969). There is clear evidence that, for elementary students
up through college students, group size—that is whether
students work alone, in pairs, or in triads—had no
significant bearing on achievement. The practical
significance is that students can learn in groups of two or
three just as well as when they are alone. Small group
learning offers a student a help-seeking advantage and the
school an economic advantage. The additional data from the
observations of the groups suggest that there are advantages
to working in groups over working alone. For example, if a
student who has insufficient knowledge (of content, or of
skills for reading text, or of procedural skills) is in a
group setting, he/she can and does rely on peers. If peers
are unavailable as a resource, the student who faces
insurmountable obstacles must either ask the teacher or give
up in frustration.

This study involved a social studies skill, and the
above-mentioned researchers had C.A.I. lessons in science
(Trowbridge & Durnin), business (Karweit & Livingston), and
education (Okey & Majer), respectively. Thus, across a
variety of C.A.I. content, as well as a variety of
populations, group size has no significant bearing on
achievement.

Student ability. High-ability students ended up with the highest posttest scores ($r=.47$, $p<.000$). The fact that ability and gain were not significantly correlated indicates that there was most likely a "ceiling effect"; that is, pretest scores for the higher-ability students were high enough to prevent large gains for those students.

In this study, the examination of ability—in an absolute rather than a relative sense—suggested some interesting (though not statistically significant) trends. Only the medium-ability students consistently did better alone than in groups. Low ability students did better in both groups of two and groups of three than they did when working alone. High ability students did better either alone or in groups of three. Again, it must be emphasized that the statistical calculations revealed no significant relationship between the separate ability levels and achievement in relation to group size.

Another way of viewing ability is as a function of group composition rather than as an isolated individual student characteristic. Webb discusses this point:

The importance of relative ability within the group as a predictor of giving explanations, in contrast to the nonsignificant effect of absolute ability, shows that it may be misleading to consider student characteristics apart from characteristics of the group. In this study, students of comparable ability had different experiences in group interaction when they were assigned to groups with different mean and variance in ability. The most able person within
the group tended to become the "explainer," regardless of his or her absolute ability.

(Webb & Kenderski, 1984, pp.168-69)

This study found that for triads, but not for pairs, students in mixed-ability groups had significantly greater gains in achievement than students in uniform-ability groups. (Webb, 1980, 1982a, 1982b, did not use pairs in her studies of small groups for mathematics lessons.)

Webb (1980, 1982b, 1985) found that students in mixed-ability groups with high-ability plus medium-ability or medium-ability plus low-ability had higher achievement than students in uniform-ability groups. This led her to hypothesize that when all ability types are in one small group, the medium-ability students were often left out of the discussion because the most able students may feel responsible for the least able member of the group but not for those of medium ability (1982b). Among the triads in this study, the random assignment of students resulted in only two groups that were composed of all three ability levels. In those two groups, the medium-ability students interacted and gained as much as the other students. Thus, the limited data here do not support Webb's findings but it is insufficient to offer a clear contrast.

The literature concludes that students in small groups do best if they represent a variety of ability levels (Hallinan, 1984). The data in this study support that conclusion for triads, but not for pairs.
Sex and achievement. Our finding that there was no significant relationship between sex and achievement is important in light of the work of others. Early studies of primary-aged students (Fletcher & Atkinson, 1972; Green, Henderson, & Richards, 1968) indicated that boys made greater gains than girls on C.A.I. lessons. Furthermore, recent work reported that high school boys gained more than expected while high school girls gained less than expected in computer literacy (Locheed & others, 1983). The results of our study diverge from the findings of those researchers. Even though the boys did better on the pretest, there was no significant difference between boys' and girls' achievement (as measured on the posttest or in terms of gain). The data of this study suggest that among the primary-aged pupils of 1985 sex-bias in using the computer has not yet surfaced.

Class and achievement. Post hoc findings about which classes of students made the most gains, revealed that there were significant differences between the three classes. In fact the variable of "classroom assignment" explained the greatest variance in the multiple regression. There are several explanations for why class was a significant variable: There may have been an advantage to having (a) moderate--rather than none or a lot--of prior teaching of the social studies skill, and/or (b) previous exposure to using the computer, and/or (c) the most experience working cooperatively (class and cooperation correlate at p=.002).
Since this study was not designed to explore the differences between the three classes, we cannot be sure which explanation is most valid.

**Group size preference.** There was no significant change in the students' preference for group size. This means that students were generally happy with their group experience. If they were alone, they were satisfied and if they were working with their peers in a small group they were also content.

**Type of help-seeking.** In this study, procedural help accounted for slightly more verbalizations than map skills (substantive) help. This concurs with the findings of Peterson, et al. (1984).

**Students’ Interaction in Small Groups**

**The categories of interaction.** The coding protocol which was developed for this study was tailored to the interactions of these particular students. Trowbridge & Durnin (1983), Wilkinson & Calculator (1982), Wilkinson & Spinelli (1983), and Webb (1982b, 1982c, 1984b, 1984c) developed similar coding schemes. Many subcategories of behavior were needed to describe what occurred in the groups, but only the four major categories were used in the statistical calculations: "Receives an explanation on content", "Gives help on content", "Receives no explanation on content", and "All procedural help".

Among the twenty-five children whose interactions were
analyzed verbatim, there were 217 "Giving help" interactions. The number of responses ranged from one student who gave 2 to another student who gave 17. For all types of "Procedural" interactions, there were a total of 511 interactions, with the number of responses ranging from 6 to 42. Positive correlations between the four categories of interaction suggest that those students who were active participants in the group tended to be active in all kinds of interactions.

One type of behavior (receiving only an answer but not an explanation) was coded two different ways: first it was subsumed under the category of "No explanation" as Webb had done; later it was changed to be included under the category of "Receives an explanation". This was for the purpose of exploring whether that behavior (receiving a terminal response) correlated with achievement or other dependent variables. It made no difference whether receiving only an answer was grouped with "Receiving an explanation" or with "No explanation given"; there were no significant correlations between any of the categories of behavior and posttest or gain scores. This is in contrast to Webb's findings across her five major studies which included more than 350 students across a variety of grade levels (1985). She found that receiving a terminal response was negatively related to achievement but that receiving an explanation was positively related to achievement. The most likely explanation of this result is that the students in this study
were cognitively and verbally less mature than the population from which Webb drew her subjects. Primary-aged students do not have sufficient verbal skills to give a full explanation of a content skill (Webb, phone conversation, May 30, 1986). Piaget's work also indicates that a child can typically act and think effectively about a concept before he/she can verbalize or even be conscious of his/her actions or thoughts (Ginsburg & Opper, 1979).

