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Group Computer-Assisted Learning: Differences Among Male, Female, and Mixed Pairs of Fourth Grade Students with Respect to Social Interactions, Computer Contact, and Achievement.

Edgar Lawrence Guntermann

A Thesis

in

The Department

of

Education

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ABSTRACT

Group Computer-Assisted Learning: Differences Among Male, Female, and Mixed Pairs of Fourth Grade Students with Respect to Social Interactions, Computer Contact, and Achievement

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Concordia University, 1988

This study was conducted to determine differences among male, female, or mixed pairs of fourth graders learning LOGO with respect to social interactions, computer contact, and product measures. Sixty students were taught the principles of LOGO programming in pairs then were required to complete two tasks; the programming of two graphics, one on each of two separate days.

Social interaction, computer contact, and achievement measures were recorded for each of the pairs as a whole by means of audio recordings, observation sheets, and a computer program respectively.

Social interactions were coded from transcripts of audio recordings by two individuals independently according to a condensed version of the Bales Interaction Process Analysis Scale (Bales, 1950). The four resulting measures were positive social interactions, negative social interactions, questions, and statements.

Independent raters as well assigned a score to each of the two graphics produced by each pair of students for the achievement measure. Number of commands and number of minutes used for graphic completion were also recorded.

Computer contact measures, recorded by means of observation

sheets, included turns at keyboard, turns writing on paper, turns simulating screen activity, monopolizing equipment, and removing self from the group.

No overall differences were found among group types (i.e., male, female, or mixed pairs) for any of the interaction, product or computer contact measures.

Only the variable removing self from group suggested differences between group types; male groups having the highest incidence of this behavior. No other gender differences were found.

Overall differences were found between task one and task two for the product measures; specifically for number of minutes and number of commands used for programming. Turns at keyboard and statements were also significantly different across tasks; task two reflecting the higher values on the four measures.

The relation between achievement and the other dependent measures was explored. None of the measures were strongly related to achievement. Other interesting relations are discussed.

These results may have implications for theories of group learning and may lay the groundwork for future research on how children learn on computers.

ABRÉGÉE

Group Computer-Assisted Learning: Differences Among Male, Female, and Mixed Pairs of Fourth Grade Students with Respect to Social Interactions, Computer Contact, and Achievement

Edgar Lawrence Guntermann Ph.D.
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Cette étude a été organisée pour déterminer les différences entre des paires de garçons et de filles ainsi que des paires mixtes de quatrième année apprenant LOGO. L'étude a pour but l'analyse des intéractions sociales, du contact avec l'ordinateur et du produit final.

Soixante élèves divisés en groupe de deux ont d'abord appris les principes de la programmation LOGO et ensuite ont du compléter deux tâches: la programmation d'une image par jour pendant les deux jours de l'étude.

L'intéraction sociale, le contact avec l'ordinateur et les produits finaux furent enregistrés pour chaque paire sur cassettes, feuilles d'observations et programmes d'ordinateur.

Les intéractions sociales ont été codées d'après des textes transcrits des enregistrements sur cassette, par deux personnes indépendantes selon la version condensée du "Bales Interaction Process Analysis Scale" (Bales, 1950). Les quatre mesures résultantes étaient les suivantes: intéractions sociales positives, intéractions sociales négatives, questions et affirmations.

Les codeurs indépendants attribuèrent une valeur à chaque image produite par chaque paire d'élèves pour obtenir la mesure du produit final. Le nombre d'instructions à l'ordinateur et le

nombre de minutes utilisées pour achever la tâche furent enregistrés.

Les mesures de contact avec l'ordinateur, enregistrées par le moyen de feuilles d'observation, incluent le nombre de tours au clavier, d'écriture sur papier, de simulation de l'activité sur l'écran, de monopolisation de l'équipement et de retrait du groupe.

Aucune différence globale n'a été trouvé parmi les divers groupes (garçons, filles et mixtes) pour aucune des intéractions, produit final ou mesures de contact avec l'ordinateur.

Seule la variable de retrait du groupe fut plus fréquente chez les paires de garçons. Aucune autre différence entre les sexes n'a été demontree.

Des différences globales ont été trouvées entre la première et la deuxième programmation pour les mesures du produit. Les différences ont été notées dans le nombre de minutes, nombre d'instructions à l'ordinateur, nombre de tours au clavier et affirmation employé pour les deux tâches. La deuxième tâche ayant des valeurs supérieures pour ces variables.

La relation entre la mesure d'accomplissement du produit final et les autres mesures dèpendantes est explorée. Aucune de ces mesures ne sont fortement liées. D'autres relations intéressantes sont discutées.

Ces résultats auraient des implications pour les théories d'apprentissage en groupe et peut être établiront un point de départ pour d'autres recherches sur l'éducation des enfants auprès de l'ordinateur.

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TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

CHAPTER 1

Introduction

A debated issue over the last decade has been the concern over the efficacy of computer-assisted learning (CAL). CAL has usually been termed successful when achievement scores reflect an increase in higher cognitive functions that are similar, if not identical, to those expected of a non-computer based school curriculum.

Despite the early resistance in schools, computer-assisted learning may prove to be important to overcoming some of the problems encountered by educational systems (Edwards, 1980).

These problems include the lack of equality in education (i.e., disadvantaged areas having smaller budgets for physical facilities, resources and personnel), the general lack of progress in achieving higher educational standards and the lack of sufficiently qualified teachers to instruct in certain areas (Silverman, 1970).

In order to effectively address the solution that computer-based learning offers to these problems in a comprehensive manner, research must be undertaken into the impact that computers are likely to have on our educational system. This research must, moreover, be conducted in the near future to take advantage of the research window accompanying every new educational product or process (Lepper, 1985). This research window implies that beyond the relatively short period of time between the introduction of a new medium of mass appeal and its infusion into many aspects of our lives one cannot hope to make any significant contribution to the manner in which such a technology is implemented.

Television presents a relatively contemporary example of such an infusion. Only once television had found its way into almost every North American home had the important research questions concerning its use been isolated (Schramm, Lyle, & Parker, 1961).

In contemporary education we are in danger of a similar situation happening with respect to computer-based education unless important research questions are isolated and acted upon accordingly (Lepper, 1985).

One such question concerns the impact of computers on basic educational outcomes (e.g., achievement in mathematics, reading, etc.). This question has been addressed in a comprehensive fashion with the results indicating that computer-assisted learning is at least as efficient as its non-computer counterparts. For instance, meta-analyses of recent studies in the field of CAL reveal an increase in achievement test scores in elementary school children (Kulik, Kulik, & Bangert-Downs, 1984), in secondary school students (Kulik, Bangert, & Williams, 1983), an improvement in attitudes towards computers and subject matter (Burns, & Bozeman, 1981), as well a reduction in instructional time (Menis, Snyder, & Ben-Kohav 1980).

These studies demonstrate that CAL should be integrated into the curriculum and should not be treated as an anomaly to be used only to placate parents and school board administrators. Those responsible for education must be made aware of and become confident in the ability of CAL to fulfill various goals either directly or indirectly.

Directly, one can envision the role of CAL as a conveyor of knowledge, or an aid in the development of the application of that knowledge; a laboratory and resource center. Indirectly, another role comes to mind, that of neutral object or tool that stimulates individuals to reach beyond their own experiences and perceptions to share and cultivate common knowledge structures and operations in a social setting.

Current educational systems are placing more emphasis on achievement gains while at the same time questions are being asked concerning the need for the social isolation traditionally associated with individualized instruction, which in turn has often been equated with such gains. One educator, Jernstedt (1983), argues that computers have been used as replacements for teachers and group learning therefore leading to socially isolated learning. He emphasizes the need for peer group interaction to support academic achievement, cognitive problem-solving skills and self-esteem.

Cartwright (1972), as well, has argued that group CAL may be more acceptable than individual CAL as it tends to reduce the dehumanizing aspects of technology and may be a catalyst for social interaction (Cartwright, 1971).

Many of the arguments against curriculum, at least partially based on CAL, have dealt with the issue of social isolation during computer instruction. The point is a valid one if one's educational objectives center on social interaction or at least touch upon them. One must therefore explore ways of achieving gains in cognitive areas that may also produce positive social outcomes.

How then can computers be used advantageously to foster and encourage such important variables? A solution currently offered by many professional Educational Technologists is the use of Computer Assisted Learning in group settings (Bork, 1985).

The history of Educational Technology reveals this solution is a result of a progression through the phases of mass learning, individualized learning and group learning. These phases are reflected in the theoretical bases of industrial technology, behavioral psychology and humanistic psychology respectively (Percival & Ellington, 1984) indicating a trend towards viewing the learner as a complex system with many facets.

This complex system has generally been approached from either a humanistic or technological perspective in a learning environment. While the technological aspect of CAL has been explored - computer manufacturers redesigning their machines to make them more efficient - the humanistic aspect has not. Both these areas individually are unable to deal with the diversity of the learning environment therefore perhaps what is needed is an integration of both perspectives; this may prove to be the underlying theme of group CAL.

Research in the area of group CAL has evolved from the tradition of group learning per se to become a distinct entity. Considering the inter-disciplinary nature of such research it is clear that Educational Technologists must provide an integrating framework in order to channel knowledge and resources in an environment that will actually result in positive learning outcomes that go beyond achievement to encompass social behavior and humanistic concerns.

Statement of the Problem

The practical implications of the research in the area of group CAL has not been realized primarily because studies have tended to be diverse and difficult to interpret, mainly because dependent measures have not been standardized and various types of software have been used. The full range of CAL from drill and practice, tutorial, to laboratory, and simulation modes have been investigated without any common denominator to tie investigations together, except of course, the presence of a computer and a group of students ranging in age anywhere from preschoolers to adults.

Perhaps the most fruitful means of addressing the problem of assessing various anticipated outcomes in group computer-assisted learning is to look at both the product and the process of the learning. Unfortunately research in this area is sparse, especially that addressing the issue of social interaction processes as well as cognitive outcomes.

Two basic research areas converge in group CAL yet their antecedents are quite disparate. The first is the area of small group interaction in learning or problem solving situations; the second, computer-assisted learning. The former area has tended to focus on the qualitative aspects of small groups working together with the emphasis on improving cooperative interaction among the participants. The latter has, in contrast, emphasized the quantitative outcomes that are overtly measureable when individuals or groups work on the computer.

Recently researchers in the area of CAL have highlighted the importance of group interaction, the computer's potential for facilitating group learning (Bork, 1985; Chen, 1985) and the need for tools that facilitate cooperation among students in problem-solving situations (Brown, 1985). Moreover, as group CAL currently appears to be the norm rather than the exception, research on group size, group composition, and the processes ocurring during learning in such a group setting must be undertaken.

Purpose of the Research

The research undertaken therefore has important consequences by virtue of the following: first, it brings together the research in two areas, small-group learning and computer-assisted learning; second, it addresses the social aspects of learning on computers and relates this to achievement; third, it may shed some light on the differences between three group types (male, female, and mixed); fourth, it fills the void present in the literature on instructional design considerations for computer-assisted learning, hopefully offering practitioners guidelines on the manner in which to optimize group achievement outcomes while at the same time encouraging the positive social interactions possible in cooperative learning; and finally, this research may provide norms for use by future research that may address issues of group gender composition on computers.

CHAPTER 2

Review of the Literature

Group Learning

Group learning has been a part of educational philosophy for years, supported generally by educators and researchers from the humanistic-experiential school of thought that have argued that learners can develop their own knowledge structures through interaction with their environment and their peers. This is echoed implicitly in the writings of Piaget (1967) who argued that individuals can learn optimally by generating theories about reality, then testing these theories against their environment to either support or reject them. This is an obvious analogue to the workings of science within a particular discipline with the scientist assuming the role of the learner. Scientific pursuits, moreover, are most often collaborative efforts whereby theories are presented and critiqued by fellow scientists. Such peer collaboration may be a useful model for a learning environment, especially on a computer where the environment may be manipulated or discussed prior to manipulation to test the learner's theories concerning a particular discipline.

Although most instructional computer software has been designed for individuals, as opposed to groups, Papert (1972b) has suggested that software like that incorporating the LOGO programming language can offer children a sample environment in which there are a set of tools to test their hypotheses about the environment in which they live. The appeal to children, he argues, is that they have the opportunity to participate in free problem-solving activities similar to play, which Piaget (1967) considers crucial for the assimilation of reality. Play moreover is a catalyst for an equally important development that runs parallel to cognitive development; that is the building of socialized thought processes replacing egocentric thought (Flavell, 1963). Only with the establishment of socialized thought processes can children recognize and act upon the needs of others.

Literature in the area of group learning in various contexts is supportive of the above concept (e.g., Johnson, 1981; Sharon, 1980; Slavin, 1980a). The underlying principles supporting group learning focus on the importance of human interaction as essential for education. These principles imply that education is a social process, that learning occurs through interaction and that self-knowledge and self-understanding result from peer interactions (Stanford & Roark, 1974).

The essential aspects of grouping that facilitate the acquisition and maintenance of cognitive skills include peer modelling, coaching, rehearsal, group feedback, the buddy system, behavioral assignments and contracts (Rose, 1977).

In support of the above, Webb (1982), in a review of the literature in the area of student interaction and learning in small groups, found that group processes such as group helping, giving help, and receiving help, are predictors of individual achievement. As is to be expected, off-task and passive behavior has been found to be negatively related to achievement (Webb, 1980a).

Although he was not necessarily arguing for group learning, Polya (1945, p. 1), who offered an important contribution to the area of teaching of problem solving, suggested the following to teachers: "The teacher should put himself in the student's place, he should see the student's case, he should try to understand what is going on in the student's mind, and ask a question or indicate a step that could have occurred to the student himself."

In group learning another student is much more able to fulfill the above due to some of aspects of peer teaching discussed below. Further, other students offer different points of view considered by Polya to be so necessary for successful problem solving.

In group learning the peer teaching that occurs has been hypothesized to facilitate learning for both the tutor and tutee. Chen (1985) has described the following as benefits that occur due to the peer teaching process

- a reduction of anxiety among students resulting from differences with teachers in status, age, and background
- a greater degree of individualized instruction
- a greater student motivation to learn in peer groups
- an opportunity for students to exercise competence and responsibility, leading to an increase in self-esteem and self-confidence
- an opportunity for students to organize and communicate knowledge
- a greater patience of student tutors with tutees (p. 53).

Supporting the above, Trowbridge and Durnin (1984) found that in small groups of students (two, three or four per group), working on a computer task, there was less of a chance of misinterpretation and more incorrect problem solving processes being detected and remediated than with individuals working alone.

A final argument in favor of group CAL that is of particular interest to school board and college administrators concerns the cost-effectiveness of the above in relation to individual CAL (Gerrell, 1972; Greenberg, Marvias, Tovar & Vasquez-Abad 1983). Cartwright (1972) suggests that, at least at the university level, cost reductions up to 75 percent are possible, depending on the size of the groups.

It is interesting that concepts like feedback and the ability to explore alternate paths through knowledge (Thompson & Thompson, 1987), currently popular in the literature on expert instructional systems or intelligent computer-assisted instruction (ICAI), are similar to those found in small group learning.

An effective tutor, whether human or machine, must have four kinds of knowledge or skills in order to teach effectively. He/she/it must know the subject area, the student's knowledge level, principles of teaching, and how to communicate (Woolf & McDonald, 1984). Whereas an ICAI system would be capable of encompassing a larger data base than its human counterpart, the peer may be more effective at assessing the student's entry knowledge, and how to communicate it in the most agreeable manner. Perhaps the designers of expert instructional programs are unconsciously attempting to simulate processes that have been known and used effectively for years in peer teaching and group learning.

Theories of group learning. Three types of theories have attempted to explain the increase in performance of small group members. First, Bargh and Schul (1980) suggest that in peer teaching the act of preparing to teach someone else may result in a cognitive restructuring beneficial for a deeper understanding of the material for the student assuming the role of teacher. The second theory, advocated by Johnson and Johnson (1979), concerns the cognitive benefits of resolving disagreements in groups. These benefits, they claim, take the form of a wider generalization of principles to suit the broad range of learner characteristics or styles in groups. Finally, with respect to children, Buckholdt and Wodarski (1978) hypothesize that interaction which produces superior learning results due to the fact the children may be more sensitive to each other's non-verbal signs of needing help than the teacher.

Definition of cooperative groups. Whether groups are facilitative depends to a large degree on whether groups operate under a cooperative structure (Ames, 1981). Such a structure has been proposed as including the following behaviors: promoting feelings of inclusion and membership, and the sharing of decision making and mutual reinforcement in the pursuit of learning goals (Catteral & Gazda, 1978).

Stodolsky (1984) has proposed a definition of cooperative groups which includes the following:

- common ends or goals,
- common means end activities,
- all members expected to interact and contribute,
- joint projects evaluated (p. 114).

Empirical literature has supported the concept of cooperative grouping, as being superior to individualized learning, with respect to the cognitive development of children (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981). For example, Johnson and Johnson and their associates (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981) conducted a meta-analysis of studies dealing with group learning versus individual learning. These studies, which dealt with a wide range of subject areas with various age groups, concluded the following: cooperative learning resulted in more achievement than independent learning in 108 studies, in six studies the reverse was found (i.e., cooperative learning groups showed less achievement than independent learners), and in 42 studies no significant differences were reported.

The underlying causal factors contributing to these differential results between individuals and groups may basically relate to the conversations, arguments and multiple perspectives occurring in cooperative groups. Results of a study conducted by Barnes and Todd (1977) support this. They tape recorded groups of young adolescents as they solved problems. Their study suggests that discussion facilitates problem solution due to the effects of multiple contributions and multiple perspectives.

Numerous authors have also contended that cooperation among group members is superior to competition with respect to cognitive outcomes and the social development of individual members. A recent meta-analysis of studies comparing cooperative and competitive group learning revealed the following: 65 studies presented results suggesting that cooperation increased achievement; eight that cooperation decreased achievement, and 36 showed no significant differences (Johnson & Johnson, 1981).

The difference between competitive and cooperative groups may be described in terms of orientation of the groups; while competitive groups are product oriented, cooperative groups are process oriented (Kohn, 1986). The product oriented approach of competitive groups may be reflected in the philosophy of "the end justifies the means" therefore effectively destroying any possibility of meaningful social relationships that may lead to social development. The resulting effect on the individual competitor's positive social skills will undoubtably be harmful in the long run.

In contrast, the process oriented approach may lead to "give and take" behaviors and meaningful exchanges that may result in hightened social, emotional, and cognitive development.

At the individual level cooperative settings may lead to higher levels of self-esteem (Johnson, Johnson, & Maruyama, 1983), emotional maturity, well-adjusted social relations, and a strong personal identity (Johnson & Johnson, 1983).

Supporting the above, Aronson (1976, p. 210) found that students in cooperative settings developed greater self-esteem than children in regular classrooms. Rubinstein (1977) similarly found that the measures of self-esteem among boys and girls, ages 10 to 14 increased for those attending a cooperative summer camp while those attending a competitive summer camp did not.

Cooperative settings have been said to promote more mutual liking, sharing, and helping behaviors (Ames, 1978). In a study of fifth grade boys Barnett and Bryan (1974) found that those engaged in cooperative play displayed more helping behavior afterwards than those engaged in competitve play.

Studies that have investigated the size of cooperative groups, with respect to achievement, have concluded that cooperation was more effective in promoting achievement the smaller the group (Johnson & Johnson, 1974; p. 53). Moreover, the more complex the task the greater the influence of cooperation on achievement (Johnson & Johnson, 1974; p. 54).

Increases in cognitive achievement have been recorded in various areas including concept attainment, spatial problem-solving, retention, and memory in cooperative settings (Johnson & Johnson, 1983).

With respect to the characteristics of individuals Johnson, Johnson, and Scott (1978) found that competitiveness of fourth graders, when measured by a 15 item picture test, correlated negatively with school achievement. This trend was found as well in both male and female fifth and sixth graders as measured by standardized tests (Spence & Helmreich, 1983). What these studies suggest therefore is that competition may hinder performance when a group is structured competitively, or when individuals themselves may be characterized as competitive.

The individual outcomes associated with cooperative group problem-solving reflect an interesting tendency for greater outcomes than even the most expert group member (Johnson & Johnson, 1974). This may lead one to conclude that in cooperative groups "the group is greater than the sum of its parts". In fact cooperative learning has been shown to improve the performance of the low, medium, and the high ability members (Johnson & Johnson, 1983; Okes, 1985) therefore dispelling the myth that only low ability students benefit from cooperative learning.

Teaching others has long been regarded as an effective means of consolidating one's knowledge therefore these results are not surprising. Other group processes as well, however, must account for the increases in achievement as it appears to be generalized across learner characteristics with respect to ability.

Stodolsky (1984) has outlined other characteristics that influence peer group processes and outcomes. For instance, in terms of group composition she suggests that age, sex, size, race and ethnicity, ability and self-selected versus assigned groups are all important variables to consider as contributing to the success or lack there of amongst members of a cooperative group. Of these variables, only ability (e.g., Webb, 1984b; Webb, 1985), group size (e.g., Guntermann & Tovar, 1987; Trowbridge & Durnin, 1984) and gender composition of groups (e.g., Guntermann & Tovar, 1987; Webb, 1984a, Webb, 1985) appear to have been investigated to any extent in computer-assisted group learning.

Research on Group Learning on Computers

CAL research with children. Research on children using computers in groups to date has actually investigated group learning only to a limited extent; most reported being based on anecdotal observations. For instance, Bourgh and Dickson (1983) found that childen readily learn to share a microcomputer with others, Jewson and Pea (1982) found that children tend to collaborate and teach each other, and Watt (1982) observed that they tend to prefer working in groups. Although these observations have not been verified at all age levels, one apparent finding that is generalizable is childen's fascination with computers, from the age of two and up, providing the software is age appropriate (Shade & Watson, 1985).

Actual research investigating the optimal size of groups, as well as group composition and productivity, has generally been conducted with 10 year olds and up (e.g., Guntermann & Tovar, 1987; Webb, 1984b; Webb, 1985); this will be addressed latter.

CAL research with adults. The research on group CAL with adults has generally focused on University students using measures of productivity with various types of programming or problem-solving activities (e.g., Cartwright, 1972); this will be elaborated on later on.

One recent study, however, addressed the issue of group processes in computer-based training. McCombs (1985) presents arguements in favor of group computer-based training and highlights the importance of the roles of group members and teachers in arriving at positive learning outcomes with the aid of computers.

Gender and CAL. Recently the issue of gender differences in CAL has emerged as an important variable to consider with respect to group learning on the computer. This has generally been the direct result of earlier research that has indicated that in science and mathematics gender differences in attainment and attitude exist, girls being disadvantaged (Byrne, 1978; Kelly, 1981).

Attitude measures have indicated that dramatic differences are not evident, although some interesting comparisons are worth noting. Harvey and Wilson (1985), sampling 212 fourth grade children on a semantic differential scale of 20 items; found that boys thought that microcomputers were more fun and smarter while girls thought they were more expensive. The latter is interesting in that twice as many boys reported computers in their homes as girls.