**Students' interaction and achievement.** In this study there was no relationship between any of the four categories of students' group interaction and achievement. Webb found significant correlations for certain categories of student interaction and students' achievement when the small groups were doing mathematics (1982a, 1982b, 1982c, 1983) but not when the small groups were learning a computer language (1984a). Thus, the data in this study differ from Webb's findings about small group mathematics learning but concur with Webb's findings about small group computer learning.

**Giving Help.** Webb (1985) discusses the different effects on achievement of giving a terminal response versus giving a detailed explanation. Giving explanations was consistently and positively related to achievement while giving only terminal responses was not related to achievement in five studies of small group learning.

Hypotheses concerning the greater benefit of giving explanations than of giving terminal responses
come from cognitive theories of learning and studies of cognitive processes. Particularly relevant here is Wittrock's model of generative learning, in which the learner generates associations between new information and concepts already learned (Wittrock, 1974a,b). Giving explanations not only involves verbalizing associations between new and learned information but may also involve generating new elaborations. A recent study on the cognitive benefits of teaching by Bargh and Schul (1980) also supports the efficacy of giving explanations. Bargh and Schul compared the achievement of persons studying the material only to learn it themselves. Students studying to teach the material learned more than did students studying only to learn. (Webb, 1985, p.155)

Receives an explanation of the map skill. In the five studies Webb (1985) discussed, receiving an explanation was beneficial for achievement while receiving a terminal response was negatively related to achievement. Our results show no relationship between either the explanations or the terminal responses and achievement scores. Again, the most likely explanation of this result is that the students were developmentally quite different from the population from which Webb drew her subjects. Because these students were much younger, they probably could not generate the type of explanations necessary to influence their peers' achievement.
Attributes of Groups.

Beyond the characteristics of the individuals, such as sex and ability, the groups as distinct entities had characteristics which can be described. For example, the "odd man out" was a function of the group not of isolated individuals. Some of the attributes of groups which were described in the Review of Literature offer an appropriate framework for describing the characteristics of the groups which participated in this study.

Of the dimensions of group interaction presented by Schmuck and Schmuck (1971), two are useful in discussing this study: how group members gained status and how task oriented a group was. The other dimensions described by Schmuck and Schmuck more appropriately pertain to groups which function during many meetings, rather than the one-time session allowed the groups in this study.

Schmuck and Schmuck ask whether group members gain status by their performance or by some inherent characteristic. Our groups demonstrated that some inherent or previously ascribed characteristic influences a student's status in a group. For example, the "odd man out" phenomenon noticed in the groups of three commenced as soon as the groups began their work. The odd man out was different in some way from the other students (such as labelled "learning disabled", or of a different ethnic group than the other group members, or a
non-native American). What is important, though, is that in some cases the odd man out could rehabilitate him/herself. In two cases the ascribed characteristic which hindered full participation was cancelled out by "meritorious" behavior. Those two students could be described as persistent as well as assertive in gaining social acceptance from their peers. Over the course of the session, they achieved acceptance as an equal group member. Durnin and Trowbridge (1983) did describe the "odd man out" phenomenon in their groups of three and four students. They did not, though, assess the development of the group process, as was done in this study. Whereas this study showed that a student could "rehabilitate" him/herself, Durnin and Trowbridge do not investigate this possibility.

Schmuck and Schmuck's fifth dimension of group interaction asks how much of the group work is focused on the content of the assigned task. This seems to be a function of motivation. For the most part the groups in this study were not distracted from the C.A.I. assignment, had very high motivation because using the computer was novel, and were thus focused heavily on the assigned task. There was one anomalous group. This was a pair which, although capable of doing the lesson (as measured by their ability and their pretest knowledge), stayed on-task only when the observer intervened.

Group goals, in all their variations, are also
applicable to the behavior of the students in this study. The two dichotomies are individual/group and task/social-emotional (Schmuck and Schmuck, 1971).

First, were individual task goals achieved? That is, did the students make achievement gains? The individual posttest minus pretest scores prove that the majority made significant gains. Second, individual's social-emotional goals were achieved as shown by their continued high rating of computer learning and continued preferences for working in groups. Again, the observer's notes revealed one maverick group. In this case, it was a triad made up of one high-ability but socially-naive boy and two lower-ability but "streetwise" classmates. The higher-ability student had social studies and procedural knowledge, but was too much intimidated to share any information with his peers. The others were not inclined to seek help. No one dominated the group but it did not function very successfully. On the whole, though, it is remarkable that most groups functioned as well as they did with no training in the process of group process. The qualitative data support the conclusion that for almost all students—the above-mentioned triad being an obvious exception—this C.A.I. lesson was a positive social-emotional experience.

Third, were group task goals achieved? For example, could they play the game which required the application of all of the previous skills learned? All groups (except for
the one pair which consistently required observer intervention to stay on task) completed the game. Only two groups necessitated a lot of observer intervention to do the game task; these two groups were very deficient in either reading skills or knowledge of the social studies skills. All other groups worked cooperatively to play the game and were successful at the task.

Fourth, were group social-emotional goals achieved? Many researchers have suggested that a group needs to be trained in order to work cooperatively (Jakovino, 1980). In this instance, the overwhelming majority of groups were able to work cooperatively without having had any previous explicit training in group processes. Were there group cohesiveness and a sense of accomplishment? For most groups the answers were yes. Many ended the session with a cheering "We Won!".
Cooperation, Cooperation in the small groups was defined as helping each other on content or procedure, sharing the keyboard, encouraging peers to participate, and joint problem-solving. Controversy about the content or the best course of procedural action often led to cooperative interaction; only when controversy resulted in hostile action or one student seeking to compete with another student was it not included under the definition of cooperation. Both cooperation and competition required active interaction between peers. When students refused to speak to one another, as occurred in one pair, that group was labelled neither cooperative nor competitive.

Cooperation was not correlated with sex, dominance, or achievement. Yet high ability students were more likely to be found in a group which was labelled cooperative ($r=.29$, $p<.02$). Because so many of the students were cooperative, the data did not lend itself to a comparison between cooperation and competition.

In the largely cooperative learning environment of this study, students in all group sizes made significant achievement. This is consistent with the findings of a meta-analysis of 98 studies which found that cooperative learning experiences, compared with competitive or individualistic ones, promote greater interpersonal
attraction among all types of students, promote the discovery and development of higher quality cognitive strategies for learning, and promote active oral involvement (Johnson & Johnson, 1985). As a consequence, cooperative learning experiences result in students feeling more positive about themselves as learners and students liking the subject matter better (Johnson & Johnson, 1985).

**Competition.** Competition in the small groups was defined as seeking to gain advantage at the expense of another group member. Shoving a peer away from the keyboard so that one could be in control was an example of competitive behavior. An example of a competitive verbal exchange:

Z: That was very stupid, you know?
G: What?
Z: You're not supposed to press space... I said right next to it! I said right next to it (in a more demanding tone). Right next to W.
G: Oh.
Z: Are you blind? Are you blind?
G: Let me do it. I am going to do it!

The definition of competition used in this study did not include friendly bantering or normal physical contact. The definition used for competition was the same one used by Trowbridge and Durnin (1983) and is consistent with the explanations of Pepitone (1985).

Competition was not correlated with ability or...
dominance or achievement. Boys were more likely to be found in a group labelled as competitive than were girls \( (r=0.22, p=0.055) \).

**Competition and cooperation on the game task.**
The C.A.I. utilized in this study contained a tic-tactoe game which is usually a competitive activity. Pairs of students were asked to "play against each other". Yet, some of the pairs continued to cooperate on problem-solving, share answers, and give assistance on strategy to their peers. Groups #7 and #8 were illustrative of students who helped each other, rather than competed against each other when playing the game.

It should be noted, again, that the groups of three were instructed to work as one team against the computer. Thus, their assigned task was not as inherently competitive as was the task of the groups of two (although it was the same tic-tactoe game). In the groups of three, the patterns of group interaction established earlier in the session usually extended into the game part of the C.A.I. That is, if one student dominated, such as in Group #12 and #19, that same person continued to dominate even though the assigned task was changed to a game. In Groups #18, #20, and #21, cooperation continued throughout the whole session. In a few groups (#14, #17, & #22), though, when the program changed to the game, the interaction among the students changed. For example, the
boys in Group #14 became competitive during the game even though they were very cooperative prior to that task.

Trowbridge and Durnin (1983) concluded that "pairs were somewhat superior in terms of cooperative and tutorial behavior." (p.10) This study does not concur with their findings. It should be noted that this study examined students who were in second grade whereas Trowbridge and Durnin looked at seventh and eighth middle-ability students. They deliberately set up groups which were homogeneous in terms of ability. In light of both classroom reality and the work of (Hallinan, 1984; Webb, 1980, 1982a, 1982b), heterogeneous-ability groups seem to be a better choice.

Dominance. It usually was a male when one student dominated a group and it always was the highest-ability student (r=.23, p=.046). Dominance had no correlation, though, with achievement. Nor did the groups which had a dominant person have greater tendency to be cooperative or competitive. Dominance did not have a significantly positive nor a negative effect which could be quantitatively measured.

The only visible advantage to having one dominant member of the group was in facilitating group functioning, particularly at the commencement of the C.A.I. session. Having one dominant group member usually was effective in getting the group quickly working on task. In contrast,
the pair which had two completely passive students could not get started on the assignment until the observer intervened.

Why were highest-ability students and male students more likely to be the dominant individuals in a group? Cohen says that

status characteristics, whether diffuse or specific, tend to become salient in new collective tasks where they have no direct relevance to the task at hand. This occurs through the medium of beliefs presuming superior competence of individuals with higher social status; these expectations regarding an individual’s competence tend to generalize to group interaction on tasks having nothing to do with the status distinction. As a result, higher-status individuals will be more active and influential than lower-status individuals in the group task.

(Cohen, 1984, p.172)

Group #12 illustrates this point. This was a triad where the dominant individual did indeed possess greater competence in reading the text. She led the group even though she did not have an understanding of the social studies skills. The only one who had knowledge of the social studies skills and who eventually taught the others the necessary skills was the poorest reader. That individual (the poorest reader) initially had the lowest status in the group. In fact, the others in the group repeatedly ignored his input until the game part of the session, when his knowledge became essential to the group’s success.
Individual learning in a C.A.I. group. In all groups using one computer terminal, whether they are characterized by mixed-ability levels or not, there was often disagreement among the group members as to what answer should be keyed into the computer. Sometimes, a discussion resulted in a consensus. In that case, peer teaching in the form of explanation and persuasion was beneficial to the speaker as well as the listener. Johnson and Johnson (1985) say that if a student has the social skills and the groups are structured properly, controversy can be very positive.

When managed constructively, controversy promotes epistemic curiosity or uncertainty about the correctness of one's views, an active search for more information, and, consequently, higher achievement and retention of the material being learned. Individuals working alone in competitive and individualistic situations do not have the opportunity for such a process, and therefore, their achievement suffers.

(Johnson and Johnson, 1985, p.115)

In this study, occasionally one student dominated the groups to such an extent that he/she invariably prevailed as to what answer should be entered. More frequently, two students came to a consensus as to what was the right answer. A third student in the group might retain a "minority opinion", but only the consensus answer could be submitted to the computer. Cartwright (1976) suggests a theory for why all of the students who are in a C.A.I. group learn, even though each person in the group cannot key in his/her preferred answer. Cartwright explains that each child individually
processes whatever the computer feedback is.