Chen (1986), investigating effects of experience on attitudes, found that adolescent males had more experiences with computers both in school, in programming courses and computer clubs, than their female peers. Males also had more positive attitudes towards and confidence in computers than females, however, controlling for amount of computer experience, males and females had similar levels of interest.

A study of attitudes towards computers among 76 sixth graders using a 17 item scale found no differences between male and female students' attitudes towards computers (Swadener &

Hanafin, 1987). It was found moreover that boys and girls felt equally about the role of computers in their lives.

In a study with college students, Kwan, Trauth, and Driehaus (1985) did not find gender differences in attitudes. They attibuted this to two basic factors: a) that female college students were not as willing to accept societal stereotypes concerning computers and gender; and b) that most of their female college subjects had their first exposure to computers at home rather than through mathematics courses. The latter, the authors argue, suggests a lessening of the link between mathematics and computing; and therefore between the concomitant attitudes that each engenders.

Very little research has actually been conducted on differences between males and females with respect to working on computers per se, however, some of the published results present some interesting differences between boys and girls. There are no reported studies investigating such differences in adults.

Case studies in this area are common. One representative example is from the LOGO Maths Project (Hoyles, Sutherland, Evans, 1984) wherein children aged 12 or 13 worked together in pairs with LOGO towards goals they themselves devised. Gender differences found were the following: boys tended to explore more of the keyboard functions and had difficulty initially collaborating as they were more concerned with putting down their partner or winning than with working together. Girls, on the other hand, were more conservative but cooperated more willingly.

Among preschoolers, Lipinski, Nida, Shade, and Watson

(1986), investigating free-play activities, found that aggressive behavior among the boys tended to discourage girls from interacting with the microcomputer.

Similarly, Guntermann and Tovar (1987) reported that there were different patterns of social interactions among 10 year old male, female and heterogenous groups, though achievement measures did not reflect any differences. These patterns generally reflected boys' attempts to dominate their groups and not work cooperatively.

Webb (1985), in contrast, showed no differences between 11 to 14 year old boys and girls in two studies; one involving programming in LOGO, one in BASIC. In the first 15 girls and 20 boys learned LOGO using self-instructional material in groups of three (two boys and one girl) in a cooperative setting. They were given individual pre and post tests to assess their competence in LOGO. They were also tape recorded for 30 minutes in the middle of the workshop to gather data on task-related group interaction.

In the second study a similar procedure was used with 55 students working in pairs with BASIC. Results from both studies revealed no differences in learning outcome and only minor differences in verbal behavior (e.g., boys tended to repeat commands while typing though girls did not).

Differences between these and other studies may reflect differences in a sample that is contained in one school in the former (Guntermann & Tovar, 1987) and not the latter (Webb, 1984a), who were all volunteers from various schools.

In the Guntermann and Tovar (1987) study it is not clear what the nature of the differences between boys and girls are or how they arise. Specifically, are they related in any way to achievement? and are differences between males and females in group CAL related to computer contact that may inhibit girls from working interactively with others and the computer?

To answer these and related questions an integration of the two research areas (i.e., achievement and social interaction) is needed to address issues proposed by educators concerning the social-emotional implications of working together on the computer (Jernstedt, 1983; Bork, 1985; Chen, 1985).

To date research outcomes have either been in the area of social interaction or the cognitive products of that interaction. The investigations that have looked at both the product and process of interaction have tended to do so at the expense of the full social emotional range of interactive behaviors (e.g., Webb, 1984b; Webb, 1985; Webb, Ender, Lewis, 1986). In other words, while investigations have addressed the full range of helping behaviors (i.e., giving help, receiving help, etc.) they have disregarded any positive or negative interactions amongst group participants that may have a positive or negative effect on learning outcomes.

Studies in the area of group CAL have, nevertheless attempted to delineate the optimal size of groups (Love, 1969; Okey, & Major, 1976; Trowbridge & Durnin, 1984) with two or three being considered appropriate for cognitive outcomes.

In support of group CAL recent studies have found, moreover, that the sharing of previous solutions motivated further student effort (Dugsdale, 1979), that computer assignments resulted in a higher degree of peer interaction as well as greater willingness to identify peers as resources for help (Hawkins, Sheingold, Gearhart, & Berger, 1982). It has also been reported that working with peers increases adolescents' interest and enthusiasm for computer classes (Crist-Whitzel, Dasho, & Beckum, 1984).

Two general themes have therefore contributed to the research literature on group computer-assisted learning: that of research on product measures and that on social interaction process measures.

Research with product measures. Research on group CAL has generally led to the conclusion that there is no difference between small groups and individuals in terms of outcome measures. This has been demonstrated in various age groups: 14 to 18 year olds working in pairs or individually (Love, 1969), in 12 year olds in groups of three, two or individually (Karweit & Livingston, 1969), and in 12 and 14 year olds working in groups of four, three, two or individually (Trowbridge & Durnin, 1984).

Research with adults has reached similar conclusions with respect to no differences found in performance between individuals and groups of four, three or two (Cartwright, 1972; Okey & Major, 1975) or individuals and groups of two (Lebel, 1982).

A theme of group learning (e.g., Skon, Johnson, & Johnson, 1981) that has become important in the area of CAL concerns the effects of cooperative, competitive or individualistic goal structures on achievement. Johnson, Johnson, and Stanne (1985) investigating these three goal conditions on 14 year olds concluded that computer-assisted cooperative instruction resulted in higher quantity and quality of daily achievement as well as higher scores on various problem-solving measures. This of course reinforces Papert's (1980) assertion that computers should be used for non-competitive learning.

Research on the Relation between Computer Achievement and Group Interaction. Some recent research has attempted to define variables within groups that may be associated with outcome measures. This type of research has its antecedents in investigations of collaborative learning in a non-computer environment; this was addressed earlier. For example, Webb (1984b) investigating, among other things, group processes in relation to programming outcomes in 11 to 14 year old three person groups found that five of 11 process variables predicted outcomes. The positively related ones were: receiving explanations in response to errors and time at the keyboard. Receiving explanations in response to questions, receiving no explanations after an error, and receiving no response to a question were negatively related. In a further investigation of these effects with two person groups Webb, Ender, and Lewis (1986) found that the following group interaction variables were related to learning outcomes: giving and receiving explanations, receiving responses to questions, and verbalizing input aloud while typing at the keyboard.

Research with social interaction process measures. Despite the fact that recent studies have emphasized group interaction, none has done so in a complete manner in the sense of a categorization of all verbal utterances without regard to their direct task-relatedness. For example, Webb (1984b) categorized behaviors as related to the task but not to the emotional connotations of the task. When assessing the ability of a new type of instruction (i.e., group CAL), the emotionally ladden interactions of the participants may reveal more about the ultimate effectiveness of the medium than just the task-related interactions.

The need exists therefore for the integration of another area of research into group CAL; that being the area investigating the social processes underlying small groups. A major contribution to the general area of research in social processes has come from the use of the Bales Interaction Process Analysis Scale (IPA)(Bales, 1950). This is a superior instrument to the group process measures described in previous CAL research (e.g., Clements & Nastasi, 1985; Lipinski, Nida, Shade, & Watson, 1986; Webb, 1984b; Webb, Ender, & Lewis, 1986).

The previously mentioned scales all suffer from one or both of the following deficits: a) they are incomplete in that the scales reflect only processes in relation to the task, not processes stemming from the emotional context of working on a computer or in a group, and b) they are "home grown" therefore are incompletely documented or have only been designed for a particular environment or piece of software in mind.

The Bales IPA (1950), however, is not limited by these two conditions as this scale has been in use for over 30 years in various settings and has been used previously to investigate social interactions in group CAL (Guntermann & Tovar, 1987; Trowbridge & Durnin, 1984). Bales designed his scale specifically as a vehicle to quantify interaction patterns in groups of two to eight working on a problem-solving task, therefore it is well suited as an instrument for analyzing interactions in a computer learning environment. Because the emphasis for the use of the Bales IPA has generally been on group dynamics in clinical or therapeutic areas per se rather than on group processes in relation to group learning, the literature supportive of Bales in various situations is not relevant here (except Guntermann & Tovar, 1987; and Trowbridge & Durnin, 1984).

Clements and Nastasi (1985) describe a scale of social-emotional development that in some ways is similar and overlaps with the Bales (1950) scale. This scale, however, was devised for their study with little reported supporting documentation and was designed for real-time coding at intervals as opposed to coding of interaction from recordings. A real-time coding scheme may be appropriate to categorize free-play type activities where one may be interested only in very general behavior patterns rather than specific behavioral indices. For goal-oriented learning sessions the IPA is more useful due to the flexibility of its categories which allow either general or precise measurement depending upon one's requirements.

Ethnographic research and anecdotal reports: Implications for group Computer-Assisted Learning. One factor that has not been reported in the literature is each individual's interaction processes within the group and how he/she relates to his/her peers, these relations, and how the relation with peers compares with that of a relatively interactive medium, the computer. Further, group CAL research has not addressed the issue of group processes over time especially with regard to the previously mentioned variables.

Moreover, despite the recent proliferation of studies in the area of group CAL, the emphasis has always been on achievement, or group interaction as related to achievement (e.g., Webb, 1984a; Webb, 1985; Webb, Ender, & Lewis, 1986). Ethnographic research has, however, presented some fruitful areas for further inquiry. Turkle (1984), for instance, alludes to various recurrent themes in children's programming that may be essential to investigate if one wishes to optimize group learning in CAL.

Using unstructured or semi-stuctured observational and question and answer techniques with 200 children and 200 adults, she partially conludes that involvement with a simulated microworld may affect one's relationship with the real one. For children, at the ages of nine, 10, and 11, whom she describes as mastery-oriented, such an involvement may manifest itself in a form of social isolation characterized by the philosophy of "ignore what you cannot control." Turkle declares that some children may be predisposed to getting lost in microworlds at the expense of the development of patterns of relationships with other people. Such children may be enticed by the clearly defined logical rules for behavior that the computer offers that are not available in other intensive childhood activities (e.g., role playing).

According to Turkle, Rousseau presented such a scenario as occurring with the introduction of the pen to children. He argued that there would be a loss of direct human contact, the construction of a private world, and a replacement of real things with their representations. Whether this has happened with the introduction of the pen is certainly debatable, but one must wonder what Rousseau's reaction would be to the computer where children are faced for the first time with an interactive medium that can take many forms and engenders various outcomes (e.g., video game, educational program, word processor, etc.) Often their manifestations require such intensive concentration on the part of the participant (such is the case especially with video games) that social isolation is a necessity for the successful participant.

What then is the outcome of such individualistic behavior on the interactions of a group forced to share a medium that has been associated for some with competition, individualism, and perfect rule-governed behavior?

Such a question may be basically applied to any interactive medium, however, despite Rousseau's reservations about the pen, only now due to the interactivity of the computer medium is the issue of social isolation and its manifestations an important and timely one to address.

Ethnographic research in the manner of Piaget's is important to bring to light interesting phenomena requiring further study. In the area of CAL Turkle has done just that. The present study has addressed some questions derived partially from Turkle's work and partially from the author's own observations of group computer interaction to more rigorous investigation.

Pilot research was conducted with 36 fourth grade students in January and February 1985. Students worked individually, in groups of two or three. During the data analysis of this previous study (Guntermann & Tovar, 1987) the following observation, that are similar to Turkle's, were made (unpublished results). Some students had difficulty integrating into a group on the computer, resulting in a group that though ostensibly cooperative was actually run competitively by at least one member.

It may be conjectured that perhaps, once these children had achieved a certain "mind set" concerning how computers are to be used, they found it difficult to engage in profitable social interactions while working on the computer and their sessions could be categorized as including to a large extent monopolization of the keyboard by the experienced individual or at the very least turn taking with little constructive overlap between members. This was found in both two and three person groups, particularly in male groups. This suggests a lack of ability to adapt to a cooperative goal structure that Papert considers so important to optimize learning on computers.

Johnson and Johnson (1986) drew attention to the negative effect of social isolation inherent in individual CAL; especially that stressing individual achievement outcomes. They suggest that the emotional effort of individual achievement in problem solving or learning can promote either of two types of behavior: increased effort to complete the task or withdrawal from the learning situation. Collaboration among peers, according to Johnson and Johnson (1983), promotes positive moods therefore an increase in motivation to achieve.

Rationale for the Research Questions

Research in the area of group CAL has not investigated all aspects of the group/computer environment that relate to achievement outcomes and social interaction processes.

Specifically, with respect to gender and CAL, research has been limited to delineating attitudes related to various aspects of computers with differential results. The only systematic investigation which specifically addressed the issue of gender composition of groups for CAL was the Pilot study (Guntermann & Tovar, 1987). This study set the groundwork for the present research in that it found that groups of two and three were as successful at achieving goals on the computer as individuals. From the perspective of social interaction, however, groups of two were at an advantage as they tended to be more cohesive. In general, across group size, boys tended to resist working cooperatively while girls did so readily. The sample size was too small (group size and gender composition being the independent variables at issue), however, to draw any meaningful conclusions concerning this behavior.

Other studies that have investigated social interaction and CAL have done so only to a limited extent. For example, Webb's work (Webb, 1984b; Webb, 1985; Webb, Ender, & Lewis, 1986) was limited to delineating only the task-related social interactions such as giving help, receiving help, etc. A more detailed categorization is needed to specify the manner in which that help is given, a positive or negative social climate, as that has a bearing on how successful help giving behavior will be in terms of learning.

Further, the positive and negative emotional reactions accompanying, preceding or following task-related interactions may allow one to make inferences concerning the degree and kind of social processes involved that may indicate how worthwhile group CAL is from a social perspective.

Variables relating directly to computer contact must also be studied to determine not only the interaction patterns among group members in male, female, and mixed two-person groups but also patterns of interaction with the computer (i.e., typing, simulating screen activity, turn taking, monopolizing equipment, and removing self from the learning situation).

Research Questions

The following questions relate to the above issues:

Question 1. Is there a difference in group productivity, computer contact, and group processes among groups composed of only males, only females or heterogeneous two-person groups? Furthermore, one may address this question to differences between males and females.

Another issue in the area of group CAL concerns the relationship between group productivity and group processes. Other investigations that have looked at this relation have done this with only task-related behaviors (e.g., Webb, 1984b; Webb, 1985; Webb, Ender, & Lewis, 1986). It is useful to define what social processes relate most positively to achievement outcomes in a group computer environment. The following question is therefore of relevance.

<u>Question 2</u>. Are achievement scores positively related to positive social interactions across the three group types (i.e., male, female, mixed) in two-person groups? Further, is there a relation between achievement and kind and amount of computer contact?

<u>Question 3</u>. Finally, are there changes with respect to achievement, social interaction and computer contact over two group CAL sessions? This final question has never been addressed with respect to group CAL yet is important in terms of revealing how stable such two person groups are over time.

CHAPTER 3

METHOD

Subjects

The subjects were sixty 10-year olds drawn from Roslyn Elementary School Westmount, Quebec. They participated in groups of two over at least one teaching and two experimental sessions. All students had some limited computer experience with some having taken after-school courses or gone to computer camp. Students were randomly assigned to treatment groups, within the limits imposed by the research design and their personal time constraints.

Design

The design of the study was as follows: Group composition (males, females and heterogeneous pairs) and task (task one and two) were the independent variables.

The four major Bales IPA Categories, observational data (concerning subject behavior not coded by the Bales IPA; i.e., turns at keyboard, turns writing on paper, turns simulating turtle movements, monopolization of equipment and removing self from group) and product measures (number of minutes to program a graphic, number of commands used and a final score) were the

MM(10)	FF(10)	MF(10)

Figure 1

Male, Female and Mixed Group Types with Number of Groups per Group Type dependent measures over two sessions. Group types with number of groups per group type are presented in Figure 1.

Dependent Measures

The dependent measures were of two types: process and product measures. Process measures were collected continuously throughout the session; social interactions were categorized by the Bales Interaction Process measures while computer contact measures described some physical actions of the pairs during the sessions mainly vis-a-vis the computer.

Social interactions characterized by the Bales IPA yielded four measures: Positive social interactions, negative social interactions, statements (i.e., task-related suggestions, opinions, and information), and questions. Each unit of interaction was coded as one of these four categories by two independent raters on the first, middle, and last four minutes of interaction of each session.

Units of interaction refers to what Bales (1950) calls verbal acts. This will be defined later.

The computer contact measures dealt with the following: turns at keyboard (i.e., how many turns each subject had at the keyboard per minute); turns writing on paper (i.e., how many times each subject wrote on the paper per each minute interval); simulating turtle movements (i.e., how many times each subject turns simulated turtle movements per minute); monopolizing equipment (i.e., the number of times per minute each subject monopolized the equipment by either refusing to physically allow the other to use the computer or not allowing them to use it after being asked); and removing self from group (i.e., the number of times per minute the each subject disassociated him/herself from the group by either retreating away from the other group member physically or psychologically). This last type would be scored as such if one of the pair either withdrew from the learning situation by moving more than five feet from the computer or turning his/her back on the computer or partner.

The product measures consisted of the following: Final score (i.e., a score arrived at according to evaluation criteria as judged by two independent coders); time (i.e., the number of minutes to completion of what the pair considered a proper representation of the graphic - maximum time was set at 45 minutes); and number of commands (i.e., the number of commands needed to complete what the pair considered a proper representation of the graphic).

Materials

Materials used were of three general types: Instructional materials designed for software and the appropriate software itself; coding and observational instruments; and the hardware such as the computer and the audio tape recorder.

Instructional Materials. A checklist was used to assess each pair of students' competence in LOGO (see Appendix A). This checklist incorporated basic LOGO commands and procedures such that one could easily identify where deficits are present and subsequently take remedial action. The instructional modules permitted instruction in any areas in which deficits were found to arise on the checklist. The modules focused on basic turtle commands, the repeat command, defining a procedure in the editor and running it, editing a procedure, saving and loading a procedure and using subprocedures and finally drawing polygons and circles. Each module contained instructional material as well as exercises designed for students to demonstrate mastery of the material.

The checklist was designed to insure that children possess appropriate knowledge of LOGO to accomplish the programming of two graphics (a truck and a snowman) that were drawn on paper and were presented to subjects to program (see Appendix A).

During each experimental session students were given a copy of some important LOGO commands that they were permitted to consult for reference (see Appendix A).

The LOGO Programming Language. Computer programming may provide a rich environment for problem solving and learning to occur especially in a group situation. According to Statz (1973)

- computer programming provides experiences and a language with which people can talk about their problem solving
- computer programming provides an especially rich medium in which to deal with problems
- computer programming provides examples which facilitate use of analogous problem solving notions (p. 37).

LOGO moreover was the programming language of choice for the following reasons:

- it has been used extensively in the Montreal area schools, both English and French versions are available (although only the English version was used for the study);

- LOGO is appropriate for mixed ability students, it being possible to readily teach the novice the underlying concepts to permit them to communicate with another individual and make a contribution in a group environment;
- LOGO being procedural facilitates the breaking down of problems such that the problem-solving task can be shared in many ways;
- LOGO may encourage children to become involved in problem-solving activities that they do not view as being tedious, thus it may be a catalyst to initiate cooperative involvement amongst pairs of students.

Apple LOGO has previously been used in studies of group interaction (e.g., Guntermann & Tovar, 1987; Webb, 1984b; Webb, 1985).

The LOGO Teach Program was used to save the commands and graphics produced by students.

<u>Coding and Observational Instruments.</u> A scoring sheet was used to evaluate the final graphic produced by each pair. This sheet allowed each component of the graphic to be evaluated individually, then subjected to stylistic analysis of the whole to arrive at a final score (see Appendix B).

The Bales Interaction Process Analysis (1950) was used to categorize the social interactions of the subjects (see Appendix B). It was chosen to study social interaction during problem solving because it has been successfully used to this end for 35 years, in diverse settings (e.g., Hare & Narch, 1985; Landsberger, 1955; Michler & Waxler, 1965; Shaw & Small, 1981). This technique involves coding observed interaction into four major categories: (1) positive socio-emotional interactions (2) statements, (3) questions, and (4) negative socio-emotional interactions. Figure 2 presents the Bales Scale.

Verbal interaction was broken down into segments called acts to be coded according to the categories. An act, according to Bales (1950, p. 37), is a single item of behavior. It is the smallest discriminable segment of verbal behavior that can be classified according to only one of the categories.

Positive Socio-emotional	Solidarity
	Tension Release
	Agrees
Statements	Gives Suggestion
	Gives Opinion
	Gives Information
Questions	Asks for Information
	Asks for Opinion
	Asks for Suggestion
Negative Socio-emotional	Disagrees
	Tension
	Antagonism

Figure 2

Bales Interaction Process Analysis Scale

Bales (1950, p. 32) designed these categories as a "... general purpose framework for observation which can be used to obtain a series of standard indices regarding the structure and dynamics of interaction in any small group." These categories therefore provide a comprehensive method of delineating social interaction processes, evaluating them on the basis of their contribution to group productivity, and subsequently diagnosing problems relating to group intervention. In this sense it is thought to be superior to other scales currently in use to assess group CAL (e.g., Clements & Nastasi, 1985; Lipinski, Nida, Shade, & Watson, 1986; Webb, 1984; Webb, Ender, & Lewis, 1986).

An observation sheet was used to record observable behaviors that were not picked up by audio recordings. These behaviors dealt with computer contact and working toward the goal, such as the following: typing, writing on paper, simulating turtle movement, monopolizing equipment, removing self from group. This observation sheet is presented in Appendix C.

These computer contact behaviors were recorded on a minute by minute basis and were collated for each group by task.

Hardware. An Apple II+ microcomputer was used to present instructional material, allow students to program the tasks and collect product data. A stereo audio tape recorder was used to record social interaction. The recorder had two microphones; one per child.

Evaluation of Materials. Pilot testing of the checklist, the instructional materials and graphics was conducted during previous studies (Chadwick, 1986; Guatermann & Tovar, 1987).

The formative evaluation of the instructional materials was accomplished utilizing a variation of the three stage model proposed by Dick and Carey (1978). In sum, this consisted of individual testing of draft material with students representative of both upper and lower boundaries of expected abilities, revision, then small-group testing with average representative students, revision, and then in-field testing in the actual situation in which the materials will be used. Finally, revisions were again made with the material having reached an acceptable form for the instructional objectives.

Procedure

Experimental data were collected from January to May 1987. Permission was obtained from the School Principal, the relevant teachers and finally parental consent forms were distributed. Over 70 percent of parents agreed to have their children participate in the study. Those refusing usually cited as reasons their children's involvement in other activities at the same time as the times for the study.

The instruction and data collection was conducted during the children's lunch break (11:40 - 13:00) and after school (14:25 - 15:10) and coincided with other lunch and after school activities offered at the school.

Sessions were conducted in a room just off the computer lab. The room had in the past been used for a similar purpose (during the Pilot Study).

Once all the data had been collected, transcripts of audio tapes were prepared, and graphics printed out.

Coding manuals for the graphics, and the transcripts and the graphics and the transcripts themselves were presented to two independent coders. Ten to fourteen days were required for the coding.

Scores for each coder were tabulated for each task and where discrepancies existed the mean was taken in order to produce the data which was then analyzed by the various multivariate procedures to be described later.