An example is in order. Student A wants "North" for the answer, but Students B and C prevail and key in their preferred answer of "South". The computer response is "That is incorrect. The right answer is North." Student A has been positively reinforced even though she did not get to input her answer. Students B and C have been corrected and have learned to be less certain of their present understanding of the concept. Students B and C may each do a covert metacomprensive check, asking themselves what they know and don't know about the North-South directions. If the social conditions are ripe, they may overtly discuss what they don't understand or they may seek additional information from Student A.

The development of small group learning. What we know is that the students learned in the small groups equally as well as when they were alone. What we want to consider is how the groups developed over time in relation to the assigned tasks. We know that there were two major components of the C.A.I. lesson: the tutorial and the game. The tutorial presented information, asked questions, gave feedback, and sometimes branched for more or less practice. The game required application of the social studies skills learned, as well as knowledge of tictactoe game strategy. How did competition and cooperation change as the groups
functioned over time and as the group faced slightly different tasks?

Within the groups, students could and did compete for control over the keyboard, but rarely did they compete for access to information even when they were playing the game. In fact, it was surprising that when the task changed from tutorial to game, most of the students did not increase the amount of competitive behavior. The most frequent pattern was that a group became cooperative about halfway into the tutorial and remained cooperative through the game until the end of the session.

What students did most is help each other. Especially on procedural problems, such as which keys to press, what the text said, or how to spell a word, most students asked and received an answer (a terminal answer rather than an explanation).

In those instances where a student helped another student to understand the social studies skill, the "explanation" was mostly gesture, pointing to various directions. Occasionally, a student would explain to another how to remember the directions by an acronym or rhyme (The observer, too, was informed that "Never Eat Shredded Wheat." stands for North, East, South, West). But these explanations were so limited because the students did not have the verbal skills necessary for more elaborate explanations.
The game was a motivator for the students. They repeatedly asked when it would be time to do the game. Even though they were told as part of the directions that the skills learned in the first part of the C.A.I. were necessary to play the game, most students considered the game as reward rather than as culminating practice activity. Some had difficulty transferring the concepts learned earlier to the game format; for those students the connection between the tutorial and the game was not initially evident. Once they understood what to do, they usually wanted to play many times. (Time limitations allowed for one complete game per group.) It was interesting to note that, although the tictactoe game is inherently competitive, students often assisted each other on game strategy as well as on answering the directionality questions.
Conclusions and Recommendations

Students' Achievement on the C.A.I. Task

Group size and achievement. Finding that students who work alone, in pairs, or in triads do equally well on the C.A.I. task is reassurance to administrators that for C.A.I. tutorial work student-to-computer ratios of 3 to 1 or 2 to 1 are educationally and economically sound. There may be purposes for which each student should have individual time on the computer, but the purchase of thirty computers for thirty students is not necessary if the goal is C.A.I. tutorials such as the one that was used in this study.

Students' gains and the computer game. Students' gains were confirmed by the pretest and the posttest. The qualitative data allowed for a closer examination of the type of tasks students were asked to perform. This analysis pointed to the importance of the game component of the C.A.I. There were many instances in which students did not cognitively process the skills fully until they were confronted with the challenge of winning the game. The tictactoe game required the students to apply skills learned earlier. Although this study was not designed to isolate the game component, another researcher may want to build on the work of Malone (1980) and this study by exploring the importance of the game. Designing and implementing a study
which has some students learn a skill via C.A.I. with a game while others learn the same skill without the game would be a logical next step.

**Ability and achievement.** Students in small groups do best if they represent a variety of ability levels (Hallinan, 1984). This study found that for triads, but not for pairs, students in mixed-ability groups had significantly greater gains in achievement than students in uniform-ability groups. Webb (1980, 1982a, 1982b) did not use pairs in her studies of small groups for mathematics lessons. Thus, our findings concur with Webb's yet raise more questions: Under what conditions is the composition (in terms of ability) of the pairs is significant? What happens in the groups of three that make uniform-ability groups less functional for students' achievement? These questions need to be asked in studies that provide a larger number of groups.

**Sex and achievement.** The quantitative data showed that boys and girls did equally well on this computer assignment, and the qualitative data confirms that boys and girls were equally motivated to learn via this technology. This is an encouraging bit of information. Although for their older brothers and sisters sex may be a factor for learning via computers, these youngsters are still free from sex-role stereotyping in computer learning. It is hoped that other studies will confirm this finding.
Student Interaction in Small Groups

The odd man out phenomenon. As computer use in schools expands, small-group instruction may very well increase also. Thus, understanding the social ramifications for students is important. Further study needs to be made in order to elucidate which students end up being "odd men out", under what conditions they can rehabilitate themselves, and under what conditions they do not rehabilitate themselves. Are there skills, such as assertiveness training, that these students could utilize to improve their success in functioning in a small group?

Giving & receiving explanations. Webb (1982c, 1985) has presented convincing arguments that giving and receiving explanations rather than giving and receiving terminal responses are an advantage to students' learning. The subjects of this study rarely gave or received explanations probably because they do not yet possess sufficient verbal competence. This is a clue regarding the ideal age for successful peer-led small group learning. A more elaborate research design could investigate (a) the developmental stage when students can successfully offer explanations in small group settings; (b) whether modeling of explanations by a teacher results in students being able to offer their peers comprehensive explanations rather than only terminal responses; (c) whether there are more or fewer
Procedural help. The category of procedural help included asking, giving, and receiving help of several different types. For some of the subjects reading the text or spelling the answers to be typed in (usually just copying the answers from the screen) were very time-consuming and interaction-rich activities. Further research may explore the different elements of this category: (a) reading text, (b) following directions to complete the C.A.I. task, (c) using the computer, especially utilizing the keyboard, (d) spelling words to be typed in, (e) asking for versus receiving versus giving procedural help. It may be useful in future research to divide the procedural category.

Cooperation and competition on the game task. This study also may expand the discussion of Johnson and Johnson's (1978) conclusion that competitive learning structures promote greater quantity of output for simple, mechanical, previously-mastered tasks. The task in the tic-tactoe game could be labelled mechanical and the skills were previously-mastered by some of the students before they attempted the game. Yet, the children chose to cooperate rather than compete. A follow-up study designed to compare students who cooperate on the game with those who compete on the game or to analyze conditions that promote cooperation
may be useful additions to Johnson and Johnson's work.