Each pair of children participated in three sessions on three separate days. The first involved assessment by means of the checklist and remedial instruction, if needed, with the experimenter presenting the appropriate modules to the group. This session ended when it was felt that at least one member of each pair, could complete the checklist and therefore demonstrate an adequate knowledge of LOGO for the tasks to come.

The second and third sessions consisted of students programming a graphic presented to them at the beginning of each session (a truck and a snowman respectively; see Appendix A).

Students had 45 minutes to program this graphic which they were told should be similar in shape though not necessarily in size to that presented to them as an example. They were given a list of LOGO commands to consult as needed (see Appendix A). Students were told to program the graphic in or out of the editor and were encouraged to use subprocedures. Paper and pencils were also made available for use.

Students were able to stand or sit in front of the computer, according to their preference, provided that they stayed within range of the microphone cord.

The following was read to each pair of students.

> I would like you to produce a program in the computer language LOGO that will draw the

> picture you have here. You can use the list of LOGO commands on this sheet to help you and you can use this paper and pencil to write anything down.
>
> The picture that you make must look like the one here on the paper although it doesn't have to be the same size as long as it looks similar and it has all the same parts.
>
> You can program your graphic in the editor or outside the editor whichever you wish.
>
> Since you are a team it is important that you work together and help each other to accomplish the task.
>
> If you have any questions please ask me now because I can't answer them once you have started.
>
> You have at most 45 minutes to finish the graphic. This is not a test so you won't be graded on it but try to do the best you can. Also I will be the only one listening to this tape so don't worry about others hearing what you say.

During the experimental sessions an audio tape recorder recorded the pairs' verbal utterances. Such methods of data collection have been used sucessfully in the past (Guntermann & Tovar, 1987; Webb, Ender & Lewis, 1986). Audio tapes were later transcribed then coded by means of the Bales Interaction Process

Analysis (1950) in order to determine the interaction of the participants during the problem-solving sessions (see Appendix B for the IPA coding manual).

This audio/transcript coding method has been described as an adequate means of obtaining all information concerning content of verbal utterances (or surface structure) while retaining voice inflections which may change the semantic (or deep structure) content of interaction (Waxler & Mishler, 1966).

While students worked on the tasks, the experimenter recorded observable behavior specific to the computer task on an observation sheet. These behaviors were collectively referred to as the computer contact measures.

At the completion of each session, the graphics and respective commands that students had produced during the session were saved by means of the LOGO Teach Program for the product analysis.

<u>Analysis of Product Measures</u>

The product measures of number of commands and number of minutes to complete the graphic were obtained from the LOGO Teach Program and by the length of the audio tape respectively.

The final score for each graphic was assigned by two independent raters who were unaware of the compositions of the pairs that produced each graphic as well as the questions addressed by the research. The rating criteria for both tasks is found in Appendix B.

This rating procedure has been used in the past with near perfect reliability (Chadwick, 1986; Guntermann & Tovar, 1987), however, any discrepancies in the two raters' scores were dealt with by using the mean of the two for the statistical analyses.

Analysis of Interaction

Twelve minutes of each task was transcribed from audio tape resulting in 306 pages or over 16,000 interactions. These verbal interactions were then analyzed by two coders working independently. The twelve minute sample represented the first four minutes, the middle four minutes, and the last four minutes of each session.

Twelve minutes of the interactions of each pair on each task was therefore coded independently by each coder. Little discrepancy existed between the two coders, however, where coders disagreed on the coding of a particular transcript the mean of their combined coding for each category was used for analysis.

The coders had no knowledge of the aims or experimental design of the research and were paid for their assistance. Both coders were instructed in the Interaction Process Analysis coding using the IPA Coding Manual designed specifically for this type of research (see Appendix B).

The coders worked with a four point IPA scale rather than the original 12 point scale described by Bales (1950). Bales emphasized the flexibility and adaptability of his scale for various needs. It was felt that a four point scale would be detailed enough to show differences between group types.

Inter-coder Reliability

Inter-coder reliablity estimates were calculated and found to be high across all interactions for the interaction categories ($\underline{r}$ = 0.96) and the final score achievement measure ($\underline{r}$ = 0.92) (see Appendix D for specific category calculations).

Reliability was assessed by taking into consideration all interactions and final scores coded by both coders and performing appropriate analyses using the SPSS Reliability Program.

Data Analysis

All data collected were for groups, this was of two types: that collected at the end of each experimental session or product data and that collected continuously throughout each session; the process data. The product data consisted of the length of the session, the number of commands used to produce the graphic and a score for the graphic. The IPA categories and observation measures served as the process measures.

Multivariate analysis of variance techniques performed on the data tested differences between groups with respect to product data and category usage on the basis of their group composition. Further, multivariate regression techniques were conducted on product and social interaction data to determine whether a relationship exists between these measures.

Specifically, the first and third questions concerning the differences among the three group types as well as differences within these group types over time were dealt with by subjecting the data for the three groups (male, female, and mixed) to separate MANOVAs (SPSS MANOVA) for interaction measures and product measures and separate ANOVAs for each of the computer contact measures. This Doubly Multivariate Repeated Measures Analysis of Variance design is presented graphically in Figure 3.

The second question concerning the relation between achievement, interaction measures and computer contact measures was addressed by subjecting the data to a Regression Analysis (SPSS Standard Regression). SPSS Multivariate Regression was used to test the relation among all dependent measures.

	MM	FF	MF
Task 1			
Task 2			

Pairings

Figure 3: Research Design

CHAPTER 4

Results

Overview of the Analyses

Analyses conducted on SPSS were as follows: A repeated measures doubly multivariate analysis of variance on the interaction measures for effects group type and task; a repeated measures doubly multivariate analysis of variance on the product measures for effects group type and task; and repeated measures ANOVAs on the computer contact measures for effects group type and task. Standard Regression was conducted to determine the relation between achievement (i.e., final score) and the other measures. Multiple Regression was used to determine the relation among all the dependent measures.

Analyses Addressing Question One

Interaction measures by group type. Multivariate analysis of variance of interaction measures revealed no significant main effects for group type $F(8,48) = 0.87$, $p > .05$, or the interaction of group type by task $F(8,48) = 1.00$, $p > .05$.*

Table 1 presents the univariate analysis of variance for the interaction measures by group type and tasks. None of the main effects or interactions proved to be significant.

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* Interaction Process Analysis data is missing for one of the mixed groups as the male member of the group disconnected the microphones without the researcher's knowledge prior to experimental session one. All data, however, except the four interaction process categories was collected, and task two was conducted normally without any loss of data.

Table 2 shows the means and standard deviations for the interaction measures for male, female and mixed group types across tasks. There were no trends of note evident.

Figure 4 presents graphically the percentage of each interaction measure to the total of all interaction measures for group types across tasks. Figures 5 and 6 present graphically the percentage of each interaction measure to the total of all interaction measures for group types on task one and on task two respectively. These three figures show similar trends for male, female and mixed group types on each task and across tasks.

Statements were by far the most numerous on both tasks with questions, positive social interactions and negative social interactions being more or less equally represented.

Product measures by group type. Multivariate analysis of variance of product measures revealed no significant main effects for group type $F\ (6,52) = 1.12$, $p > .05$ or the interaction of group type by task $F\ (6,52) = 0.73$, $p > .05$). Table 4 presents the univariate analysis of variance for product measures by group type and task. None of the measures displayed significant differences for group type or the interaction of group type and task.

Tables 5 shows the means and standard deviations for the product measures for male, female and mixed group types across tasks. No trends of note were evident across group types.

Computer contact measures by group type. Table 7 presents the analysis of variance for the computer contact measures by group type and task. The measures turns at keyboard, turns writing on paper, turns simulating turtle movements and monopolizing equipment did not produce significant effects for group type or the interaction of group type and task.

Removing self from group produced a significant ($p < .01$) effect for group type. The interaction of group type by task was not significant.

Table 8 presents the means and standard deviations for male, female and mixed group types across tasks. No trends of note were evident.

Analyses Addressing Question Two

The correlations between achievement (i.e., final score) and interaction measures, product measures and computer contact measures across group types and tasks is shown in Table 10. None of the interaction, product or computer contact measures were strongly correlated with achievement.

The intercorrelations among dependent measures across group types and tasks are presented in Table 11. Some interesting associations are worth noting. For instance, turns at keyboard was highly positively correlated with number of minutes of programming ($r = .88$) and simulating turtle movements ($r = .60$). Simulating turtle movements was also positively correlated with number of minutes of programming ($r = .52$) and negative social interactions ($r = .57$). Positive social interactions was positively associated with statements ($r = .50$) and negative social interactions ($r = .47$). Finally, questions was positively correlated with statements ($r = .47$).

Analyses Addressing Question Three

Interaction measures by task. Multivariate analysis of interaction measures revealed no significant main effect for task F (4,23) = 2.10, $p > .05$. The univariate analysis of variance for the interaction measures by group type and task, presented in Table 1, shows the effect task to be significant ($p < .05$) for statement though not for the other interaction measures.

Table 3 presents the means and standard deviations for the interaction measures for the male, female and mixed group types on tasks one and two. There were no trends of note evident.

Product measures by task. Multivariate analysis of product measures revealed a significant main effect for task F (3,25) = 24.10, $p < .001$. Table 4 presents the univariate analysis of variance for product measures by group type and task. Number of minutes and number of commands were significantly different for the effect task ($p < .001$ and $p < .001$ respectively).

Table 6 presents the means and standard deviations of the product measures on tasks one and two for the three group types. For each group type the variables number of minutes and number of commands had higher means and standard deviations on task one than on task two. The reverse was true for final score.

Computer contact measures by task. Analysis of computer contact measures, presented on Table 7, revealed that the measure turns at keyboard was significant ($p < .05$) for task. Turns writing on paper, turns simulating turtle movements, monopolizing equipment and removing self from group were found to be non-significant for task.

Table 9 presents the means and standard deviations of computer contact measures for male, female and mixed group types on tasks one and two. Interesting trends of note were the following: male, female and mixed group types tended to have higher scores on turns on keyboard on task two than task one. Moreover, male groups had the highest incidence of removing self from group on both task one and task two.

Summary

In response to question one, there was no significant difference overall among group types. There were no significant differences among group types for the individual interaction measures. Further, when the proportion of each interaction measure to the total of the four measures was compared for the three group types, similar results were evident.

For the product measures, no significant overall difference was found among group types. The individual product measures were not significant for group type.

The computer contact measures, analyzed individually, revealed the following with respect to group type: removing self from group was found to be significant ($p < .01$) while turns at keyboard, turns writing on paper, turns simulating turtle movements and monopolizing equipment were not significant.

In response to question two, none of the interaction measures, product measures or computer contact measures were strongly correlated with achievement (i.e., final score). Some interesting intercorrelations were found, however, among the dependent measures.

In response to question three there was no significant overall difference between tasks for the interaction measures. There was, however, a significant ($p < .05$) difference between tasks for statements though not for the other interaction measures.

A significant ($p < .001$) main effect for task was found for the product measures. The individual product measures number of minutes and number of commands were found to be significant ($p < .001$ and $p < .01$ respectively) for task. Final score was not significant.

The computer contact measures analyzed individually revealed the following with respect to task: turns at keyboard was significant ($p < .05$) while turns writing on paper, turns simulating turtle movements, monopolizing equipment and removing self from group were not significant.

Table 1

Univariate Analysis of Variance for Interaction Measures by Group Type and Task

Variable, Source of Variation	df	Hypoth. MS	Error MS	F	p
Positive Social					
Group Type	2,26	177.64	191.18	0.93	0.41
Task	1,26	206.73	066.78	3.10	0.09
Group Type by Task	2,26	013.04	066.78	0.20	0.82
Negative Social					
Group Task	2,26	221.00	298.80	0.74	0.49
Task	1,26	058.00	059.57	0.97	0.33
Group Type by Task	2,26	083.70	059.57	1.41	0.26
Statements					
Group Type	2,26	4639.15	3735.20	1.24	0.30
Task	1,26	5083.60	0790.13	6.43	0.02
Group Type by Task	2,26	039.74	790.13	0.05	0.95
Questions					
Group Type	2,26	077.57	130.62	0.59	0.55
Task	1,26	115.93	40.58	2.86	0.10
Group Type by Task	2,26	100.61	040.58	2.50	0.10

n = 30 groups

Table 2

Means and Standard Deviations of Interaction Measures for Male, Female and Mixed Group Types Across Tasks

Measure		Male	Female	Mixed
		Group Type		
Positive Social				
	M	31.20	31.87	26.22
	SD	(13.17)	(10.81)	(11.74)
Negative Social				
	M	36.92	31.05	31.93
	SD	(10.05)	(11.66)	(15.42)
Statements				
	M	149.32	179.40	156.80
	SD	(59.98)	(41.38)	(50.49)
Questions				
	M	22.30	24.90	20.85
	SD	(10.45)	(09.90)	(07.40)

Table 3

Means and Standard Deviations of Interaction Measures for Male, Female and Mixed Group Types On Tasks One and Two

Measure		Task 1 Male	Task 1 Female	Task 1 Mixed	Task 2 Male	Task 2 Female	Task 2 Mixed
Positive Social							
	M	32.40	34.65	27.89	30.00	29.10	24.55
	SD	(10.78)	(12.08)	(13.05)	(11.48)	(09.54)	(10.43)
Negative Social							
	M	35.70	32.60	34.06	38.15	29.50	29.80
	SD	(12.36)	(12.17)	(15.22)	(13.48)	(11.15)	(15.61)
Statements							
	M	157.10	189.35	170.50	141.55	169.45	149.10
	SD	(35.97)	(42.55)	(47.10)	(58.98)	(40.21)	(53.88)
Questions							
	M	22.95	28.80	20.44	21.65	21.00	21.25
	SD	(09.92)	(12.09)	(06.33)	(09.11)	(07.74)	(08.48)

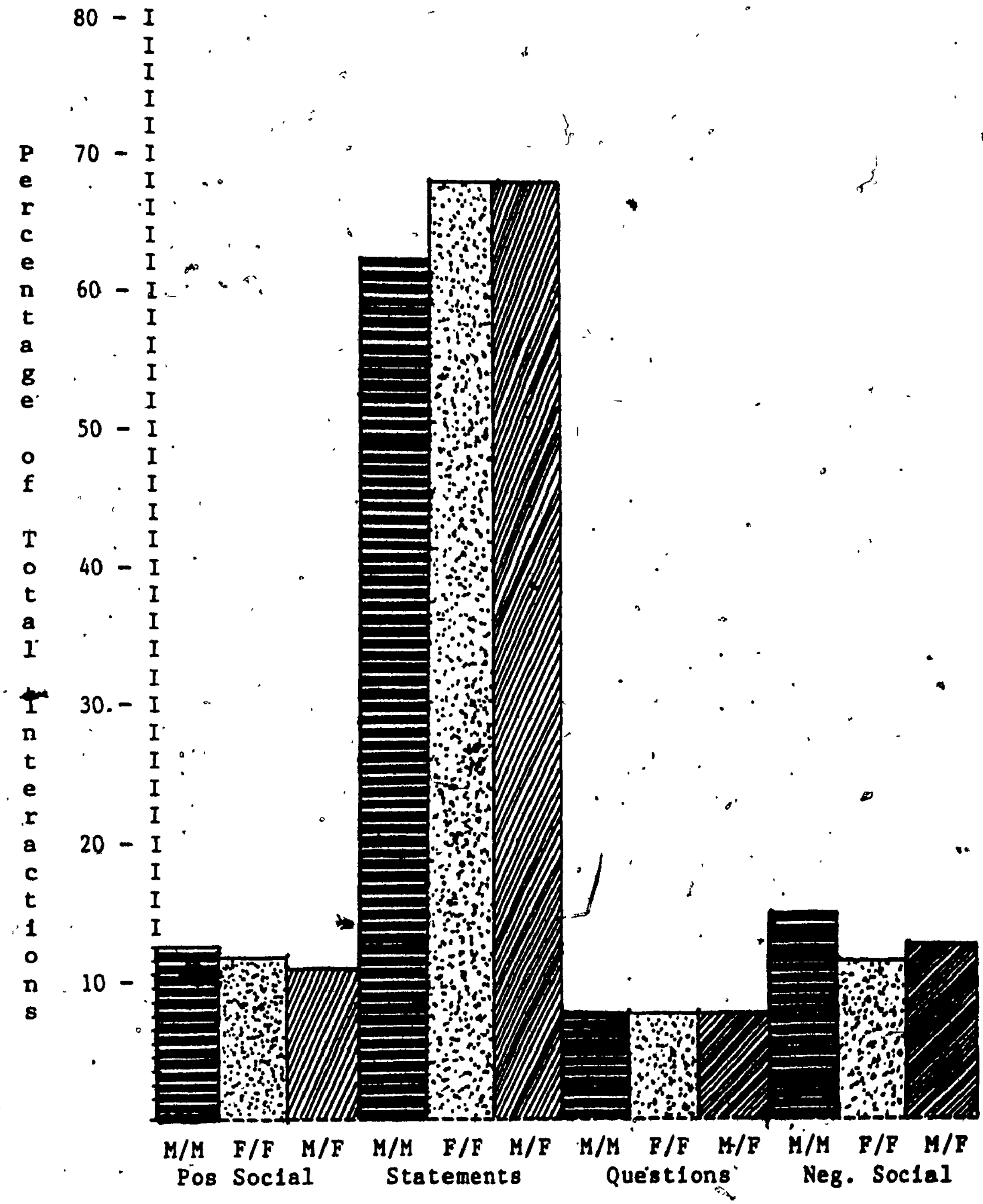


Figure 4

Interaction Data in Relative Percentage of Each Category to the Total Interactions by Group Type Across Tasks

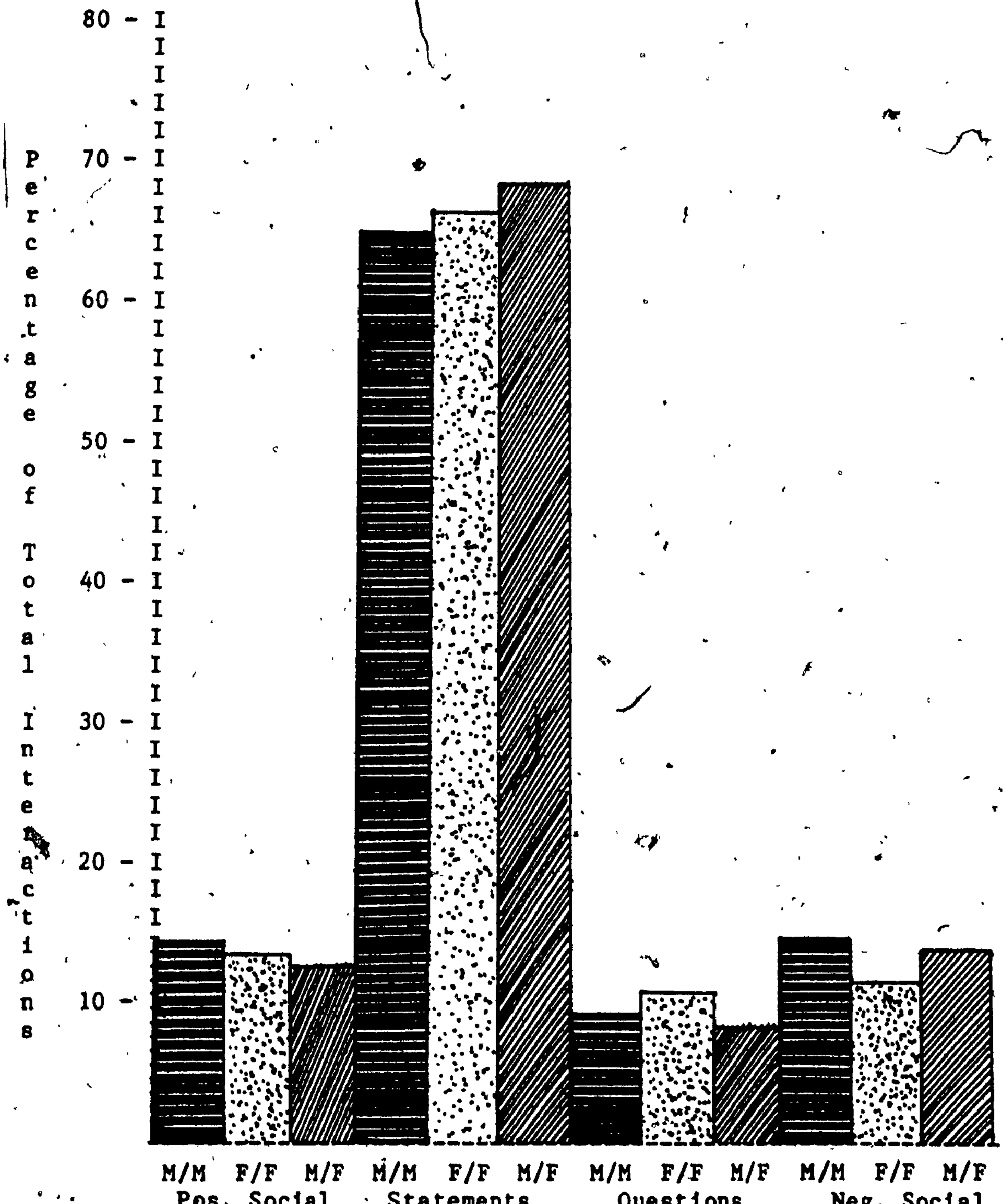


Figure 5

Interaction Data in Relative Percentage of Each Category to the Total Interactions by Group Type on Task One