**General Issues**

**The mortality of novelty.**

For the students in this study, the novelty of computer technology was still evident. It is unlikely that future researchers will have to deal with the advantages (high motivation) or disadvantages (computer illiteracy) of computers in their infant stage of use. When most young people can easily handle a computer keyboard, there may be a significant reduction in procedural help-seeking. On the other hand, it is likely that students will be less motivated to do assigned computer tasks when the computer is no longer novel.

**C.A.I. in the classroom.** The mix of C.A.I. with conventional teaching was an assumption of this study and of more and more teachers and administrators (Koontz, personal communication, July 1984). No longer is there a fear that computers will replace teachers. Rather, the questions being asked are: (a) How can computers effectively complement teachers? (b) What kinds of skills should be presented via C.A.I.? (c) How much prior teaching and follow-up teaching is optimal? While this study illustrates how a tutorial on concrete social studies skills can effectively be used with young children, it only begins to address the issue of prior teaching and was not designed to look at teaching which
follows the C.A.I. Systematic research on these issues would offer guidance to educators who are daily implementing C.A.I. in their schools and classrooms.
Attention Patron:

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LITERATURE CITED


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structured games as a teaching strategy in a secondary school class to increase the group cooperation behaviors of its students. (Doctoral dissertation, University of Pennsylvania, 1980). Dissertation Abstracts International. 41(08), 3403-A.


Okey, J. R., & Majer, K. *Individual and small group learning with computer assisted instruction.* (ERIC Document Reproduction Service No. ED 107 239)


APPENDIX A: The Compass Rose Tutorial

0 REM 4/22/84
1 REM
2 REM ************
ID=31410
15 ZO=0:ZI=1:S=6:ML=1536:DIM F$(16),A$(12):POKE 106,PEEK(106)-16:GRAPHDICS 7:COLOR:
APHIC5 17
19 GUSUB 32000:GRAPHDICS 17
20 POSITION 2,10: "cardinal"
30 POSITION 5,1: "MAP SKILLS"
40 POSITION 2,5: "THE COMPASS ROSE"
50 POSITION 2,8: "FOR:
60 POSITION 2,10: "cardinal"
70 POSITION 2,12: "intermediate"
80 POSITION 2,14: "relative"
90 POSITION 1,16: "DIRECTIONS"
100 POSITION 0,20: "PLEASE WAIT"
110 IF PEEK(1791)>255 THEN 130
120 RESTORE 260:POKE 1791,255:FOR I=0 TO 255:READ A:POKE ML+I,A:NEXT I
130 CHSET=(PEEK(106)-9)*256:FOR I=0 TO 1023:POKE CHSET+I,PEEK(57344+I):NEXT I
140 READ A:IF A=-1 THEN 170
150 FOR J=A TO 7:READ B:POKE CHSET+A*E+J,E:NEXT J
160 GOTO 140
170 POKE 1791,255:POKE 1790,CHSET/256
180 POSITION 0,20: "PRESS start TO BEGIN":GUSUB WAIT:GOTO 540
190 DATA 5,85,170,85,170,85,170,85,170
200 DATA 5,1,3,7,15,31,63,127,255
210 DATA 6,125,192,224,244,248,252,254,255
220 DATA 7,7,7,7,7,7,7,7,7
230 DATA 32,224,224,224,222,224,224,224,224
240 DATA 62,195,195,36,24,24,36,195,195,195
260 DATA 153,195,104,201,128
270 DATA 144,4,41,127,195,195,170,141,250,6,224,96,176,15,169,64,224,72,144,2,16
280 DATA 9,224,24,109,250,6,141,250,6,104
290 DATA 104,141,251,6,104,104,141,252,6,14,252,6,104,104,141,253,6,135,186,255
300 DATA 87,169,10,224,3,240,8,169,20,224
310 DATA 5,240,2,169,40,133,207,133,187,165,65,133,203,165,69,133,204,52,228,6,2
320 DATA 147,252,6
330 DATA 101,205,133,203,144,2,230,250,204,24,165,205,101,212,153,203,165,204,101,21
340 DATA 133,204,175,250,6
350 DATA 133,187,169,8,133,186,32,228,6,165,212,133,205,173,244,2,101,213,153,20
360 DATA 6,160,0,162,8,169,0,133,208,133,209
370 DATA 177,205,69,195,72,104,10,72,144,8,24,173,251,6,5,208,133,208,224,1,240
380 DATA 8,6,208,38,209,6,208,38,209
390 DATA 202,208,226,104,152,72,160,0,165,209,145,203,200,165,208,145,205,104,16
400 DATA 8,24,165,203,101,207
410 DATA 133,202,144,2,230,250,204,200,192,8,208,183,96,169,0,133,212,162,8,70,186,1
420 DATA 44,3,24,101,187,106,102,212,202,208
430 DATA 245,133,213,96,0,1,28
450 POKE 752,1:RETURN
455 POKE CON,8
115