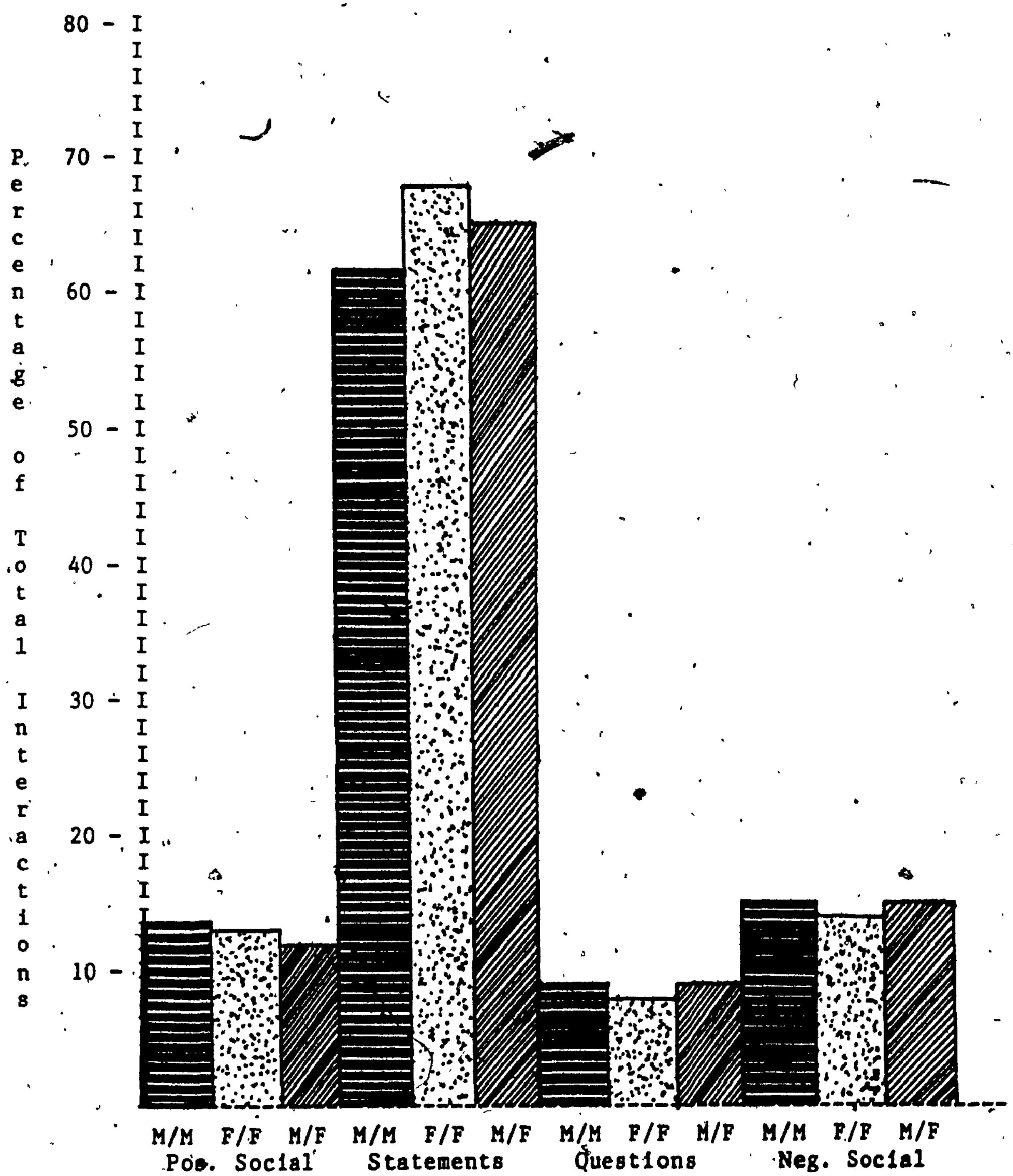


Figure 6

Interaction Data in Relative Percentage of Each Category to the Total Interactions by Group Type on Task Two

Table 4

Univariate Analysis of Variance for Product Measures by Group Type and Task

Variable, Source of Variation	df	Hypoth. MS	Error MS	F	p
Number of Minutes					
Group Type	2,27	008.32	182.45	0.04	0.96
Task	1,27	1197.07	037.31	32.09	0.001
Group Type by Task	2,27	27.32	37.31	0.57	0.57
No. of Commands					
Group Type	2,27	3350.72	2631.18	1.35	0.28
Task	1,27	61056.60	0908.77	67.18	0.001
Group Type by Task	2,27	1434.35	908.771	1.58	0.22
Final Score					
Group Type	2,27	022.95	315.69	0.07	0.93
Task	1,27	350.42	177.17	1.98	0.17
Group Type by Task	2,27	035.10	177.17	0.20	0.82

n = 30

Table 5

Means and Standard Deviations of Product Measures for Male, Female and Mixed Group Types Across Tasks

Measure		Male	Female	Mixed
		Group Type		
Number of Minutes				
	M	32.45	32.80	31.55
	SD	(11.02)	(09.66)	(10.78)
Number of Commands				
	M	130.20	153.05	129.50
	SD	(32.06)	(43.72)	(44.75)
Final Score				
	M	88.25	86.12	87.45
	SD	(16.38)	(12.55)	(16.77)

Table 6

Means and Standard Deviations of Product Measures for Male, Female and Mixed Group Types on Tasks One and Two

		Task 1			Task 2	
		Group Type				
Measure		Male	Female	Mixed	Male	Female	Mixed
Number of Minutes	M	26.80	28.80	27.80	38.10	36.80	35.30
	SD	(13.16)	(10.20)	(10.61)	(08.31)	(09.02)	(10.92)
Number of Commands	M	89.20	122.60	105.00	171.20	183.50	154.00
	SD	(29.23)	(31.79)	(32.64)	(36.86)	(55.66)	(56.86)
Final Score	M	89.25	88.75	91.05	87.25	83.50	83.80
	SD	(17.16)	(16.47)	(18.15)	(16.52)	(08.65)	(15.36)

Table 7

Analysis of Variance for Computer Contact Measures by Group Type and Task

Variable, Source of Variation	df	SS	MS	F	p
Turns at Keyboard					
Group Type	2	183.90	91.95	0.26	.77
Task	1	1892.82	1892.82	5.36	.02
Group Type by Task	2	605.03	302.52	0.86	.43
Explained	5	2681.75	536.35	1.52	.20
Turns Writing on Paper					
Group Type	2	5.20	2.60	0.39	.68
Task	1	1.67	1.67	0.25	.62
Group Type by Task	2	6.93	3.47	0.52	.60
Explained	5	13.80	2.76	0.42	.84
Simulating Turtle Movements					
Group Type	2	70.93	35.47	0.18	.83
Task	1	183.75	183.75	0.94	.34
Group Type by Task	2	148.80	74.40	0.38	.68
Explained	5	403.48	80.70	0.41	.84
Monopolizing Equipment					
Group Type	2	0.23	0.12	0.17	.84
Task	1	1.35	1.35	2.00	.16
Group Type by Task	2	2.10	1.05	1.55	.22
Explained	5	3.68	0.74	1.09	.38
Removing Self from Group					
Group Type	2	93.10	46.55	5.35	.008
Task	1	28.02	28.02	3.22	.078
Group Type by Task	2	38.03	19.02	2.19	.122
Explained	5	159.15	31.83	3.66	.006

n = 30 groups

Table 8

Means and Standard Deviations of Computer Contact Measures for Male, Female and Mixed Group Types Across Tasks

Measure		Group Type: Male	Female	Mixed
Turns at Keyboard	M	44.95	47.10	45.75
	SD	(16.15)	(18.54)	(19.23)
Turns Writing on Paper	M	00.70	00.60	01.30
	SD	(02.07)	(01.57)	(02.98)
Simulating Turtle Movements	M	19.10	18.85	16.25
	SD	(11.95)	(11.47)	(15.38)
Monopolizing Equipment	M	00.30	00.20	00.35
	SD	(00.69)	(00.63)	(00.58)
Removing Self from Group	M	02.60	00.00	00.98
	SD	(04.35)	(00.00)	(01.09)

Table 9

Means and Standard Deviations of Computer Contact Measures for Male, Female and Mixed Group Types on Task One and Two

Measure		Task 1 Male	Task 1 Female	Task 1 Mixed	Task 2 Male	Task 2 Female	Task 2 Mixed
Turns at Keyboard							
	M	36.90	43.50	42.60	53.00	50.70	48.90
	SD	(19.34)	(19.46)	(20.46)	(13.47)	(17.63)	(17.99)
Turns Writing on Paper							
	M	00.90	00.10	01.00	00.50	01.10	01.60
	SD	(02.85)	(00.32)	(03.16)	(01.30)	(03.48)	(02.80)
Simulating Turtle Movements							
	M	17.60	15.70	16.70	20.60	22.00	15.80
	SD	(11.41)	(10.37)	(16.67)	(13.74)	(14.68)	(14.96)
Monopolizing Equipment							
	M	00.40	00.00	00.00	00.20	00.40	00.70
	SD	(00.97)	(00.00)	(00.00)	(00.42)	(01.26)	(01.16)
Removing Self from Group							
	M	00.60	00.00	00.23	04.60	00.00	01.73
	SD	(01.90)	(00.00)	(01.10)	(06.80)	(00.00)	(01.08)

Table 10

Correlations Between Achievement and Interaction Measures, Product Measures and Computer Contact Measures Across Group Types and Tasks

	M	SD	r (with Final Score)
Interaction Measures			
Positive Social	29.36	11.79	.303
Negative Social	32.85	13.74	.129
Statements	160.37	51.71	.315
Questions	22.23	09.54	.141
Product Measures			
No. of Minutes	31.53	11.62	-.319
No. of Commands	139.70	64.84	-.150
Final Score	87.09	18.07	----
Computer Contact Measures			
Turns at Keyboard	45.93	19.20	-.149
Turns Writing on Paper	00.87	02.51	-.150
Simulating Turtle Movements	18.07	13.62	-.088
Monopolizing Equipment	00.28	00[illegible]	-.164
Removing Self from Group	01.19	03.26	-.092

n = 30 groups

Table 11

Intercorrelations Among Dependent Measures Across Group

Types and Tasks

	key	paper	sim	mon	rem	pos	neg	stat	quest	com	time	fs
key	---											
paper	.10	----										
sim	$.60^{c}$	-.08	---									
mon	.01	.11	-.17	---								
rem	.11	-.06	-.15	.18	---							
pos	.15	-.16	$.30^{a}$	$-.26^{a}$	$-.27^{a}$	---						
neg	$.40^{c}$	-.19	$.57^{c}$	-.31	-.14	$.47^{c}$	---					
stat	.18	.06	$.43^{c}$	$-.30^{a}$	$-.44^{c}$	$.50^{c}$	$.33^{b}$	---				
quest	$.29^{a}$	-.02	$.30^{b}$	-.24	-.14	.25	$.32^{b}$	$.47^{b}$	---			
com	$.29^{a}$	.02	.13	.13	.19	-.22	-.20	$-.26^{a}$	-.23	---		
time	$.88^{c}$	.22	$.52^{c}$	.17	.17	.05	$.31^{b}$	.06	.15	$.32^{b}$	---	
fs	-.15	-.15	-.09	-.16	-.09	$.30^{a}$	.13	.31	.14	$-.32^{a}$	-.15	---

key = Turns on keyboard
paper = Turns writing on paper
sim = Turns Simulating turtle movement
mon = Monopolizing equipment
rem = Removing self from group
pos = Positive social interactions
neg = Negative social interactions
stat = Statements
quest = Questions
com = Number of commands
time = Number of minutes
fs = Final score

a = $p < .05$
b = $p < .01$
c = $p < .001$

CHAPTER 5

Discussion

Discussion of Question One

Group type differences. The results showed no significant overall differences among group types for the interaction measures nor for them individually. The product measures were found to be non-significant overall for group type, as well the individual product measures were not significant for group type. The only computer contact measure reflecting a significant difference for group type was removing self from group. The three group types were similar in terms of product measures indicating that the outcome of group CAL was consistent across group types.

The interaction process data suggest that no differences were present among groups for the measures positive social interactions, negative social interactions, questions, and statements. This would lead one to conclude that the social process of group learning in CAL was similar across the three group types.

When the relative ratio of each category to the total number of interactions was compared for the four interaction process measures, statements was by far the highest for all groups across tasks. As the ratio for asking questions was much lower than statements, subjects spontaneously gave suggestions, opinions, and information without being asked; only one of seven of the statements was in response to a question.

One could infer from the above that peer teaching was going on, most of it spontaneous. As in the Webb (1985) study, some of the verbalization was the process of repeating what was being typed on the keyboard. The data for the present study makes it impossible to differentiate between, for instance giving information spontaneously and repeating what is being typed. It may be argued, however, on the basis of observations of the subjects collaborating on the task, that these are not mutually exclusive behaviors. Children often told their peers the commands they were going to type or repeated the commands after they were typed, sometimes with an explanation. Since in a previous study comparing individuals with groups (unpublished results of Guntermann & Tovar, 1987), it was observed that only in groups did children verbalize while typing, individuals remaining silent, it may be assumed that the commands were repeated in order to communicate to the partner what steps were being taken to solve the problem.

Positive and negative social interactions were low for all group types; however, the negative social interactions tended to be slightly higher than the positive social interactions for both task one and task two. This may reflect groups at a particular stage of social development, or children at a stage of personal development. This may have a bearing on their problem solving abilities suggesting that the problem solving process was more task oriented and less emotionally oriented.

However, more disagreement (associated with negative social interactions) than agreement (associated with positive social interactions), may reflect a healthy interchange that brings to light divergent points of view. Such interaction, though appearing debilitating on the surface, may in fact reflect a healthy dialog that has as an end point learning for both partners, successful problem solving, and the rehearsal of future social processes.

The data for the mixed pairs reflects a not totally unexpected finding: lower total number of interactions as well as fewer of each of the interaction process measures than either male or female pairs. This is thought to be an age dependent finding as pre-pubescent boys and girls of this age have much more experience interacting with children of the same sex than of the opposite sex. However, though the number was lower for the mixed sex pairs, the proportion of the interaction process measures was similar, indicating similar group processes.

As the final score among the three group types was not affected by the reduced interaction it may be argued that collaboration between the girls and boys was qualitatively but not quantitatively the same as other group types.

Research looking at different age groupings or the same age grouping, as in the present study, over a greater time frame, could lend credence to the above hypothesis.

Among the computer contact measures only removing self from group significantly reflected differences between groups. Male pairs displayed a higher frequency on this variable, indicating that their's were the pairs with the lowest cohesion. Although the other computer contact measures reflect a consistency across group types, in terms of turns at the keyboard, turns writing on paper, simulating screen activity, and monopolizing the computer, the groups with at least one female member were the most successful at keeping both members involved in activity on the computer. An explanation for the above may be that perhaps males are more used to solitary computer experiences. Males when faced with a frustrating experience on the computer in a group environment may tend to retreat rather than work cooperatively with other males who may themselves be too intensively involved in the computer activity to recognize the signs of frustrations in his partner. This would obviously be contrary to the expected behavior for members of cooperative groups.

This solitary computer experience is moreover often linked with individual achievement, be it immediate (i.e., video games) or delayed (i.e., programming) (Selnow, 1984). The above results may be interpreted in light of Johnson and Johnson's (1986) observation that behavior which is linked to individual achievement is often interrupted by emotional mood, which may have the effect of either increasing effort or promoting withdrawal from the learning situation. In the present study, ingrained individualistic behavior may have promoted increased effort by one partner and withdrawal by another, increased effort by both or withdrawal by both. Only withdrawal from the learning situation was among the variables measured here. There were no cases of both partners withdrawing.

The male groups' higher incidence of removing self from the group probably reflected less cohesion in male than female or heterogenous groups.

This lack of cohesion in male groups is in direct contrast to the results presented in Guntermann and Tovar (1987) which found that male groups displayed more solidarity than either female or mixed groups.

This may be due to differences in the measures used in the two studies. In Guntermann and Tovar, the 12 point Interaction Process Analysis Scale was used to measure only verbal behavior. In the present study the condenced Interaction Process Analysis Scale (four points) was used to measure verbal behavior and other behavior was recorded separately on observation sheets. As computer programming is a "hands on" activity an observational instrument is necessary to record non-verbal behavior involved in group CAL.

Guntermann and Tovar also found that though male groups asked for more information, they were also more antagonistic than female or mixed groups.

Among the few researchers dealing with group computer-assisted learning, Webb (1984b, 1985) has been the most prolific. Her concerns were generally with individual achievement and helping behavior in computer-assisted learning rather than the social and emotional aspects of working in groups, however, some of her results are comparable to the present study.

In a study assessing the role of gender in computer programming learning processes, Webb (1985) found no differences between males and females working in pairs in terms of learning outcomes and verbal behavior assessed individually. The only difference found was that males tended to talk more than females.

The present study, assessing groups as a whole, found as well no differences between male and female groups' verbal behavior or achievement.

Hoyles, Sutherland, and Evans (1984) found differences between males and females that reflected difficulty in establishing collaboration within the male groups of students. The present research lends support to these observations as among the three group types the males tended to display the most uncollaborative behavior (e.g., removing self from group).

Gender Differences. The fact that there were few gender differences is consistent with the literature that has found no differences in attitudes between males and females (e.g., Swadener & Hannafin, 1987), (assuming that behaviors may reflect underlying attitudes). The one difference found, for the variable removing self from group, has been discussed earlier in terms of group types.

Other researchers have reported differences in attitudes to and experiences with computers. Harvey and Wilson (1985) and Chen (1986) reported that girls had either less access to computers and/or less experience with computers. Children in the present study all had some computer experience as they were required to participate in computer labs as part of the regular school curriculum. It is therefore difficult to argue for differential access to computers based on school experiences.

The lack of overall differences between boys and girls may not be surprising considering the conditions under which the study was conducted. Even though every effort was made to maintain an environment that was as close as possible to the normal computer lab sessions taking place at the school (i.e., same type of computer and software, same location, sessions the same length as regular labs), there was a difference between the school lab periods and the experimental sessions that was not controlled. This factor was the length of time partners worked together. While in school computer labs students are often paired for weeks as they work on programming projects, the present study required them to work cooperatively for a maximum of three session (maximum of two and one half hours), spaced within a one week period.

One could argue that a study to observe the long-term effects of cooperative interaction would be necessary to observe differences in gender that deal with group cohesion and the social development of pairs in a CAL environment.

It may also be the case that the behaviors studied were too broad measures of differences between males and females. The differences between the engineering and artistic style discussed by Turkle (1985) may not be easily differentiated by measures used in the present study. Perhaps a more detailed version of the IPA is needed to discriminate gender differences. Unfortunately, detailed IPA coding, while increasing overall coding time, also requires a large amount to training time for coders to achieve an acceptable level of reliability. When dealing with social interaction it may be that there will always be a trade-off between achieving detailed coding of behavior and reliability.

Nevertheless, despite the lack of overall differences, gender differences, such as removing self from group found among male groups in the present study, should be a consideration in the development of software. This will be discussed later.

Discussion of Question Two

Relationship between achievement and other measures. None of the interaction measures, product measures or computer contact measures were stongly correlated with achievment.

The immature nature of the groups with respect to their lack of experience at cooperative computer-related problem solving, as discussed earlier, may have resulted in lower correlations than expected between achievement and other measures that may be indicative of peer teaching (e.g., positive social interactions, statements, questions). Mature groups would be expected to work optimally to achieve their goal through long-range and short-turn planning, sub-goal formation, and means-ends analysis, all of which depend upon an environment which is socially conducive to cooperation.

Alternatively, perhaps the measures were too broad to reflect complex, sometimes subtle, social processes that are associated with group achievement.

Positive social interactions, questions, statements, turns simulating turtle movements, and turns writing on paper would be expected to be positively associated with achievement as they may be related to the above activities involved in goal attainment.

It would be interesting to follow the development of group behavior over numerous sessions to confirm that this is the case with more mature practiced groups. In the present study the time frame was too short to observe such developmental occurrances.

Webb (1984b) investigated cognitive requirements and group-processes in small group CAL by examining 11 group process variables. Of the five that predicted programming outcomes (i.e., receiving explanations in response to errors, time at the keyboard, receiving explanations in response to questions, receiving no explanations after an error and receiving no response to a question) none were relevant to the present research. Turns at keyboard was found to have no relation to programming outcomes in Webb's study while in the present study it was mildly negatively related to the outcome measure.

As in Webb's study, students participated in other ways even when not actively typing. They often gestured, wrote down commands for future reference or verbalized commands.

<u>Relationship among other dependent measures</u>. Some interesting intercorrelations found among the dependent measures were as follows: turns at keyboard was strongly positively correlated with number of minutes of programming and simulating turtle movements. Simulating turtle movements was positively associated with number of minutes programming and negative social interactions. Positive social interactions was positively associated with negative social interactions and statements. Questions was positively associated with statements.

Such associations are to be expected. For example, number of minutes of programming may be expected to increase when the number of turns at the keyboard and simulating turtle movements increase. Simulating turtle movements may occur more often in heated discussions where negative social interactions are an integral part of the give and take of the group problem solving process, Similarly, positive social and negative social interactions may be related in the same type of a process that may go from agreement to disagreement and back again until a solution is found. Although statements and questions are related, the former outnumbered the latter by a ratio of seven to one.

Discussion of Question Three

The lack of differences between task one and task two on most interaction and computer contact measures is not surprising considering the short time frame between the two (between one and three days). The differences between the two tasks found for the measures statements, turns at keyboard, number of minutes, and number of commands (i.e., higher for task two than task one) may be indicative of the level of difficulty of task two in relation to task one. On the other hand, the consistency across tasks suggests that the effects found were not idiosyncratic to one problem-solving session and that the verbal and behavioral measures reflected behaviors that were stable over at least short periods of time. A study of longer duration, perhaps over weeks or months, would be necessary to support the notion of the consistency of these behaviors over time.

Informal Observations

The measure removing self from group may reflect a male orientation towards solitary computer experiences that starts at an early age with video games and continues with solitary programming experiences that may hinder the development of subsequent healthy group/computer interaction.

The solitary computer experiences may engender a need to control and achieve mastery over the machine, an engineering outlook, versus an artistic orientation toward the machine that is more amenable to peer involvement with goals that are flexible and open to discussion (Turkle, 1985). Computer literacy programs, according to Turkle, encourage the mastery computer perspective whereby one correct programming strategy is emphasized rather than processes that are open to discussion and sharing.

Research has indicated that, at least with video games, the machines may be perceived as more important than human companions, provide companionship, provide action and involvement, and provide solitute and escape (Selnow, 1984).

In the present study, casual questioning of subjects revealed that males tended to have had computers in their homes more and for longer periods of time than the females. Of those males that did not have computers in their homes almost all had ready access to a computer, which they made use of, while the same sub-group of females tended either not to have access to a computer, or if they did, said they were not as interested in making use of the access they had.

Previous research substantiate these observations. Harvey and Wilson (1985) found that twice as many 10-year old boys as girls had computers in their homes and in a survey in California, more boys than girls, between the grades of six and 12, had access to computers both at home and at school (Fetler, 1985). Finally, a survey of computer camps and summer courses found that boys outnumbered girls three to one (Hess & Miura, 1985).

In the present study, of the males that had their own computers, or had access to a computer, a small but vocal number exhibited behavior that could only be described as fanatic. This behavior included harassing the researcher for access to the computer, asking for more programming projects, and trying generally to increase their knowledge of computer-related terminology in any way possible.

None of the females displayed such behavior. Moreover females displayed a higher rate of absenteeism than males, with females in the mixed groups having the highest.

Although this may be taken as a withdrawal from the group, questioning of the subjects suggested this was not the case. It may be conjectured that the presence of the computer is the cause for this reluctance to participate. While boys tended to be interested in both the software (LOGO in this case) and the hardware (how the computer, disk drives, and monitor work and interact), the girls tended to be interested in only the uses of the software.

The computer for the girls then may have only been a tool whereas it appears to be perceived as at least an object of interest and perhaps a source of power for the boys. This power may be manifested over another, as in a competitive arrangement on the computer, or power over the computer as in video games. The computer may therefore be viewed by boys as either an ally or a source of competition, however, even when an ally it is often used to compete against others.

This fascination with electronic components was explified by the male member of one of the mixed groups as, he partially dismantled the microphone without the knowledge of the researcher therefore losing that session's verbal interaction data. This was done in his words, "to see how it works".

The lack of interest in computers may also reflect a distrust and feeling of intimidation by the females. Chen (1986) found, in a sample of adolescents, that males had a more positive attitude towards and more confidence in computers than their female counterparts. Girls, especially in a group with a boy, may feel uncomfortable working in a pair with someone possessing more experience and/or interest in computers.

Paisley (1985, p.24) reinforced the above by stating that when both gender and socioeconomic status are considered, "males and children of higher socioeconomic status are learning to control (that is, to program) the computer while females and children of lower socioeconomic status are learning to be controlled by the computer through the use of 'canned' programs only."

LOGO may be one of the few pieces of educational software that allows groups of students to work together in a non-competitive environment. Students can cooperate on projects either by working together on one program, or working on subprograms that can then be combined. When the latter is the case so much intra-group consultation occurs that authorship in procedures is usually shared.

Previous research addressing the issue of locus of control (LOC) among children using computers found that LOC tended to be more internalized with LOGO therefore resulting in students that are more autonomous (Louie, Luick, & Louie, 1985). As LOGO has no external reinforcement contingencies associated with it, it may be seen as a sharp contrast to the video and some educational games that overwhelm the child with auditory and visual cues signalling the right answer or an accurate shot.

Since internalized LOC has been found to correlate positively with academic competence, mature social processes, and self-motivated behavior (Nowicki & Strickland, 1973) LOGO may be a good model upon which to base software designed specifically for group learning.

If it is the case that the proposed cognitive benefits of LOGO programming (Papert, 1980) can transfer beyond the LOGO environment, as is claimed by some (e.g., Rieber, 1987), then perhaps some social benefits may be transfered as well. This area needs to be investigated to deal with questions arising from such claims.

Results in Relation to Theories of Group Learning

The present results may provide some insights into the process of small group learning. For instance, peer teaching definitely occurred, as is evident in the high number of giving suggestions, opinions, and information (i.e., the statements category), however, whether cognitive restructuring occurred, as suggested by Bargh and Schull (1980) is debatable. While some students spontaneously talked about their new found knowledge of angles and geometric representation after having worked on the tasks, these students were in a minority. Even these students may not necessarily have learned actively from their peers as they could have passively picked up knowledge from watching their partner working on the computer.

This would suggest that when investigating peer learning on computers two kinds of learning should be differentiated: one active as when a student instructs another either verbally or on a computer and the other passive learning whereby the student learns by simply watching another enter something on the computer and observing the results.

While the former may be what has generally been called peer learning the latter may prove to be a latent educational innovation, inherent in interactive learning environments.

The second theory, that by Johnson and Johnson (1979), implies that resolving disagreements in groups is responsible for their superior performance. In the present study there were many disagreements that were resolved, evident in the number of negative and positive social interactions. One may infer that this is what was happening within the groups but there is no evidence that this actually improved groups' performance.

The final theory by Buckholdt and Wodarski (1978) states that children are more sensitive to each other's non-verbal signs for help than adults therefore superior learning results when children work together.

Again no solid evidence appears to suggest that this was the case in the present study, however, observations of children working in pairs would tend to lend credence to this theory. The fear of evaluation that is instilled in childen early on in elementary school is not present when they work with their peers. There is more exchange, more interaction and less fear of asking questions with a peer than with a teacher.

In sum, all three theories probably are at least partially correct in explaining small group learning, however, with group computer-assisted learning, there is an interactive medium therefore the learning environment becomes much more complex than conventional group learning. Theories of group learning may need to be refined to account for this complexity.

Implications for Group CAL

As the results did not offer any evidence concerning major differences between males and females in group CAL environments little can be said with respect to the impact of the present research on group CAL. The one difference found, for the variable removing self from group, indicates, however, that careful observations must be made of the groups, especially the male groups, in order to verify that they are functioning cooperatively. This may be taken as an indication of the importance of the role of the teacher to monitor the social behavior of the participants in order to reduce the possibility of alienation by one member of a pair.

Future Research

Future research must be conducted on the development of small group CAL to ascertain how such groups evolve over time; specifically do they become more efficient members become more able to pick up on each other's learning needs?

Further age factors in small group CAL must be addressed to determine at what age it is possible to expect peer teaching to go on in the presence of a computer. Kindergarten to graduate students may be studied to determine the kinds of factors within each age level that would determine successful group CAL, both in terms of achievement, social interaction, and amount of computer contact.

Computer contact measures must change as well to reflect the new technologies confronting students; both hardware and software.

Conclusions

Despite the fact that only one computer system has been described in the literature as being designed specifically for group computer-assisted learning (Jernstedt, 1983); research conducted in this field suggests that group CAL is a practical and efficient alternative to individual CAL. The present study showed little differences among male, female and mixed group types in terms of the product and process of group learning. It showed as well that these group types were stable over at least a short period of time. The issues that need to be further addressed concern the human side of the technological advances that have occurred during the last decade and the means of facilitating learning in both cognitive and social areas of students' lives. As the use of interactive technologies becomes more prevalent, research that builds upon that presented here becomes necessary to upgrade our knowledge of group learning in line with these technologies.

REFERENCES

Aronson, E. (1976). The social animal 2nd ed., San Fransisco: W. H. Freeman.

Ames, C. (1978). Children's achievements attributions and self-reinforcement: Effects of self-concept and competitive reward structure. Journal of Educational Psychology, 70, 345-55.

Ames, C. (1981). Competitive versus cooperative reward structures: The influence of individual and group performance factors on achievement attributions and affect. American Educational Research Journal, 18(3), 273-287.

Bales, R. (1950). Interaction process analysis: A method for the study of small groups. Cambridge, Mass: Addison-Wesley.

Bales, R. (1970). Personality and interpersonal behavior. New York: Holt, Rinehart, & Winston.

Bargh, J. A., & Schul, Y. (1980). On the cognitive benefits of teaching. Journal of Educational Psychology, 72, 593-604.

Barnes, D., & Todd, F. (1977). Communication and learning and small groups. London: Routledge & Kegan Paul.

Barnett, M. A., & Bryan, J. H. (1974). Effects of competition with outcome feedback on childen's helping behavior. Developmental Psychology, 10, 838-42.

Borgh, K., & Dickson, P. (1983). Two preschoolers sharing one microcomputer: How they handle it. On Wisconsin Computing, 1, 6-9.

Bork, A. (1985). Group learning on microcomputers. In M. Chen & W. Paisley (Eds.) Chidren and microcomputers. Beverly Hills: Sage Publications.

Buckholdt, D. R., & Woolarski, J. S. (1978). The effects of different reinforcement systems on cooperative behaviors exhibited by children in classroom contexts. Journal of Research and Development in Education, 12, 50-68.

Burns, P. K., & Bozeman, W. C. (1981). Computer-assisted instruction and mathematics achievement: Is there a relationship? Educational Technology, 21, 32-39.

Byrne, E. (1978). Women and Education. London: Tavistok.

Cartwright, G. F. (1972). "The use of groups in computer-assisted instruction." Paper presented at the Canadian Symposium on Instructional Technology, Calgary, May 24-26.

Cartwright, G. F. (1976). "Differential interpretation of feedback in small groups." Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, California, April 19-23.

Caterall, C. D., & Gazda, G. M. (1978). Strategies for helping students. Springfield, Il: Charles C. Thomas.

Chadwick, C. (1986). "Differential Group Composition in Problem Solving using LOGO." Unpublished Master's Thesis, Concordia University.

Chen, M. (1985). A macro-focus on microcomputers: Eight utilization and effects issues. In M. Chen & W. Paisley (Eds.) Children and microcomputers. Beverly Hills: Sage Publications.

Chen, M. (1986). Gender and computers: The beneficial effects of experience on attitudes. Journal of Educational Computing Research, 2(3), 265-281.

Clements, D. H., & Nastasi, B. K. (1985). Effects of computer environments on social-emotional development: LOGO and CAI. Computers in the Schools, 2(2/3), 11-32.

Crist-Whitzel, J. L., Dasho, S. J., & Beckum, L. C. (1984). Achieving equity: Student-led computer training. San Francisco: Far West Laboratory for Educational Research and Development.

Dick, W., & Carey, L. (1978). The systematic design of instruction. Glenview, Il.: Scott, Foresman, & Co.

Dugdale, S. (1979). "Using the computer to foster creative interaction among students." Research Report No. E-9. Urbana: University of Illinois, Computer-Based Education Laboratory.

Edwards, J. B. (1980). "CAI and training needs." Proceedings of National Conference on Development and the Eductional Technologist, Washington D. C., Jan, 16-18.

Fetler, M. (1985). Sex differences on a California statewide assessment of computer literacy. Sex Roles, 13, 181-191.

Flavell, J. H. (1963). The developmental Psychology of Jean Piaget. Princeton, N.J.:Van Nostand.

Gerrell, G. E. (1972). "Computer-assisted instruction of college physics students in small groups." Final Report. National Center for Educational Research and Development (DHEW/DE) (ERIC Documentation Reproduction Service No. ED 064 952).

Greenberg, S., Marvias, S., Tovar, M., Vasquez-Abad, J. (1983). "Some consideration on children's interaction with computers." Paper presented on PACT-PAPT joint convention. Montreal, Canada, November.

Guntermann, E., & Tovar, M. (1987). Collaborative problem-solving with LOGO: Effects of group size and group composition. Journal of Educational Computing Research, 3(3), 313-333.

Hare, A. P., Narch, D. (1985). Creative problem solving: Camp David Summit, 1978. Small Group Behavior, 16(2), 123-138.

Harvey, T. J., & Wilson, B. (1985). Gender differences in attitudes towards microcomputers shown by primary and secondary school pupils. British Journal of Educational Technology, 3(16), 183-187.

Hawkins, J. (1985). Computers and girls: Rethinking the issues. Sex Roles, 3, 165-180.

Hawkins, J., Scheingold, K., Gearhart, M., & Berger, C. (1982). Microcomputers in schools: Impact on the social life of elementary classrooms. Journal of Applied Developmental Psychology, 3, 361-373.

Hess, R. D., & Minuray, I. J. (1985). Gender differences in enrollment in computer camps and classes. Sex Roles, 13, 193-203.

Hoyles, C., Sutherland, R., & Evans, J. (1984). The LOGO maths project: A preliminary investigation of the pupil-centred approach to the learning of logo in the secondary school mathematics classroom. Research Report, London: University of London Institute of Education.

Jernstedt, G. G. (1983). Computer enhanced colaborative learning: A new technology for education. Technological Horizons in Education Journal, 10(7), 96-101.

Jewson, J., & Pea, R. D. (1982). LOGO research at Bank Street college. Byte, 7, 332-333.

Johnson, D. W., & Johnson, R. T. (1974). Instructional goal structure: Cooperative, competitive, or individualistic. Review of Educational Research, 44, 313-40.

Johnson, D. W., & Johnson, R. T. (1979). Conflict in the classroom: Controversy and learning. Review of Educational Research, 49, 51-70.

Johnson, D. W., & Johnson, R. T. (1983). The socialization and achievement crisis: Are cooperative learning experiences the solution? In L. Bickman (Ed.) Applied Social Psychology Annual 4, Beverly Hills, Calif.: Sage Publications.

Johnson, D. W., & Johnson, R. T. (1986). Computer-assisted cooperative learning. Educational Technology, 26(1), 12-18.

Johnson, D. W., Johnson, R. T., & Scott, C. (1978). The effects cooperative and individualized instruction on student attitudes and achievement. Journal of Social Psychology, 104, 207-216.

Johnson, D. W., Johnson, R. T., & Maruyama, G. (1983). Interdependence and interpersonal attraction among heterogeneous and homogeneous individuals: A theoretical formulation and a meta-analysis of the research. Review of Educational Research, 53, 5-54.

Johnson, R. T., Johnson, D. W., & Stanne, M. B. (1985). Effects of cooperative, competitive, and individualistic goal structures of computer-assisted instruction. Journal of Educational Psychology, 77(6), 668-677.

Johnson, D. W., Marruyama, G., Johnson, R., Nelson, D., & Skon, L. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. Psychological Bulletin, 89, 47-62.

Karweit, N., & Livingston, S. A. (1969). "Group versus individual performance and learning in a computer game: An exploratory study." Report 51, Center for the Study of Social Organization of Schools, The John Hopkins University, Baltimore, Maryland. (ERIC Documentation Service No. ED 032 789).

Kelly, A. (1981). The missing half: Girls and science education. Manchester: Manchester University Press.

Krasnor, L. R., & Mitterer, J. O. (1983). "LOGO and the Development of Problem-Solving Skills." Unpublished Manuscript, Brock University.

Kulik, C. C., Kulik, J. A., & Bangert-Drowns, R. L. (1984). "Effects of computer-based education on elementary school pupils." Paper presented at the annual meeting of the American Educational Research Association, New Orleans, April.

Kulik, J. A., Bangert, R. L., & Williams, G. W. (1983). Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 75, 19-26.

Kwan, S. K., Trauth, E. M., & Driehaus, K. C. (1985). Gender differences and computing: Students' assessment of societal influences. Education and Computing, 1, 187-194.

Landsberger, M. A. (1955). Interaction process analysis of professional behavior: A study of labor mediators in twelve labor-management disputes. American Sociological Review, 20, 566-575.

Lepper, M. R. (1985). Microcomputers in education: Motivational and social issues. American Psychologist, 40(1), 1-18.

Lerch, H. J., & Rubensal, M. (1983). Eine analyse des Zusammenhangs zwischen Schulleistungen und dem Wetteifermotiv. Psychologische Beitrage. 25, 521-31.

Lipinski, J. M., Nida, R. E., Shade, D. D., & Watson, J. A. (1986). The effects of microcomputers on young children: An examination of free-play choices, sex differences, and social interactions. Journal of Educational Computing Research, 2(2), 147-167.

Love, W. P. (1969). "Individual versus Paired Learning of an Abstract Algebra Presented by Computer Assisted Instruction." Report 5, Florida State University, Tallahasse (ERIC Documentation Reproduction Service No. ED 034 403).

Louie, S., Luick, A. H., & Louie, J. L. (1985/86). Locus of control among computer-using school children: A report of a pilot study. Journal of Educational Technology Systems, 14(2), 101-118.

Michler, E. G., & Waxler, N. E. (1965). Family interaction processes and Schizophrenia: A review of current theories. Merrill-Palmer Quarterly, 11, 269-315.

Nowicki, S., & Strickland, B. R. (1973). A locus of control scale for children. Journal of Consulting and Clinical Psychology, 40, 148-154.

Oakes, J, Keeping track: How schools structure inequality. New Haven: Yale University Press, 1985.

Paisley, W. (1985). Children, new media and microcomputers: Continuities of research. In M. Chen & W. Paisley (Eds.) Children and microcomputers. Beverly Hills: Sage Publications.

Papert, S. (1972). Teaching children thinking. Programmed Learning and Educational Technology, (85), 245-255 (b).

Percival, F., & Ellington, H. (1984). A handbook of educational technology. London: Kogan Page Ltd.

Piaget, J. (1971).. Science of education and the Psychology of the child, New York: Viking (c).

Polya, G. (1957). How to solve it: A new aspect of mathematical method (2nd ed.). Princeton, New Jersy: Princeton University Press.

Psathas, G. (1961). Alternative methods for scoring social interaction process analysis. Journal of Social Psychology, 53, 97-103.

Rieber, L. P. (1987). LOGO and its promise: A research report. Educational Technology, 27(2), 12-16.

Rose, S. D. (1977). Group therapy: A behavioral approach. Englewood Cliffs, N. J.: Prentice-Hall.

Rubinstein, P. R. (1977). Changes in self-esteem and anxiety in competitive and noncompetitive camps. Journal of Social Psychology, 102, 55-57.

Schramm, W., Lyle, J., & Parker, E. B. (1961). Television in the lives of our children. Stanford, Ca.: Stanford University Press.

Selnow, G. W. (1984). Playing videogames: The electronic friend. Journal of Communication, 34(2), 148-157.

Shade, D. D., & Watson, J. A. (1985). In mother's lap: The effect of microcomputers on mother teaching behavior and young children's classification skills. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Toronto, Canada, April.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and effects on achievement, attitudes and ethnic relations. Review of Educational Research, 50, 241-271.

Shaw, M. A., & Small, P. A., jr. (1981). Interaction patterns and facilitation of peer learning: Two replication. Small Group Behavior, 12(2), 233-240.

Silberman, C. E. (1970). Crisis in the classroom: The remaking of American Education. New York: Vintage Books.

Slavin, R. E. (1980). Cooperative learning. Review of Educational Research, 50, 315-342.

Spence, J. T., & Helmreich, R. L. (1983). Achievement-related motives and behavior. In J. T. Spence (Ed.) Achievement motives: Psychological and sociological approaches), San Fransisco: W. H. Freeman.

Stanford, G., & Roark, A. E. (1974). Human interaction in Education. Boston, Ma.: Allyn and Bacon.

Statz, J. A. (1973). "The development of computer programming concepts and problem-solving abilities among ten-year-olds learning LOGO" (Doctoral Dissertation, Syracuse University) Dissertation Abstracts International, 34, 11, see B, p. 5418.

Stodolsky, S. (1984). Instructional processes in peer work-groups. In P. L. Peterson, L. C. Wilkinson, & M. Hallinan (Eds.) The social context of instruction: Group organization and group processes. London: Academic Press, Inc.

Swadener, M., & Hannafin, M. (1987). Gender similarities and differences in sixth graders' attitudes toward computers: An exploratory study. Educational Technology, 27(1), 37-47.

Thompson, B., & Thompson, B. (1987). Breaking with tradition: Nonlinear reading. AI Expert, March, 21-24.

Trowbridge, D., & Durnin, R. (1984). Results from an Investigation of Groups Working at the Computer. (ERIC Documentation Reproduction Service No. ED 238 724).

Turkle, S. (1984). The second self: Computers and the human spirit. New York: Simon and Schuster.

Turkle, S. (1985). The new computer kids. Interview on Realities (TV Ontario), February, 28.

Watt, D. (1982). LOGO in the schools. Byte, 7, 116-134.

Waxler, N., & Mishler, E. (1966). Scoring and reliability problems in IPA: A methodological note. Sociometry, 29(1), 28-40.

Webb, N. M. (1980). Group processes: The key to learning in groups. New Directions for Methodology of Social and Behavioral Science: Issues in Aggregation, 6, 77-87, (a).

Webb, N. M. (1982). Student interaction and learning in small groups. Review of Educational Research, 52(3), 421-445.

Webb, N. (1984). Sex differences in interaction and achievement in cooperative small groups. Journal of Educational Psychology, 76(1), 33-44 (a).

Webb, N. (1984). Microcomputer learning in small groups: cognitive requirements and group processes. Journal of Educational Psychology, 76(6), 1076-1088 (b).

Webb, N. (1985). The role of gender in computer programming learning processes. Journal of Educational Computing Research, 1(4), 444-458.

Webb, N. M., Ender, P., & Lewis, S. (1986). Problem-solving strategies and group processes in small groups learning computer programming. American Educational Research Journal, 23(2), 243-261.

Woolf, B., & McDonald, D. D. (1984). Building a computer tutor: Design issues. IEEE, September, 61-73.

APPENDIX A: INSTRUCTIONS TO RESEARCHERS, LOGO CHECKLIST, INSTRUCTIONAL MODULES, AND EXPERIMENTAL TASKS

INTRODUCTION

The purpose of this instructional material to establish that the sample of subjects has attained a given level of entry skills with the computer language LOGO. It is assumed that the subjects have some skills, however, if some deficits exist then the modules can be used to address specific problem areas.

This material is composed of three parts: A pretest or checklist, instructional modules and tasks. The diagnostic checklist is used to determine whether instruction is required and if so, in which areas. The instructional modules are used, if necessary, to bridge the gap between the students present level of skill and that required to achieve the instructional goal. They are designed to do this through the use of demonstrations, examples and exercises.

The experimental tasks consist of programming of the graphic designs of a truck and a snowman using the turtle graphics.

Sections A and B explain in detail how to use the diagnostic checklist and instructional modules respectively. Section C explains the administration of the truck and snowman task.

SECTION A: THE DIAGNOSTIC CHECKLIST

The teacher should do the following:

1. Load the LOGO master file.
2. Have the subjects stand in front of the computer; the teacher being behind them.
3. Ask subjects to perform the actions using the exact wording as shown in the column WORDING OF THE TEACHER. Ask each subject in turn to perform one of the actions. The subject should respond by typing the commands shown on the same line in the column COMMANDS. Begin with Unit 1 and continue through to the end of Unit 5 until either:
   i) both subjects working in the group show they are having difficulty (even if only one group member is able to complete the actions, continue working through the checklist) OR
   ii) the fifth unit has been completed.
4. If the subjects are not able to complete Unit 2 on "Using the Repeat Command", they should be given instruction immediately from the Instructional Module 2. When instruction is completed, go back to the Diagnostic Checklist and recommence with Unit 3.
5. If subjects are not able to complete an action in any unit other then Unit 2, mark an X on the same line as the WORDING OF THE TEACHER in the column CHECK X then refer to Section C.

SECTION B: INSTRUCTIONAL MATERIALS

1. Look at the ckecklist to determine where the subject was unable to complete a unit. Note the unit number and title.
2. Turn to the instructional materials and refer to the unit of the same number and name.

Example

A pair of subjects was unable to complete the actions on the checklist in Unit 2 "Using the Repeat Command". Their instruction will begin with the instructional materials Unit 2 "Using the Repeat Command".

3. Begin instruction at the beginning of the unit.
4. Continue the instruction until Unit 6 has been completed.

INTRODUCTION

Before beginning any unit please check the following:

1. The computer and monitor are working
2. LOGO is loaded and functioning
3. The subjects are placed so that they can easily see the keyboard and the monitor.

The presentation of the instructional examples takes the following form:

- the teacher types EXAMPLE A himself/herself
- each one of the pairs of subjects are asked to take turns in typing EXAMPLES B and C.

For the EXERCISES the teacher should ask subjects working in pairs to take turns typing the commands for each exercise.

SECTION C. ADMINISTRATION OF THE EXPERIMENTAL TASKS

1. Once subjects have completed one of the following:

   a. All six units of the diagnostic checklist

   b. All six modules of the instructional materials

   c. A combination of a and b

2. Give them a picture of the truck (page 90)

3. Explain that "I want you to make the turtle draw a truck like this one. Your picture has to be the same shape but you don't have to make it the same size. Also I want you to save the procedure or procedures that you program to make the truck."

4. Ask subjects to recapitulate what they are supposed to do. Make sure that the explanation includes all three points underlined above. Re-explain if necessary.

5. Do the same with the snowman task.

DIAGNOSTIC CHECKLIST

INSTRUCTIONS TO THE RESEARCHER

Please check the following chart before beginning any session.

	LOAD	ERASE	MATERIALS FOR SUBJECTS
PRE-TEST		"BOHI	
CHECKLIST			LOGO commands
UNIT 1			LOGO commands & exercises
UNIT 2			LOGO commands & exercises
UNIT 3			LOGO commands & exercises
UNIT 4	"UNIN4		LOGO commands, examples & exercises
UNIT 5			LOGO commands & exercises
UNIT 6	"POL		LOGO commands, exercises & list 1
TRUCK TASK			LOGO commands & picture of truck
SNOWMAN TASK			LOGO commands & picture of snowman

INSTRUCTIONS TO THE RESEARCHER

Instructions before starting the diagnostic checklist

Ask the subject if he/she knows this kind of keyboard or if it's different in any way from what they are used to. Show then the [and] keys.