451 IF PEEK(CON)<6 THEN 451
452 FOR X=1 TO 100 NEXT X:RETURN
453 POKE 756,PEEK(1790):RETURN
540 GRAPHICS 10
550 IF CON=5 THEN 610
560 ? "IF YOU NEED HELP"
570 ? "PRESS SELECT."
580 ? "IF YOU KNOW THE"
590 ? "WORDS."
600 ? "PRESS START."
610 POKE CON,8:IF PEEK(CON)=5 THEN GOTO 640
620 IF PEEK(CON)=5 THEN GOTO 650
630 GOTO 610
640 GOSUB VOC
650 GOSUB ROSE:GOSUB OFF:? "THIS IS A COMPASS ROSE"
660 ? "PRESS START TO CONTINUE":GOSUB WAIT
670 GRAPHICS 2:COLOR 2
680 ? "AFTER PRACTICE"
690 ? "USING THE"
700 ? "COMPASS ROSE FOR"
710 ? "FINDING DIRECTIONS"
720 ? "ON A MAP."
730 ? "YOU WILL PLAY"
740 ? "A GAME"
750 ? "WITH THE COMPUTER"
760 GOSUB OFF:? "PRESS START TO CONTINUE":GOSUB WAIT:GRAPHICS 2
770 ? "THE COMPASS ROSE"
780 ? "TELLS YOU DIRECTIONS"
790 ? "ON A MAP."
800 ? ""
810 ? "N STANDS FOR NORTH."
820 ? "E STANDS FOR EAST."
830 ? "W STANDS FOR WEST."
840 ? "S STANDS FOR SOUTH."
850 GOSUB OFF:? "PRESS START TO SEE"
860 ? "THE COMPASS ROSE":GOSUB WAIT:GOSUB ROSE:GOSUB OFF
870 ? "N STANDS FOR NORTH. PRESS"
880 ? "E STANDS FOR EAST. START"
890 ? "W STANDS FOR WEST. TO"
900 ? "S STANDS FOR SOUTH. CONTINUE...":GOSUB WAIT
909 GRAPHICS 7
765,2:10 18,6,20,20,"S:"
765,3:10 18,6,20,20,"S:"
930 COLOR 1:PLTF 85,75:DRAWTO 85,50:DRAWTO 10,50:POSITION 10,75:POKE 765,1:10 18,
6,20,20,"S:"
940 GOSUB OFF:? "Enter the color of the northern part":? "of the map."
970 ? "<1> RED <2> BLUE"
980 END: "GREEN";
990 IF A$="G" THEN "ENTER 1, 2, 3, 4": GOTO 990
1000 IF A$="1" OR A$="RED" THEN 1050
1010 GOSUB OFF: "That is wrong."
1020 "The answer is RED or 1."
1030 "Press START.
1040 GOSUB WAIT: GOTO 1060
1050 GOSUB FRAG.
1060 GRAPHICS 7: COLOR 1: PLOT 70, 56: DRAWTO 70, 31: DRAWTO 70, 7: DRAW TO 74, 22: DRAW TO 74, 16: REM N
1070 PLOT 66, 22: DRAWTO 66, 16: DRAWTO 74, 22: DRAWTO 74, 16: REM N
1090 GOSUB OFF:"
1100 "Look at the arrow with the N."
1110 "This arrow points to the NORTH."
1120 "Press START to continue."
1130 GOSUB TEXT: "What letter is in the northern part of the map?": INPUT A$
1140 "part of the map": INPUT A$
1150 IF A$="A" THEN GOSUB FRAG: GOTO 1190
1160 "The letter A is in the"
1170 "northern part of the map."
1180 "Press START to continue."
1190 GOSUB TEXT
1200 "Fill in the blank:".
1210 "The letter E is in the ________"
1220 "part of the map": INPUT A$
1230 IF A$="W" OR A$="WEST" THEN GOSUB FRAG: GOTO 1270
1240 "This letter E is in the"
1250 "WESTERN part of the map."
1260 "Press Start to continue."
1280 COLOR 1: PLOT 90, 75: DRAWTO 90, 50: DRAWTO 45, 50: POSITION 45, 75: PLOT 75, 3: XIC 18, #S, Z0, Z0, "S:"
1290 COLOR 2: PLOT 90, 75: DRAWTO 155, 50: DRAWTO 90, 50: POSITION 90, 72: PLOT 75, 2: XIC 18, #S, Z0, Z0, "S:"
1300 "What color is the eastern part of the map?": INPUT A$: IF A$="B" OR A$="BLUE" THEN GOSUB FRAG: GOTO 1500
1310 "the map": INPUT A$: IF A$="B" OR A$="BLUE" THEN GOSUB FRAG: GOTO 1500
1320 "That is wrong."
1330 "The answer is B OR BLUE."
1340 "Press START."
1350 GOSUB WAIT
1360 "What color is the eastern part of the map?": INPUT A$: IF A$="B" OR A$="BLUE" THEN GOSUB FRAG: GOTO 1500
1370 "the map": INPUT A$: IF A$="B" OR A$="BLUE" THEN GOSUB FRAG: GOTO 1500
1380 "Type TEACHER and ask her why."
1500 GRAPHICS 7: COLOR 2
117

? "The Compass Rose helps us find"
? "other kinds of directions, also."
A=USR(ML,ASC("N")),2,24,35)
A=USR(ML,ASC("E")),2,34,35)
A=USR(ML,ASC("S")),2,9,63)
FLOT 76,20:DRAwT0 76,60:FLOT 43,40:DRAwT0 107,40
FLOT 76,20:DRAwT0 81,25:FLOT 76,20:DRAwT0 71,25
GOSEU WAIT
COLOR 1:FLOT 76,40:DRAwT0 105,22
FLOT 105,22:DRAwT0 98,22:FLOT 105,22:DRAwT0 105,28
? "The orange arrow points to the "
? "northeast.""
? "Press Start."
? "The compass rose shows us south and west. The direction northeast is both south and __": INPUT A$
A=USR(NL,A88("w")),2,24,35)
A=USR(ML,ASC("S")),2,9,63)
COLOR 1:PL8T 76,40:DRAWT8 105,22
PLOT 105,22:DRAwTO 98,22:PLOT 105,22:DRAwTO 105,28
FLOT 43,56:DRAwT0 44,50:FLOT 43,56:DRAwT0 51,56
IF A$="N" THEN 1800
? "That is wrong. Try again.";FOR X=1 TO 500:NExT X:GGTQ 1620
If FEEH(CDN>=6 THEN 1000
IF PEEK(764)=12 THEN RUN "D:HENU"
GOIO 1860
COLOR 1:POKE 710,133:POKE 752,1
PLOT 20,10ZDRAwTO 130,10ZDRAWTO 130,40:DRAwT0 140,40:DRAwT0 140,70:DRAwT0 107,40:DRAwT0 10,10ZDRAwT0 20,10
FLOT 60,60:DRAwT0 60,30:DRAwT0 65,35:FLOT 60,30:DRAwT0 55,35
FLOT 58,25:DRAwT0 58,20:FLOT 63,25:DRAwT0 63,26:FLOT 58,20:DRAwT0 58,20:DRAwT0 58,20:DRAwT0 53,25
This Arrow Points to the north."
? "Point one of your fingers in that": "direction."
? "Press start to continue.";
GOSEU WAIT
FLOT 45,45:DRAwT0 95,45:DRAwT0 90,40:FLOT 95,45:DRAwT0 90,50:FLOT 100,45:DRAwT0 100,50:
FLOT 100,40:DRAwT0 105,40:322=7:FLOT 100,45:DRAwT0 105,45:6CSEUB 55,50