Give them the list of LOGO commands and read through them with them. They may know all or some of them, don't teach them now, tell them they will be learning the unfamiliar ones soon. Tell them that they can use the list whenever they like if they forget a command.

Give subjects as well two blank sheets of paper and pencils that they can use in any way to complete the task.

Subjects should not be allowed to keep any of the materials. If they would like a copy, they can be given one after the final session.

At the beginning of each session remind the subjects that they can refer to the LOGO commands on the sheet.

DIAGNOSTIC CHECKLIST

UNIT 1

USING BASIC TURTLE COMMANDS

COMMANDS	WORDING OF THE TEACHER	CHECK X
ST/CS	First of all, can you make the turtle show on the screen?	
FD 80	Can you make the turtle go forward 80 steps?	
BK 40	and can you make it come back 40 steps?	
RT 90	Now make it turn right 90 steps	
FD 35	and then forward 35 steps	
LT 90	O.K. now make it turn left 90 steps	
FD 40	then go forward 40	
BK 80	and back 80	
PU	Now I want you to make the turtle lift up its pen so it won't draw when it moves	
SETH 90	O.K. now make it turn to the right 90 using SETH	
FD 35	then go forward 35 steps	
LT 90	and turn left 90	
PD	Now we need to have the pen down again so the turtle can draw	
FD 30	Go forward 30 steps	
PU	then lift the pen up again	
FD 7	and now take just seven steps forward	
PD	Now put the pen down for the last time	
FD 10	and go forward ten steps	
PE BK 5	oops, we made a mistake, can you erase five of those ten turtle steps?	

HT	Now that we've written Hi can you hide the turtle so we see it on our picture?
CS	and if we want to erase what we've drawn what do we do?
ST subject types commands to make a square	Now I want to see if you can do something on your own. Do you think that you can make a square? You need to get the turtle on the screen. I would like you to type in each command, so don't use REPEAT O.K. good, now can you clear the screen?

UNIT 2

USING THE REPEAT COMMAND

Note

If the group is not able to attempt or complete the following, give them instruction immediately from the Instructional Materials Unit 2, then proceed to Unit 3 of the Diagnostic Checklist.

COMMAND	WORDING OF TEACHER	CHECK X
	Now we're going to use the REPEAT command	
	When we're using REPEAT do we put all the commands on one line or on different lines? ANSWER "ONE"	
	Can you make the turtle draw a dotted line like this?	
	——— ——— ———	
e.g., REPEAT 3 [FD 20 PU FD 20 PD]		
CS	Now can you make the turtle draw a square using the repeat command?	
e.g., REPEAT 4 [FD 80 RT 90]		
CS	Good, now you can clear the screen again.	

UNIT 3

DEFINING A PROCEDURE IN THE EDITOR AND RUNNING IT

COMMAND	WORDING OF TEACHER	CHECK X
ED "BOX or ED TO BOX	We're going to teach the computer how to do something that we can save on the disk in case we want to use it later. This is called a procedure. We're going to write the procedure in the editor. Let's call the procedure BOX: O.K. now how do we start?	
	I want you to tell the computer how to make a square box using the repeat command. Make the square with its sides 50 turtle steps.	
REPEAT 4 [FD 50 RT 90]		
END	How do you tell the computer you've finished writing the procedure?	
CTRL C	The turtle doesn't work when you're in the editor so can you get back to the turtle screen?	
BOX	Now how can you make the turtle draw the box?	

UNIT 4

EDITING A PROCEDURE

COMMAND	WORDING OF TEACHER	CHECK X
ED "BOX	O.K. now let's say we want to make the box bigger. We have to change the number of turtle steps that we put in our procedure. How can we do this?	
CTRL N	Can you move the cursor down one line?	
----->	Now move it across to the 50	
CTRL D12 or <-----12	and change 50 to 120	
CTRL C BOX	Now let's see the turtle draw the bigger box.	

UNIT 5

SAVING AND LOADING A PROCEDURE AND USING SUBPROCEDURES

COMMAND	WORDING OF TEACHER	CHECK X
	That's the size of box that I wanted.	
CATALOG	I've written some procedures on the disk but I can't remember their names. Can you ask the computer to show me the list of the names (of the procedures I've saved)?	
LOAD "HI	The one I want is that one called Hi so can you load it from the disk into the computer so we can use it?	
HI	Will you show me what Hi does?	
ED "BOHI	O.K. but I'd like to put your BOX and my HI together so that when I type just BOHI the turtle will draw BOX and the draw HI like this (on paper the teacher draws the square first then Hi). Can you tell me what I want you to do?	
BOX	Can you put BOX at the beginning?	
HI	and the Hi next?	
CTRL C BOHI	Now let's see what the BOHI does.	
SAVE "BOHI	Good, now will you save it for me please.	

INSTRUCTIONAL MODULES

INTRODUCTION

Before beginning any unit please check the following:

1. The computer and monitor are working
2. LOGO is loaded and functioning
3. The subjects are placed so that they can easily see the keyboard and the monitor.

For the EXERCISES the teacher should ask subjects working in pairs to take turns typing the commands for each exercise.

UNIT 1

USING BASIC TURTLE COMMANDS

Performance Objective 1:

Performance: Using Basic Turtle Commands to program in LOGO

Conditions:

Given: a. - a series of three simple design exercises.
- an Apple II + computer
- the LOGO programming language (1982)
- a list of LOGO commands

b. with no assistance

Standard: Each pair of students will program the computer to produce three designs, using the Basic Turtle Commands, to be the same shape though not necessarily the same size as prototypes, within 3 minutes.

Unit Contents

a. use of full and short commands

FORWARD	FD	+ INPUTS
BACK	BK	+ INPUTS
RIGHT	RT	+ INPUTS
LEFT	LT	+ INPUTS
CLEARSCREEN	CS	
PENUP	PU	
PENDOWN	PD	
PENERASE	PE	
HIDETURTLE	HT	
SHOWTURTLE	ST	

b. Discrimination among error messages

"I don't know how to ..."

"Not enough inputs to ..."

c. Turtle directions

d. Turtle angles

1. Introduction to the keyboard

- you can see the keyboard for the computer is a lot like a typewriter
- when we press a key, the letter we pressed appears on the screen instead of on paper
- the blinking light is called a cursor, it shows you where you're going to type next (type "hello")
- you can erase "hello" by using <-----

2. Introduction to the Turtle

- "Welcome to LOGO" means that the computer is ready
- ? means that it's ready for us to type
- we're going to meet a little turtle that will make a drawing for us
- first we have to make the turtle show on the screen
- type CLEARSCREEN and press return to have the turtle show on a blank screen
- now we're ready to make the turtle draw
- whatever we type in will show here where the ? is

Demonstration of Basic Turtle Commands

EXAMPLES TEACHER TYPES	POINTS TO NOTE	ON SCREEN
FORWARD 50	- command	
RIGHT 90	- space bar	
FORWARD 50	- number of turtle steps	
RIGT 90 <-----		
RIGHT 90	- use <----- key to erase mistakes	
FORWARD 50		
BACK 10		
CLEARSCREEN		

The teacher asks the subjects to take turns in typing EXAMPLES B. and C.

EXAMPLE B

FD 70	- short commands easier to use	
RT 30	- error message	
FD 40		
BK40		
BK 40		
LT 60		
FD 40		
HIDETURTLE		
CS		

EXAMPLE C:

The teacher shows the subjects the picture he/she is going to draw.

SHOWTURTLE	- error message	
HT		
ST		
RT 90		
FD 25		
PENUP		
FD 25		
PENDOWN		
FD25 <-----		
FD 25		
PU		
RT 90		
FD 30		
RT 90		
FD 25		
PD		
FD 25		
HT		

3. Introduction to the penposition

- the turtle pen may be in one of three positions; these are the following:

  pendown (PD): draws when the turtle moves

  penup (PU): doesn't draw when the turtle moves

  penerase (PE): erases everything the turtle goes over
- the turtle always stays in whichever position (PD, PU, or PE) you put it in until you change it

4. Introduction to turtle direction

- the turtle can move forwards (FD and input) and backwards (BK and input) with the turtle in any of the three positions above (PU, PD, PE). In other words, it can move and leave a line (PD), leave no line (PU), or erase a line (PE) when the turtle goes both forward and backward.

5. Introduction to angles

- there are two ways that you can move the turtle to a different direction
- the first is by using the right turn (RT) and left turn (LT) commands with an input
- the computer will always add the angle you give it to the angle it is already at to point in a new direction

<u>EXAMPLE</u>: type RT 45 then RT 90

type LT 45 then LT 90

- see the turtle was facing straight up and we added 45 degrees then we added another 90 so now it's pointing to the lower right

- the second way to move the turtle to a different direction is by using the SETH commands
- this does the same as the previous RT and LT commands except that SETH commands do not add to each other.

<u>EXAMPLE</u> : SETH 90 is always to the right, seth 270 to the left.

The following depicts the SETH commands representing the direction of each command.

SETH 0

SETH 270 SETH 90

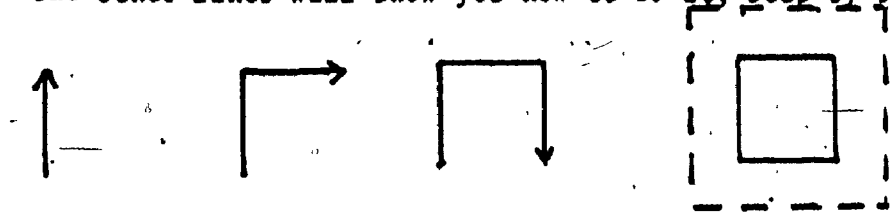
SETH 180

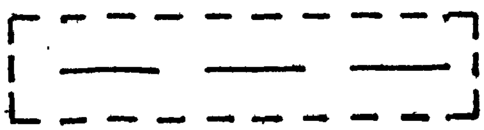
<u>EXAMPLE</u> : type SETH 90 then SETH 180 then SETH 270

UNIT 1

SUBJECTS'S COPY OF THE EXERCISES

Make the turtle draw the designs that you see inside the dotted boxes. The other lines will show you how to do it, step by step.

1. 

2. 

3. 

UNIT 2

USING THE REPEAT COMMAND

Performance Objective 2:

Performance: Program in the LOGO computer language using the Repeat Command.

Conditions:

Given: a. - a series of three simple design exercises.

- an Apple II + computer
- the LOGO programming language (1982)
- a list of LOGO commands

b. with no assistance

Standard: Each pair of students will program the computer to produce three designs using the Repeat Command to be the same shape though not necessarily the same size as prototypes, within 3 minutes.

Content of the Unit

REPEAT [input]

Introduction

If we want to make a square we have to type in a long list of commands to make the turtle go forward and turn and forward and turn etc. four times. We can make this a lot easier if we use the REPEAT command. We can make the turtle draw something as many times as we want.

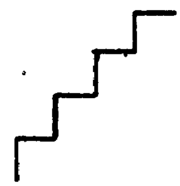
EXAMPLES

TEACHER TYPES | **POINTS TO NOTE** | **ON SCREEN**

EXAMPLE A:

FD 10 — long list of commands to make two steps
RT 90
FD 10
LT 90
FD 10
RT 90
FD 10

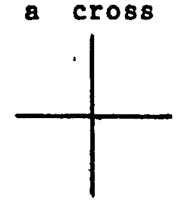
REPEAT 4
[FD 10 RT 90 FD 10 LT 90]
- to make four steps
- shorter to use REPEAT
- need to know how many times to repeat (note spacing) and what you want to repeat (in brackets)
- all commands on one line



The teacher asks the subjests to take turns typing EXAMPLES B and C.

EXAMPLE B:

CS
FD 20 — doing this four times will make a cross (show on paper)
BK 20
RT 90
CS



REPEAT [FD 20 BK 20 RT 90]
- with REPEAT
- forgot input for number of repeats
- respond to typing error messages

CS

REPEAT [FD 20 BK 20 RT 90]
- with REPEAT
- forgot input for number of repeats
- respond to typing error messages

REPEAT 4 [FD 20 BK 20 RT 90]

EXAMPLE C:

CS
REPEAT 2 [FD 20 RT 90 FD 40 RT 90]
- to draw a rectangle
- respond to typing error messages

UNIT 2

SUBJECT'S COPY OF THE EXERCISES

Use the REPEAT command to make these designs.

Your designs should be the same shape as these but they don't have to be the same size.

Before you begin each one, tell your teacher how you're going to do it. What are you going to REPEAT how many times?

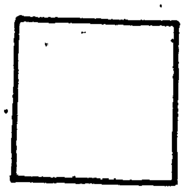
You need to clear the screen each time before you make a new design.

CS

1.

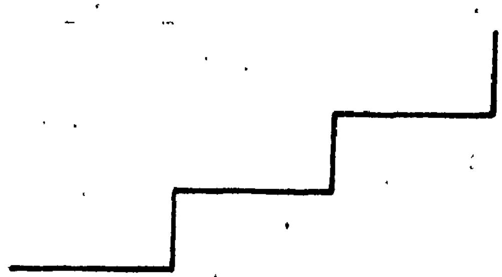
CS

2.



CS

3.



UNIT 3

DEFINING A PROCEDURE IN THE EDITOR AND RUNNING IT

Performance Objective 3:

Performance: Define a procedure in the editor and run it.

Conditions:

Given: a. - a series of three simple design exercises
- an Apple II + computer
- the LOGO programming language (1982)
- a list of LOGO commands

b. with no assistance

Standard: Each pair of students will program three procedures in the editor; within five minutes. These procedures will produce designs on the computer that are to be the same shape though not necessarily the same size as prototypes.

Content of the Unit

EDIT "--- ´procedure´

ED ´editor´

TO ---

END

CTRL C

CTRL G

---(run procedure)

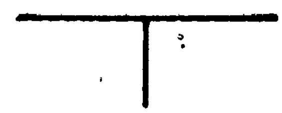
Introduction

We´re going to teach the computer how to do something that it can remember. The commands that we type for that are called a procedure.

When we´re writing a procedure we have to do it in a place called the editor. When you´re in the editor you can´t see the turtle.

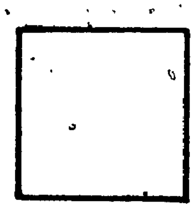
EXAMPLES

Subjects should be given a copy of the three designs to be drawn in the examples.

TEACHER TYPES	POINTS TO NOTE	ON SCREEN
EDIT "TEE	- use the shift 2 for "	
FD 60		
RT 90	- LOGO EDITOR at bottom of screen	
FD 25	- TO	
BK 50.	- type slowly and carefully	
HT	- check command is correct before pressing return	
CTRL C	- get back to drawing screen	
TEE		
CS		

The teacher asks the subjects to take turns in typing EXAMPLES B and C.

EXAMPLE B:

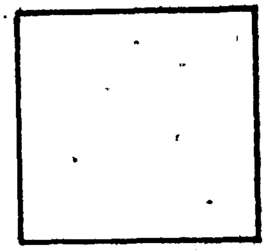
TEACHER TYPES	POINTS TO NOTE	ON SCREEN
ED "BOX	- use of <---- to erase error before pressing return	
FD 50		
RT 90	- use of CTRL G to stop procedure when an error is made.	
FD50		
CTRL G		
ED "BOX		
FD 50		
RT 90		
FD 50		
RT 90		
FD50		
<----		
FD 50		
RT 90		
FD 50		
END		
CTRL C		
BOX		

EXAMPLE C:

```
ED                     - to make a bigger square
TO BIGBOX
REPEAT 4 [FD 120 RT 90]
END

CTRL C

BIGBOX
```

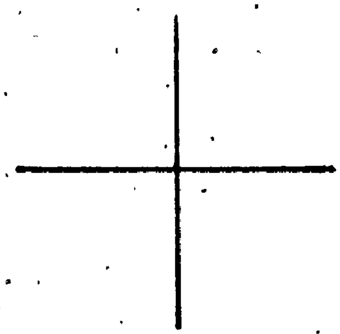


UNIT 3

SUBJECTS´S COPY OF THE EXERCISES

Write a procedure to draw each design and use the REPEAT command. Your turtle designs should be the same shape as these but they don´t have to be the same size.

1.



2.

3.

UNIT 4

EDITING A PROCEDURE

Performance Objective 4:

Performance: Edit a procedure in the LOGO computer language.

Conditions:

Given: a. - a series of three simple design exercises.

- an Apple II + computer
- the LOGO programming language (1982)
- a list of LOGO commands

b. with no assistance

Standard: Each pair of students will successfully edit three procedures; within five minutes. These procedures will produce designs on the computer that are to be the same shape though not necessarily the same size as prototypes.

<u>Content of the Unit</u>

CTRL N

CTRL P

<-----

----->

CTRL D

CTRL B

CTRL O

<u>Introduction</u>

(For both examples and exercises, the subjects should see the design that the procedure is intended to draw. Also the procedure should be called before editing is attempted. All procedures should end by hiding the turtle.)

EXAMPLES

I've written some procedures but they didn't do what I wanted them to do because they had some mistakes in them.

Here's a list of the commands in the procedures and the designs they're supposed to draw (give the subject EXAMPLES UNIT 4).

EXAMPLE A:

Let's look at the first one. It's called I.

Type I and let's see what it does.

That's what it does but what I wanted it to do is this (show the subject the design on his EXAMPLE paper).

Look at the procedure. The place marked with an X is where the mistake is.

Do you know what I've done wrong? (subjects may respond that you forgot to put the pen down)

(Show the subjects on their EXAMPLE paper what the commands produce.) Look, we did forward 60 then penup then forward 20. We need to put the pen down after the FD 20.

Can you get back into the editor so we can fix it? (subjects type EDIT "I)

O.K. we need to move the cursor down so let's look at your list of commands (show LOGO commands sheet). CTRL N will move the cursor down to the next line. N is for next.

Now move it down to FD 15 and then type CTRL O to open a line, O is for open (show on LOGO command sheet)

Now you can type PD.

O.K. let's get out of the editor (CTRL C) and try I again.

Good, you've fixed it.

EXAMPLE B:

Let's look at another procedure that has a mistake.

Type RECT. That's not what we want, is it?

What's the problem? (REPEAT 1 should be REPEAT 2)

So let's edit RECT (subject types EDIT "RECT)

We need CTRL N to get to the next line then move the cursor over (with the arrow key).

Now we need to delete 1 (show subjects on command sheet) so we use CTRL D, D is for delete.

O.K. now you can type 2.

Alright, let's see it (subject types CTRL C and RECT to get a rectangle on the screen).

EXAMPLE C:

The last one is called EL.

Can you show it to me first? (screen will say that LOGO doesn't know how to F in EL).

Can you fix it for me? Type EDIT "EL.

O.K. now move the cursor down to F and put the D that's missing.

Good.

O.K. let's try it (subject types CTRL C and EL).

Now I've got some procedures I want you to fix on your own. (give the subjects the EXERCISES sheet and read through the instructions with them.)

UNIT 4

SUBJECT'S COPY OF THE EXAMPLES

The X shows you where the mistake is.

THE PROCEDURE — **THE DESIGN**

EXAMPLE A:

```
TO I
FD 60
PU
FD 20
(line missing)    X
FD 15
HT
END
```

EXAMPLE B:

```
TO RECT
REPEAT 1 [FD 30 RT 90 FD 60 RT 90]    X
HT
END
```

EXAMPLE C:

```
TO EL
LT 90
F 60      X
RT 90
FD 100
END
```

UNIT 4

SUBJECT'S COPY OF THE EXERCISES

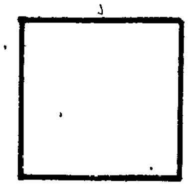
Instructions

Here are three procedures with the designs they are supposed to draw, but they don't work properly. I'd like you to fix them.

1. Type the name of the procedure to see what it does.
2. Find the X in the procedure. That means there's a mistake.
3. Fix the mistake in the editor.
4. Make sure the procedure draws a picture like the one here.

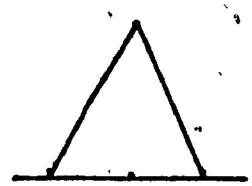
1. BOX

```
TO BOX
REPEAT 4 [FFD 40 RT 90]    X
HT
END
```



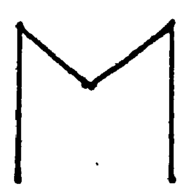
2. TENT

```
TO TENT
RT 30
FD 80
RT 120
FD80     X
RT 120
BK 20
FD 110
HT
END
```



3. EM

```
TO EM
FD 80
RT 135
FD 30
LT 90
FD 30
RT 135
FD 40
(line missing)    X
END
```



UNIT 5

SAVING AND LOADING A PROCEDURE AND USING SUBPROCEDURES

Performance Objective 5

Performance: Save and load a procedure and use subprocedures in the LOGO computer language.

Conditions:

Given: a. - an Apple II + computer

- the LOGO programming language (1982)

- a list of LOGO commands

b. with no assistance

Standard: Each pair of students will successfully do the following; within three minutes:

a. use the catalog to find certain procedures

b. load procedures needed

c. encorporate procedures (as subprocedures) into a new procedure

Content of the unit:

SAVE "...

LOAD "...

CATALOG

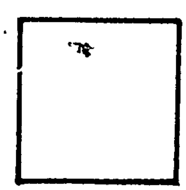
Introduction

(The notion of procedures and subprocedures should be explained.)

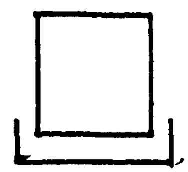
We're going to teach the computer to do something new from what it already knows. What it already knows is called a procedure, right? We write procedures in the editor and save them on a disk so we can use then again. Well, we can load some small procedures from the disk into the computer and put them together to make a bigger procedure that can do more than one thing.

EXAMPLES

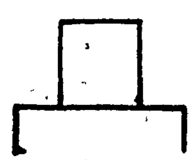
A:

TEACHER TYPES	WORDING OF TEACHER	ON SCREEN
EDIT TO SQUARE REPEAT 4 [FD 40 RT 90] END	First of all, I'm going to write a procedure called a SQUARE in the editor.	
CTRL C SQUARE	Now let's look at it	
Subject types		
CATALOG	I've written some other procedures that are on the disk but not loaded. We're going to use those and our square to make a big procedure that contains two small procedures. Will you show me the list of my procedures.	
LOAD "U	I want you to load that one called U so you have to type LOAD "U	

U	Let's see what it does. 
	O.K. we know what square does so now let's put them together.
EDIT	We're going to call the new bigger procedure SQUAREU so you can get us into the editor. Now type TO SQUAREU.
SQUARE	Now I want the turtle to draw the square first so move down a line and type SQUARE then down another line and type U
U END	Now we need to put END
CTRL C	Now let's see what SQUAREU DOES
SQUAREU	

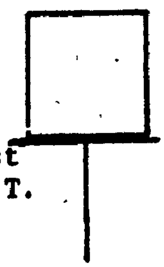


EXAMPLE B:

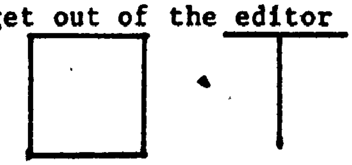
CATALOG	Let's look at the catalog again. I need you to load N for me. Do you remember how to load a procedure? 
LOAD "N	LOAD "N
N	Let's see what it does. We're going to put N and SQUARE together to make a new procedure called nsquare
EDIT	So let's get into the editor and start a procedure called NSQUARE
N SQUARE END	We want N first the SQUARE and now END
CTRL C NSQUARE	O.K. let's see it 

EXAMPLE C:

CATALOG	For the last example we'll use two procedures you haven't seen. Look in the catalog and I'll show you what we need.