1510 ? "The Compass Pose helps us find" 1520 ? "other kinds of directions, also."
1540 A=USR(ML,ASC("N")),2,24,35)
1550 A=USR(ML,ASC("E")),2,34,35)
1560 A=USR(ML,ASC("S")),2,9,63)
1580 FLOT 76,20:DRAwT0 76,60:FLOT 43,40:DRAwT0 107,40
1590 FLOT 76,20:DRAwT0 81,25:FLOT 76,20:DRAwT0 71,25
1600 GOSEU WAIT
1606 COLOR 1:FLOT 76,40:DRAwT0 105,22
1620 FLOT 105,22:DRAwT0 98,22:FLOT 105,22:DRAwT0 105,28
1620 ? "The orange arrow points to the "
1621 ? "northeast.""
1620 ? "Press Start."
1622 COLOR C:FLOT 76,40:DRAwT0 105,22
1623 FLOT 105,22:DRAwT0 98,22:FLOT 105,22:DRAwT0 105,28
1625 COLOR 3:FLOT 45,56:DRAwT0 51,56
1620 FLOT 43,56:DRAwT0 44,50:FLOT 43,56:DRAwT0 51,56
1625 ? "In what direction does the blue": "arrow point? Type one of these words.
1630 ? "northwest, northeast, southeast,"?: "southwest."::INPUT A$
1630 IF A$="SOUTH" THEN 1700
1640 ? "That is wrong. Try again.";FOR X=1 TO 350:NExT X:GO010
1700 ? "The compass rose shows us south and": "west. The direction southwest is both": "south and __": INPUT A$
1710 IF A$="WEST" THEN 1800
1720 ? "That is wrong. Try again.";FOR X=1 TO 500:NExT X:GO010
1800 GRAPHIC5 7:COLOR 1:POKE 710,133:POKE 752,1
18010 IF A$="SOUTHWEST" THEN 1700
1860 IF PEEK(764)=12 THEN RUN "D:HENU"
1870 BOTO 1860
1890 BOTO 1860
10000 GRAPHIC5 7:COLOR 1:POKE 710,133:POKE 752,1
10010 FLOT 20,10:DRAwT0 130,10:DRAwT0 130,40:DRAwT0 140,40:DRAwT0 140,70:DRAwT0 107,40:DRAwT0 10,10:DRAwT0 20,10
10020 FLOT 60,60:DRAwT0 60,30:DRAwT0 65,35:FLOT 60,30:DRAwT0 55,35
10030 FLOT 58,25:DRAwT0 58,20:FLOT 63,25:DRAwT0 63,26:FLOT 58,20:DRAwT0 58,20:DRAwT0 58,20:DRAwT0 53,25
10040 ? "This Arrow Points to the north."
10050 ? "Point one of your fingers in that": "direction."
10060 ? "Press start to continue.";
10070 GOSEU WAIT
10075 FLOT 45,45:DRAwT0 95,45:DRAwT0 90,40:FLOT 95,45:DRAwT0 90,50:FLOT 100,45:DRAwT0 100,50:
10078 FLOT 100,40:DRAwT0 105,40:322=7:FLOT 100,45:DRAwT0 105,45:6CSEUB 55,50
Now point your finger from "your other hand to the east" as the arrow with the E does. Press start.

Bring your two fingers together, so they meet in an in between position.

Press start to continue.

The blue arrow is in ___ direction. "Type 1)northeast, 2)southeast or 3)southeast."

Input A$: IF A$="1" OR A$="NORTHEAST" THEN GOTO 10240

Try again" : FOR J=1 TO 1000: NEXT J: GOTO 10230

GOSUB FRA

PCHE 252,1

GRAPHICS 2+16

RUN "D:MENU"

FOR J=1 TO 1000: NEXT J: GOTO 10230

BDSUE FRA

GRAPHICS 7: POKE 710,0: COLOR 2


PLOT 52,57: DRAWTO 52,43: DRAWTO 49,39: DRAWTO 46,43: DRAWTO 46,37

PLOT 75,22: DRAWTO 75,16: DRAWTO 83,22: DRAWTO 83,16


DRAWTO 75,65


RETURN


RETURN

DRAWTO 80,6: DRAWTO 17,6: PLOT 123,61: DRAWTO 140,61: PLOT 131,50: DRAWTO 171,70

A=USR(ML,ASC("A"),3,4,9)

A=USR(ML,ASC("B"),3,3,26)

A=USR(ML,ASC("C"),3,112,30)

A=USR(ML,ASC("D"),3,110,50)

A=USR(ML,ASC("E"),3,134,51)

A=USR(ML,ASC("E"),2,116,36)

A=USR(ML,ASC("E"),2,162,57)

A=USR(ML,ASC("E"),2,166,37)

A=USR(ML,ASC("E"),2,116,61)

RETURN

FRS$="GOOD!":M=5:F1=1:RETURN

FRS$="GREAT!":M=5:RETURN

FRS$="SUPER!":M=5:F1=2:RETURN

FRS$="CORRECT.":M=5:F1=10:RETURN

PRINT(10+RND(1)+1): ON PR 6050D 30040,30050,30060,30070,30080,30090,30100,30110,30120,30130

COLOR 1: FOR J=1 TO LEN(FRS$): A=ASC(FRS$(I,I)): V=USR(ML, A INT (A+FREX(1)+1), I,F1): FOR X=1,0004=37 TO 25

NEXT Y:NEXT I

FOR X=1 TO 750:NEXT X:RETURN
These are some words you need to know for this program.

1. DIRECTION
2. POSITION
3. ROUTE
4. POINTS
5. NOTICE
6. EXPLAIN
7. COMBINES

Type the number of any word you don't know.