LOAD "O	We want to load O and T
LOAD "T	
O	Now let's look at them. Type O first
CS	O.K. clear the screen and then type T.
EDIT	Let's call the new procedure TO.
TO TO.	We have to put a period after TO
O	We need the O first then the T and END
T	
END	
CTRL C	So now let's get out of the editor and see
TO.	

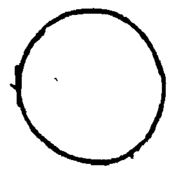
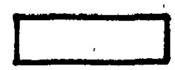
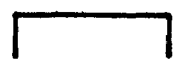


EXERCISES:

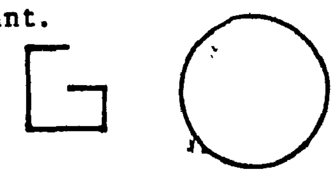
The procedures the subjects will need for these exercises are saved on the disk but should not be loaded by the teacher. Give the subjects the EXERCISES sheet and read over the instructions with him/her.

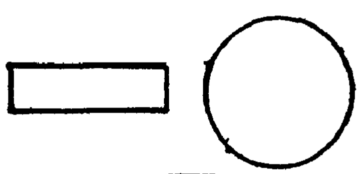
UNIT 5

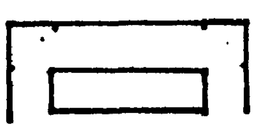
SUBJECT´S COPY OF THE EXERCISES

THE NAMES OF THE PROCEDURES SAVED BUT NOT LOADED	THE DESIGN DRAWN BY PROCEDURE
G	
PENNY	
LONG	
FRAME	

Make three new procedures that will draw the designs below. Use the CATALOG then load the procedures you need. Look at each procedure when you load it. Give the three procedures any names you want.

1.  don´t call this one GO; it won´t work!!!

2. 

3. 

UNIT 6

DRAWING POLYGONS, CIRCLES AND ARCS

Performance Objective 6:

Performance: Draw polygons, circles and arcs in the LOGO computer language.

Conditions:

Given: a. - a series of three simple design exercises.
- an Apple II + computer
- the LOGO programming language (1982)
- a list of LOGO commands

b. with no assistance

Standard: Each pair of students will program the computer to draw three designs incorporating polygons, circles and arcs; to be the same shape though not necessarily the same size as prototypes, within 3 minutes.

Content of the unit

CIRCLER + input

CIRCLEL + input

POL + input

Demonstration

Do you know how to make circles and arcs? (subjects will may respond "yes, with CIRCLER and ARCR")

So CIRCLER with inputs will made circle going to the right; CIRCLEL with inputs will make a circle going to the left.

EXAMPLE: type CIRCLER 20

type CIRCLEL 20

Well, I'm going to show you another way of making them. Can you check that the pen is down and the turtle is showing. Can you type:

REPEAT 3 [FD 20 RT 120] How many sides does this shape have?

Now I want you to type in some more REPEAT commands and we'll make different shapes. I don't want you to erase them each time so we can see all the shapes on the screen at the same time.

REPEAT 4 [FD 20 RT 90]

REPEAT 5 [FD 20 RT 72]

REPEAT 6 [FD 20 RT 60]

We've just got two more to go.

REPEAT 10 [FD 20 RT 36]

REPEAT 15 [FD 20 RT 24]

(Give the students List 1)

If we have a look at all the commands we've given the computer they all look like REPEAT, then a number of sides and forward 20 was always the same, then right a certain angle.

Well the angle is the same as 360 divided by the number of sides in the shape (show subjects the paper). For example, look at the square with four sides. If we divide 360 by four we get 90. Also for the shape with six sides the angle is 360 divided by six which equals 60. I think the easiest one is the shape with ten sides. 360 divided by 10 is 36, right?

I've written a procedure that will let us make a shape with any number of sides we want. It's called POL.

You can type in POL 3 and you get a shape with 3 sides. See? Try some other POL numbers but don't use more then 22. Also don't clear the screen then we can look at all the shapes together and compare them.

So tell me again, what is this number that you're typing after POL? (subject should say it's the number of sides). You can see that when the number of sides is bigger, the shape looks more like a circle.

So with the procedure POL we can make a triangle, a square and other shapes that look more and more like a circle.

Now we're going to look at how to make circles of different sizes. If we have a small number of forward steps before the turtle turns, we get a small circle, right? And if we have a bigger number of forward steps before it turns, what happens? Response: (the circle will be bigger.)

There is a procedure that lets us change the forward steps to get the size of circle we want. Now let's try it. Type

CIRCLER 5, but don't clear the screen then we can look at many sizes together. The five is the number of steps it goes forward before it turns each time.

Now do CIRCLER 8

CIRCLER 10

You see when the CIRCLER number we use is bigger, so is the circle, right? CIRCLER 20 is the biggest that will fit on the screen.

Let's just try CIRCLER 25 to see what it does (it wraps). O.K. leave them on the screen. All those circles are on the right side of the screen. What about drawing some on the other side. We use CIRCLEL. Let's try it.

CIRCLER 15

CIRCLER 20

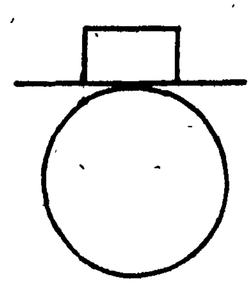
What I want to do now is draw a circle that touches a line so can you clear the screen and type

```
FD 100
BK 50
CIRCLER 10
```

Let's put all the things we've just learned together to make a picture. It's a round face with a little square hat on it.

O.K. so type

```
CS
RT 90
FD 100
BK 50
CIRCLER 12
BK 10
LT 90
```



and if you type POL 4 what will it give us? (a square) That's right, POL gives us the number of sides we want but CIR makes a circle the size you want.

POL
HT

O.K. we've looked at different shapes and circles of different sizes. Now I want to show you how to make just part of a circle.

Remember that the number of sides times the angle equals 360. Let's look at what happens when it equals only 180.

type CS
ST
REPEAT 15 [FD 10 RT 12]

so we get half a circle or what we call a semi-circle (on screen) (show on paper) if you multiply 15 repeats by 12 turning steps it only makes 180 which is half of 360.

Now let's see what happens when we change the FD 10 to FD 5.

type REPEAT 15 [FD 5 RT 12]

We get a smaller semi-circle because the number of forward steps was smaller.

This time we'll just repeat 10 so type

CS
then REPEAT 10 [FD 10 RT 12]

(on screen)

You see we get an arc because the line doesn't go even half way round a circle. Ten times 12 is 120. We can make a design that looks a bit like a fish so type

RT 90 and
REPEAT 10 [FD 10 RT 12]
(on screen)

These are both arcs because they're not complete half-circles. Remember for the half-circle we had 15 repeats but here we only have 10 so it doesn't go round as far.

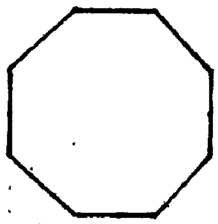
O.K. that's the end of the things that I wanted to show you but now I want to see if you can do something on your own. Can you use what we've just learned to make these designs? (show the subjects the EXERCISE page)

UNIT 6

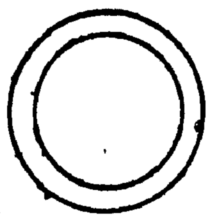
SUBJECT'S COPY OF THE EXERCISES

Make these designs using the commands you have just learned.

1.



2.



3.

LIST 1

```
REPEAT 3 [FD 20 RT 120]
REPEAT 4 [FD 20 RT 90]
REPEAT 5 [FD 20 RT 72]
REPEAT 6 [FD 20 RT 60]
REPEAT 10 [FD 20 RT 36]
REPEAT 15 [FD 20 RT 24]
```

Group CAL

EXPERIMENTAL TRUCK AND SNOWMAN TASKS

(Teacher's wording of instructions to the subject)

I would like you to produce a program in the computer language LOGO that will draw the picture you have here. You can use the list of LOGO commands on this sheet to help you and you can use this paper and pencil to write anything down.

The picture that you make must look like the one here on the paper although it doesn't have to be the same size as long as it looks similar and it has all the same parts.

You can program your graphic in the editor or outside the editor whichever you wish.

Since you are a team it is important that you work together and help each other to accomplish the task.

If you have any suggestions please ask me now because I can't answer them once you have started.

You have at most 45 minutes to finish the graphic. This is not a test so you won't be graded on it but try to do the best you can. Also no one will listen to this tape except for me so don't worry about others hearing what you say.

Give students a copy of the following LOGO commands and either the truck or snowman graphic.

NOTE ALL PROCEDURES MUST BE SAVED!!!!!

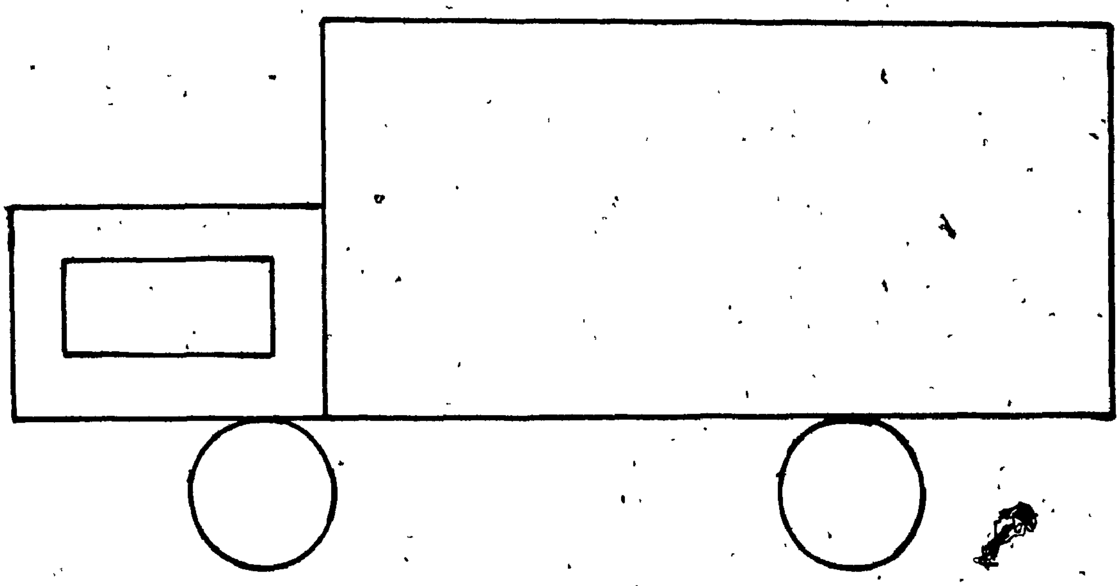


Figure 1: Truck Task Graphic

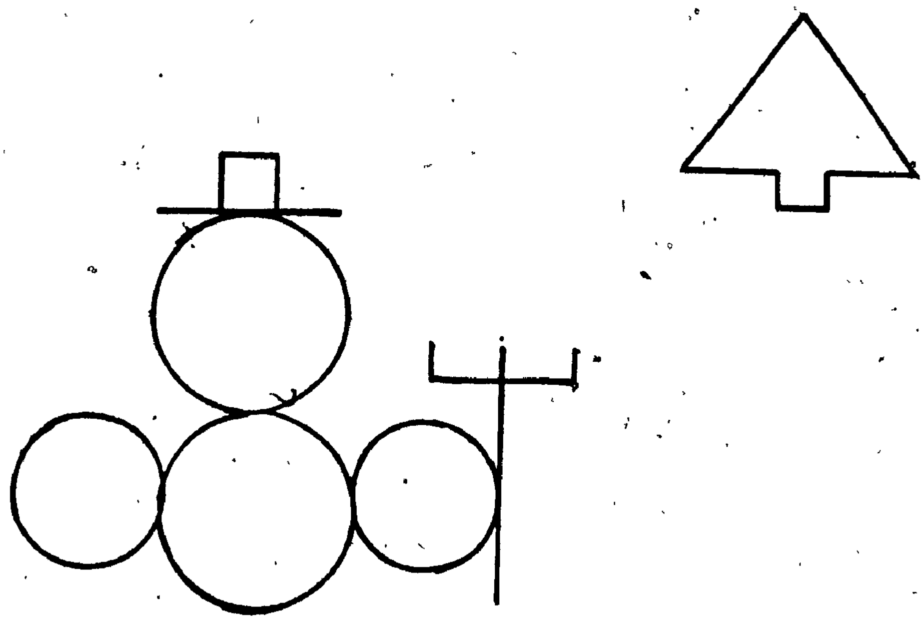


Figure 2: Snowman Task Graphic

LIST OF LOGO COMMANDS FOR STUDENTS' USE

COMMAND	ABREVIATION	EXAMPLE	EXPLANATION
BACK	BK	BK 10	MOVES TURTLE BACKWARDS
CIRCLEL	-	CIRCLEL 20	DRAWS CIRCLE TO THE LEFT
CIRCLER	-	CIRCLER 20	DRAWS CIRCLE TO THE RIGHT
CLEARSCREEN	CS	CS	CLEARS GRAPHICS SCREEN, HOMES AND SHOWS TURTLE
CLEAR	-	CLEAR	CLEARS GRAPHICS SCREEN
CTRL-B	-	CTRL-B	MOVES CURSOR ONE LEFT
CTRL-C	-	CTRL-C	EXITS EDITOR
CTRL-D	-	CTRL-D	DELETES CHARACTER AT CURSOR
CTRL-G	-	CTRL-G	EXITS EDITOR, NO CHANGES MADE
CTRL-K	-	CTRL-K	DELETES LINE
CTRL-N	-	CTRL-N	CURSOR DOWN ONE LINE
CTRL-O	-	CTRL-O	OPENS NEW LINE
CTRL-P	-	CTRL-P	MOVES UP ONE LINE
FORWARD	FD	FD 10	MOVES TURTLE FORWARD
FULLSCREEN	-	FULLSCREEN	GIVES FULL GRAPHICS SCREEN
HIDETURTLE	HT	HT	MAKES TURTLE DISAPPEAR
HOME	-	HOME	MOVES TURTLE TO CENTER OF SCREEN
LEFT	LT	LT 90	MOVES TURTLE A CERTAIN NUMBER OF DEGREES LEFT
PENDOWN	PD	PD	CAUSES TURTLE TO DRAW WHEN MOVING
PENERASE	PE	PE	CAUSES TURTLE TO ERASE EVERYTHING IT PASSES OVER
PENUP	PU	PU	CAUSES TURTLE TO LEAVE NO TRAIL WHEN MOVING
POL	-	POL 4	DRAWS A SQUARE
RIGHT	RT	RT 90	MOVES TURTLE A CERTAIN NUMBER OF DEGREES TO THE RIGHT
SETH	-	SETH 90	TURNS TURTLE IN THE HEADING SPECIFIED
SHOWTURTLE	ST	ST	MAKES TURTLE POINTER APPEAR
SPLITSCREEN	-	SPLITSCREEN	GIVES MIXED TEXT/GRAPHICS SCREENS
TEXTSCREEN	-	TEXTSCREEN	HIDES TURTLE SO ONLY WRITING APPEARS

APPENDIX B: CODING MANUAL FOR PROCESS AND PRODUCT DATA

FLOW CHART OF PROCEDURE

READ INTRODUCTION

↓

READ INSTRUCTIONS CONCERNING THE CODING OF GRAPHICS

↓

CODE EACH GRAPHIC ON THE APPROPRIATE EVALUATION SHEET ACCORDING TO THE FOLLOWING

---

1. note components completed
2. categorize errors in graphic

↓

READ INTRODUCTION TO IPA

↓

READ DESCRIPTIONS OF CATEGORIES

↓

READ INSTRUCTIONS TO CODERS

↓

READ LIST OF OFTEN ENCOUNTERED EXPRESSIONS

↓

GO THROUGH CODED EXAMPLES

↓

COMMENCE CODING INTERACTIONS ACCORDING TO THE FOLLOWING

---

1. indicate A, B, C, or D after each interaction for the appropriate category
2. leave blank if unsure (to be returned to later)

AFTER FIRST RUN THROUGH IF SOME INTERACTIONS STILL UNCODED GO THROUGH AGAIN IF NECESSARY WITH THE DETAILED CATEGORY DESCRIPTIONS TO AID IN THE CATEGORIZATION

INTRODUCTION

The following is divided into four main sections. The first section consists of instructions and examples to aid the researcher in evaluating graphics produced by children in the computer programming language LOGO.

The next part consists of the actual graphics along with evaluation sheets designed to permit the researcher to produce a score for each graphic based on certain criteria that will allow for an objective rating. Two types of graphic were produced each based on a prototype, which are also included. Thirty graphics of a truck and 30 of a snowman were produced by the students.

The third section is comprised of instructions for the coding of transcripts of verbal interactions according to the Interaction Process Analysis.

The fourth part consists of the actual transcripts.

PART I: INSTRUCTIONS FOR THE EVALUATION OF GRAPHICS AND EXAMPLES OF CODED GRAPHICS

INTRODUCTION

The following was designed to permit the evaluation of graphics produced in the programming language LOGO. This will aid the researcher in evaluating graphics in as an objective and complete a manner as is possible with material this is normally open to subjective interpretation.

The procedure is as follows: First, the components for each graphic are listed. The researcher checks off each component that was attempted in the graphic. Next, points are deducted for the following: A, proportion; B, missing lines or unconnected parts; C, distortions; (e.g., inaccurate angles resulting in lopsided figures); D, extraneous parts.

Each category results in a deduction of five points for each fault. This figure is then subtracted from 100. This figure is them multiplied by the proportion of components successfuly completed. The resulting product is the final score.

The actual scoring sheets are presented below for the truck and snowman graphic. Number of commands and programming time (these do not concern the coder) as well as room for comments is included on the forms.

The procedure then is as follows: Each graphic has an evaluation sheet attached to it. First, check off each component that was attempted or completed. Second, deduct five points for each of the reasons stated. These are: A, lack of proportion; B, missing lines or unconnected parts; C, distortions; D, extraneous parts. Each of the these will be discribed by way of examples. (see Coded Graphic Examples).

--->Please note that points are always deducted in five point increments with some categories limited to five point deductions in total.<---

A. Proportion: Points are deducted according to this category when the general or specific part of the graphic is out of proportion noticeably. Only five points can be deducted in this category.

B. Missing lines or unconnected parts: As the name suggests, if parts are missing or lines missing five points are deducted for each part or line that is missing. Please note that if a component is missing this will not be reflected by this category as it is already covered in the list of components.

C. Distortions: Five points can be deducted in total if the graphic is distorted. This may refer to a graphic that is at an off angle or parts that are at a different angle than other parts or the whole.

D. Extraneous parts: Five points are deducted for each extraneous part in the graphic.

Please note that the LOGO turtle that is used for drawing may be present on some of the graphics. This "turtle" is a small triangular object that may be anywhere in the graphic or surrounding it. Points should not be deducted for the inclusion of the "turtle".

EVALUATION CRITERIA FOR THE FINAL SCORE

Group ________

TRUCK TASK

Components
cab
window
box
left wheel
right wheel

DEDUCTIONS

Category	Points Deducted
A: proportion	
B: missing lines or unconnected parts	
C: distortions	
D: extraneous parts	
TOTAL DEDUCTIONS	

$$\text{FINAL SCORE} = 100 - \text{deductions} \times \frac{\text{no. of components completed}}{5} =$$

Number of commands used =

Total time used =

Comments:

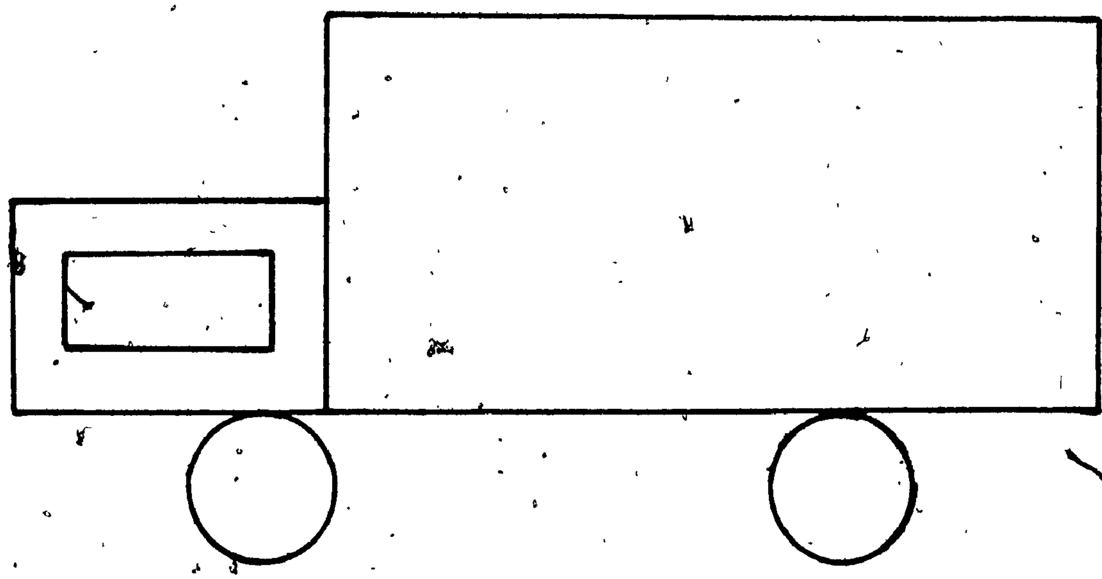


Figure 1: Truck Task Graphic

EVALUATION CRITERIA FOR THE FINAL SCORE

Group ________

SNOWMAN TASK

Components
hat
head
body
right arm
left arm
fork
tree

DEDUCTIONS

Category	Points Deducted
A: proportion	
B: missing lines or unconnected parts	
C: distortions	
D: extraneous parts	

TOTAL DEDUCTIONS =

$$\text{FINAL SCORE} = 100 - \text{deductions} \times \frac{\text{no. of components completed}}{7} =$$

Number of commands used =

Total time used =

Comments:

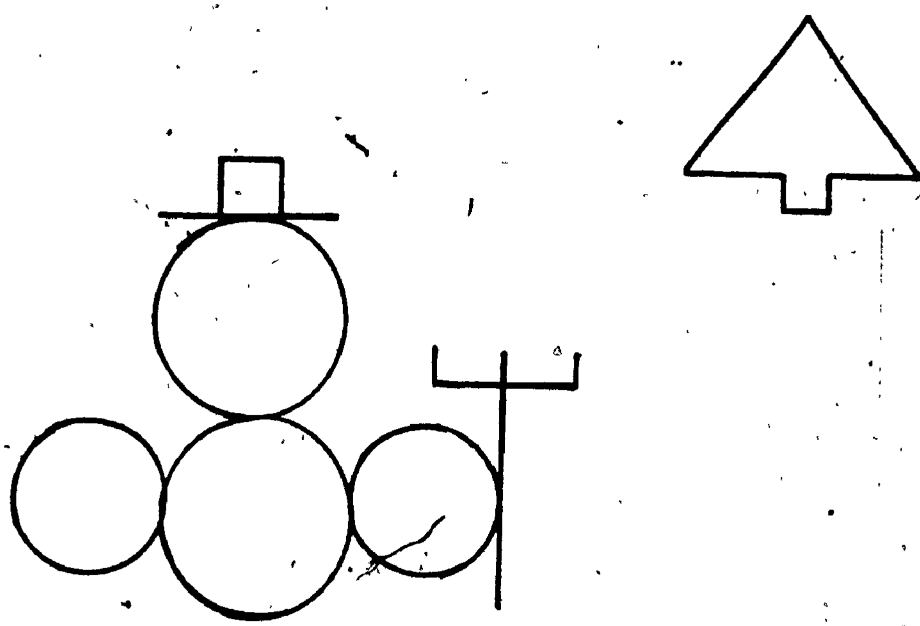


Figure 2: Snowman Task Graphic

CODED GRAPHIC EXAMPLES

The following examples (Figures 3, 4, 5, 6) when compared to the prototypes (Figures 1 and 2) would produce the following deductions. These are summarized on the evaluation sheets that follow. In each graphic all the components have been attempted therefore each component will be checked off as such in the components section.