Type D or DONE when you know all of the words.

Type the word is,
DIRECTION means
IN WHICH WAY.

***************

IN WHAT direction
DID THE PLANE GO?
IT WENT TO THE WEST.

I COULD NOT FIND THE
OFFICE, SO I ASKED
FOR directions.

THE WORD IS
POSITION

WHAT POSITION DOES
HE PLAY IN BASEBALL?
HE PLAYS FIRST BASE.
I COMBINE MEANS "TO COME TOGETHER OR" TO BRINGS TOGETHER."

WHEN YOU COMBINE SOIL AND WATER YOU GET MUD.

WE ARE GOING TO COMBINE BREAKFAST AND LUNCH.

WE ARE GOING TO HAVE BRUNCH!

A PARTNER IS SOMEONE WHO WORKS OR PLAYS WITH ANOTHER PERSON.

WILL YOU DANCE WITH ME? WILL YOU BE MY PARTNER?

HERE ARE SOME SENTENCES: "WITH THE WORD, READ THEM OUT LOUD."
COLOR 1
J=20
FOR I=40 TO 80
PLOT I,J;DRAWTO I,J+20
J=J+1
NEXT I
COLOR 2
FOR I=120 TO 80 STEP -1
PLOT I,J;DRAWTO I,J-20
J=J-1
NEXT I
COLOR 3
J=11
FOR I=60 TO 100
PLOT I,J;DRAWTO I,J+20
J=J+1
NEXT I
? "ORANGE BLUE LIGHT"
? "GREEN"
? "PLEASE ADJUST YOUR MONITOR SO THAT THESE MATCH. PRESS RETURN WHEN RE
ADV.";
OPEN #1,4,0,"K:
GET #1,A
CLOSE #1
RETURN
My name is ____________________________

Circle the right answer.

1. I am a  
   1. girl  
   2. boy

2. On this map, which part of the land has dots?  
   1. northern 
   2. southern 
   3. eastern 
   4. western 
   5. I don't know.

3. On this map, which part of the land has dots?  
   1. northern 
   2. southern 
   3. eastern 
   4. western 
   5. I don't know.

4. The letter B is in what part of the map?  
   1. southwestern 
   2. southern 
   3. northern 
   4. northeastern 
   5. western 
   6. I don't know.

5. The letter D is in what part of the map?  
   1. southwest 
   2. southeast 
   3. northeast 
   4. north 
   5. northwest 
   6. I don't know.

6. What do you think of computers?  
   1. They are boring. 
   2. They are O.K. 
   3. They are a lot of fun. 
   4. I'm not sure.
6. What do you think of computers?
   1. They are boring.
   2. They are O.K.
   3. They are a lot of fun.
   4. I'm not sure.

7. The letter C is in what part of the map?
   1. southern
   2. southeastern
   3. southwestern
   4. northwestern
   5. northeastern
   6. I don't know.

8. Chris, the person on this map, wants to go from point A to point B. In what direction will Chris have to go?
   1. north
   2. east
   3. west
   4. south
   5. I don't know.

9. Sal, the person on this map, wants to go from point E to point F. In what direction will Sal have to go?
   1. north
   2. southwest
   3. northeast
   4. west
   5. south
   6. I don't know.

10. Pat, the person on this map, wants to go from point C to point D. In what direction will Pat have to go?
    1. northwest
    2. southwest
    3. southeast
    4. north
    5. east
    6. northeast
    7. I don't know.

11. Dane, the person on this map, wants to go from point J to point K. In what two directions will Dane have to go?
    1. west, then north
    2. east, then south
    3. south, then west
    4. south, then north
    5. north, then west
    6. north, then east
    7. I don't know.

12. Jan, the person on this map, wants to go from point G to point H. In what two directions will Jan have to go?
    1. east, then north
    2. east, then south
    3. south, then west
    4. south, then north
    5. west, then north
    6. north, then east
    7. I don't know.

13. When I am learning on a computer, I would rather
    1. work alone.
    2. with one other person.
    3. with two other people.
APPENDIX B: The Pesttest

My name is ________________________________

Circle the right answer.

1. I am a
   1. girl       2. boy

2. On this map, which part of the land has dots?
   1. northern
   2. southern
   3. eastern
   4. western
   5. I don't know.

3. On this map, which part of the land has dots?
   1. northern
   2. southern
   3. eastern
   4. western
   5. I don't know.

4. The letter D is in what part of the map?
   1. southwest
   2. southeast
   3. northeast
   4. north
   5. northwest
   6. I don't know.

5. What do you think of computers?
   1. They are boring.
   2. They are O.K.
   3. They are a lot of fun.
   4. I'm not sure.

6. The letter B is in what part of the map?
   1. southwestern
   2. southern
   3. northern
   4. northeastern
   5. northwestern
   6. I don't know.
7. The letter C is in what part of the map?
   1. northern
   2. southeastern
   3. southwestern
   4. northwestern
   5. northeastern
   6. I don't know.

8. Chris, the person on this map, wants to go from point A to point B. In what direction will Chris have to go?
   1. north
   2. east
   3. west
   4. south
   5. I don't know.

9. Pat, the person on this map, wants to go from point C to point D. In what direction will Pat have to go?
   1. northwest
   2. southwest
   3. southeast
   4. south
   5. east
   6. northeast
   7. I don't know.

10. Sal, the person on this map, wants to go from point E to point F. In what direction will Sal have to go?
    1. north
    2. southwest
    3. northeast
    4. west
    5. south
    6. I don't know.

11. Jan, the person on this map, wants to go from point G to point H. In what two directions will Jan have to go?
    1. east, then north
    2. east, then south
    3. south, then west
    4. south, then north
    5. west, then north
    6. north, then east
    7. I don't know.

12. Dane, the person on this map, wants to go from point J to point K. In what two directions will Dane have to go?
    1. east, then north
    2. east, then south
    3. south, then west
    4. south, then north
    5. north, then west
    6. north, then east
    7. I don't know.

13. When I am learning on a computer, I would rather
    1. work alone.
    2. with one other person.
    3. with two other people.
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