In the snowman of Figure 3 the arms are large in relation to the body therefore five points should be deducted.

In Figure 4 there is a space between the head and the body of the snowman therefore five points will be deducted for category three.

In Figure 5 the window in the cab of the truck is at an incorrect angle requiring a five point deduction.

In Figure 6 a line exists on the back of the truck that should not be there according to the prototype. Five points are deducted for this.

---> Please note that it is not necessary for the coder to make the final calculations as they will be made later. The number of minutes and number of commands will also be completed later by the researcher. <---

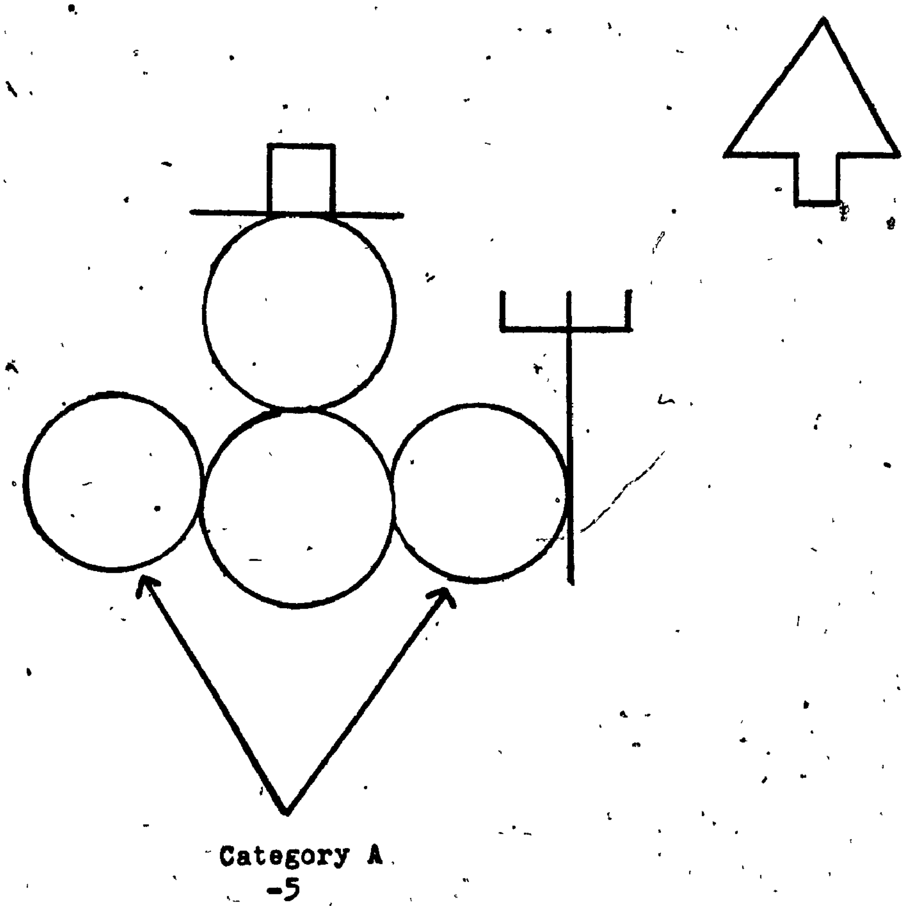


Figure 3: Coded Graphic

EVALUATION CRITERIA FOR THE FINAL SCORE

Group ________

SNOWMAN TASK

Components	
hat	✓
head	✓
body	✓
right arm	✓
left arm	✓
fork	✓
tree	✓

DEDUCTIONS

Category	Points Deducted
A: proportion	5
B: missing lines or unconnected parts	0
C: distortions	0
D: extraneous parts	0
TOTAL DEDUCTIONS =	5

FINAL SCORE = 100 − deductions X $\frac{\text{no. of components completed}}{7}$ = 95

Number of commands used =

Total time used =

Comments:

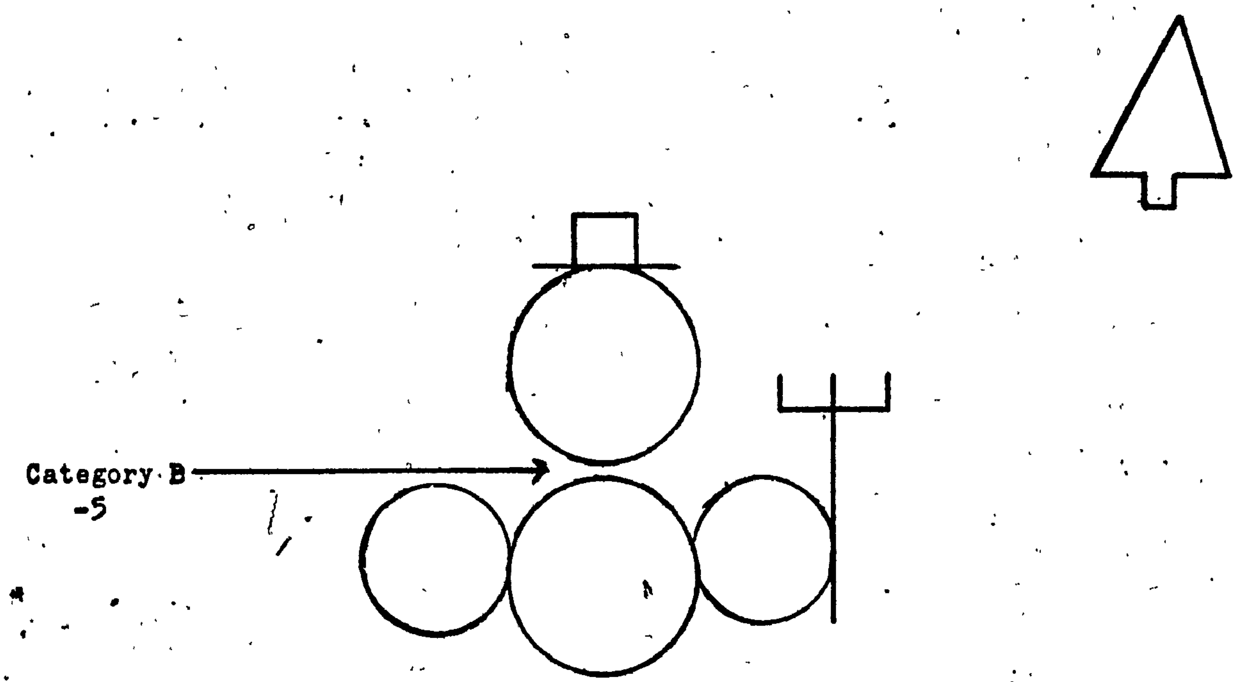


Figure 4: Coded Graphic

EVALUATION CRITERIA FOR THE FINAL SCORE

Group ________

SNOWMAN TASK

Components	
hat	✓
head	✓
body	✓
right arm	✓
left arm	✓
fork	✓
tree	✓

DEDUCTIONS

Category	Points Deducted
A: proportion	0
B: missing lines or unconnected parts	5
C: distortions	0
D: extraneous parts	0
TOTAL DEDUCTIONS =	5

$$\text{FINAL SCORE} = 100 - \frac{\text{deductions} \times \text{no. of components completed}}{7} = 95$$

Number of commands used =

Total time used =

Comments:

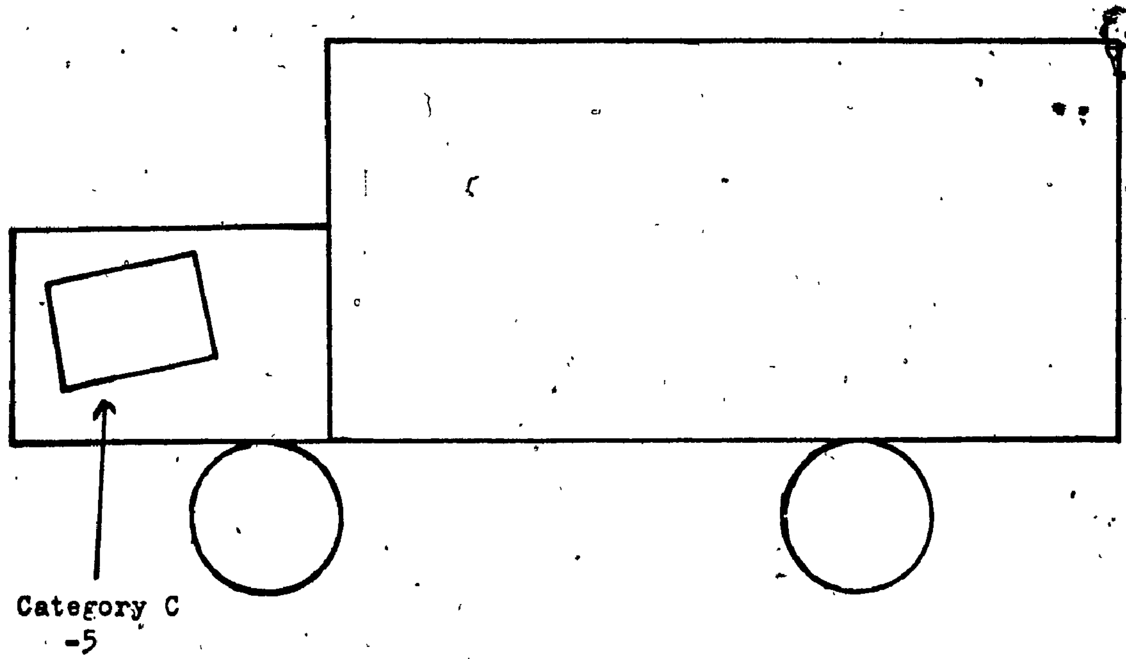


Figure 5: Coded Graphic

EVALUATION CRITERIA FOR THE FINAL SCORE

Group ________

TRUCK TASK

Components	
cab	✓
window	✓
box	✓
left wheel	✓
right wheel	✓

DEDUCTIONS

Category	Points Deducted
A: proportion	0
B: missing lines or unconnected parts	0
C: distortions	5
D: extraneous parts	0
TOTAL DEDUCTIONS	5

FINAL SCORE = 100 - deductions X $\frac{\text{no. of components completed}}{5}$ = 95

Number of commands used =

Total time used =

Comments:

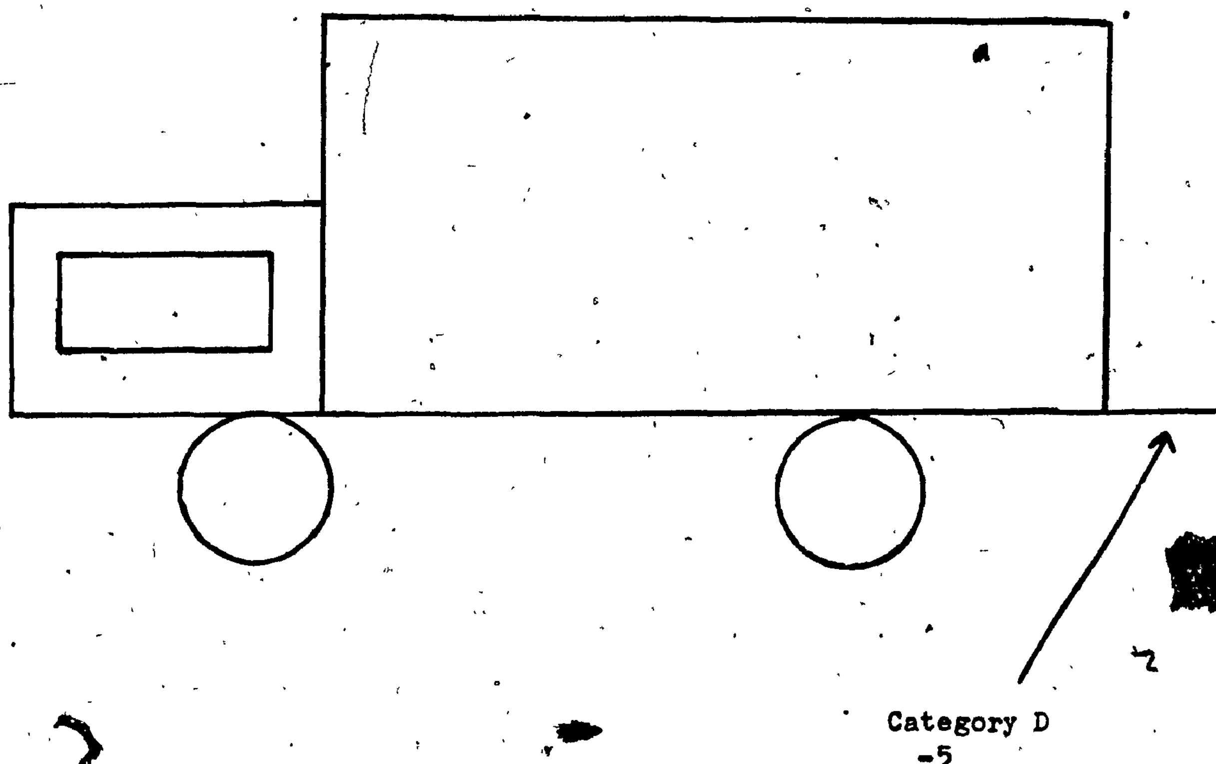


Figure 6: Coded Graphic

EVALUATION CRITERIA FOR THE FINAL SCORE

Group ________

TRUCK TASK

Components	
cab	✓
window	✓
box	✓
left wheel	✓
right wheel	✓

DEDUCTIONS

Category	Points Deducted
A: proportion	0
B: missing lines or unconnected parts	0
C: distortions	0
D: extraneous parts	5
TOTAL DEDUCTIONS	5

FINAL SCORE = 100 - deductions X $\frac{\text{no. of components completed}}{5}$ = 95

Number of commands used =

Total time used =

Comments:

CONDENSED INSTRUCTIONS FOR THE CODING OF GRAPHICS

1. Each graphic is designated by a series of numbers. Please indicate this designation on the evaluation sheet accompagning each graphic. You will find a space beside the word Group at the top of each sheet expressly for this.
2. Check off each component that was attempted in the graphic.
3. Deduct points for: A. proportion
   B. missing lines or unconnected parts
   C. distortions
   D. extraneous parts

PART II: GRAPHICS TO BE CODED AND ACCOMPAGNING EVALUATION SHEETS

PART III: INSTRUCTIONS AND CODING MANUAL FOR THE INTERACTION PROCESS ANALYSIS

INTRODUCTION TO THE INTERACTION PROCESS ANALYSIS

The IPA Categories have been used in clinical teaching (Shaw, & Parker, 1981), family therapy (Mishler, & Waxler, 1965), management /labor problem-solving (Landsberger, 1955), political analysis (Hare & Naveh, 1985) and in general to delve into the structure and dynamics of the group process.

The versatility specificity of it's categories makes it ideal for investigating interactions among individuals in small group learning and particularly small-group computer-assisted learning, of which much has been written about but little is known.

This versatility is reflected in the fact that results from investigations using the IPA are useful in three ways: First, they can be used for research purposes, to investigate either the internal workings of groups or in the comparison of groups from different populations or with differing characteristics. Second, they have practical significance in the sense of aiding in the diagnosis of problems with the sample of groups one is working with and perhaps allowing for the extrapolations to other comparable groups. Third; results can be compiled to be used in the production of norms for particular kinds of groups.

The following manual is designed to aid researchers and practitioners who are interested in small group behavior, especially as it relates to computer-assisted learning. To this end it serves two functions: First, providing general information for those wanting to interpret research using the IPA; Second, it can be used as a training manual for those interested in using the IPA for coding small-group learning situations.

This manual is based on pilot research conducted with 36 fourth grade students working in groups of two or three working collaboratively on a CAL task. Transcripts and audio recordings made of these students' interactions were subjected to coding using the IPA categories. As the IPA is a very general instrument and the documentation is a bit dated (the original was produced in 1950) it was decided to redefine the categories according to contemporary social realities and especially to make it more appropriate for small-group learning situations.

The categories themselves are as originally described by Bales in 1950 or in his revised version (Bales, 1970) with only their definitions being changed in the manner as described above.

The following theoretical rationale for the IPA is based directly on Bales original 1950 work. The IPA descriptions are only loosely related to Bales as modifications have been made to allow for easier scoring, make the IPA more interpretable for researchers and practitioners in the area of small-group learning, and make it more in line with contemporary thinking and parlance.

I. THEORETICAL RATIONALE FOR THE IPA

A) The IPA in general practical and research usage

In many respects the IPA is a systems theoretical concept as a small group is considered a system that operates within the confines of a super system (i.e., society), and can produce sub-systems (i.e., individuals or pairs that break from the main group to form a coalition). The interaction system is the key to the system that one can use to discern social systems, personality, or culture. Further, the IPA is a system in that each category derives its meaning by its context with respect to the rest of the interaction categories.

The IPA allows the social scientist to observe and classify groups and therefore make empirical generalizations about human behavior in social situations.

First, however, it may be helpful to define what is meant by a small group. According to Bales (1950, p.33) "A small group is defined as any number of persons engaged in interaction with each other in a single faced-to-faced meeting or a series of such meetings, in which each member receives some impression or perception of each other member distinct enough so that they can, either at the time or in later questioning, give some reaction to each of the others as an individual person, even though it be only to recall that the other was present."

Interaction is clearly the key to the definition as it excludes groups that may be physically present yet do not interact in the social sense of the word (e.g., students attending a lecture).

Size of small groups may range anywhere from two to eight; the greater the size the more the possibility that sub-groups will be formed.

The categories themselves are concerned with the most general aspects of interaction, not with the content of the interaction per se. This makes them ideal for cross subject matter research as the categories will be represented in the communication between members of any small group.

It is assumed, moreover, that all small groups are similar in that they are composed of individuals with a common goal and with problems of social and emotional relationships when a resolution to this goal is attempted. Each verbal act of an individual in a group is categorized in reponse to these problems. Scoring is continuous making in-depth interpretations impossible, and surface meanings the accepted norm.

Each unit to-be-scored, or single interaction may be defined as the smallest segment of social interaction that can be scored using the categories. This rather circular definition will become clearer once a familiarity with the IPA develops as one always reduces the unit to the smallest that will sustain only one classification; if there is room for two categories for one segment, then it can be divided. Every action is an interaction.

The observer/scorer's role is to code these units into one of the four categories by thinking of himself/herself as the person-to-whom the unit is addressed. The scorer must refect on how the individual that produced the unit (the actor) reacts in response to the common group experiences, its expectations, and definitions of the situation rather than on the basis of basic personality characteristics of that individual.

The basic conceptualization of groups working together is one of a series of problem-solving sequences. "The group is continually moving from a felt need toward a solution, from tension toward tension reduction, from a state of heightened motivation toward motivations reduction..." (Bales, 1950, p. 49). Each act is therefore part of the larger problem solving sequence. Individuals within the group are able to jump back and forth in the problem solving process through their ability to manipulate symbols. For instance, a group may start the problem-solving sequence with questions (considered forward reference), proceed with attempted answers (may be forward or backward reference depending upon the outcome), which may produce either negative reactions (backward reference) or positive reactions (backward reference). The successive acts may be relating to the future or the past with a continual focussing on one or the other being healthy.

In sum, the IPA is a system of categories that allows one to study processes from the most general perspective, that of goups working towards a common goal, regardless of what that goal is.

B) IPA in Group CAL

In group CAL the need for a process measure as comprehensive as the IPA is apparent in light of the previous attempts at categorization of social interaction that were much more limiting (e.g., Webb, 1984).

Perhaps the most important role that the IPA can contribute to the investigation of group processes in CAL is in the determination of norms for such interaction.

II) CODING PROCEDURES

Figure 7 depicts the IPA categories with the general descriptions of each for quick reference. A detailed description and explanation follows.

CATEGORY	DESCRIPTIONS
A POSITIVE SOCIAL-EMOTIONAL AREA	1. SEEMS FRIENDLY 2. TENSION RELEASE 3. AGREES
B STATEMENTS	4. GIVES SUGGESTIONS 5. GIVES OPINION 6. GIVES INFORMATION
C QUESTIONS	7. ASKS FOR INFORMATION 8. ASKS FOR OPINION 9. ASKS FOR SUGGESTION
D NEGATIVE SOCIAL-EMOTIONAL AREA	10. DISAGREES 11. SHOWS TENSION 12. SEEMS UNFRIENDLY

FIGURE 7: IPA Categories

A) DESCRIPTION OF THE IPA CATEGORIES

1) INTRODUCTION

The following coding procedure contains a general description of the IPA categories followed further on by the detailed IPA sub-category descriptions. You are required to code only the categories (A, B, C, and D), therefore the detailed descriptions may not be necessary except for cases of uncertainty where coding is unclear.

It is recommended that the coder work from Figure 7 and code continuously skipping any interactions where the coding is unclear. After going through the transcripts, coding where possible, the researcher may go back and consult the detailed sub-category descriptions (on page 182) for the interactions that are questionable.

2) CATEGORY DESCRIPTIONS

A brief description of the meta-categories follows:

The IPA categories are of two general types: Those related specifically to the task (categories B and C) and those dealing with socio-emotional interactions that may or may not be task-related (categories A and D).

The later consists of both positive socio-emotional interactions (category A) and negative socio-emotional interactions (category D).

Category A consists of positive socio-emotional interactions such as statements that are supportive, friendly, consiliatory, that are meant to release tension, that reflect happiness upon achieving goals, and express agreement that may be task-related, as in agreement concerning certain information. Examples would be "excellent", "good", "okay", "yes", "alright", "boy that was close".

--->Please do not confuse "okay now" or "okay" when it is used as a figure of speech with a statement of agreement. This should be clear in the transcripts as when these terms are used as figures of speech they are followed by other statements, for instance "okay forward 15".

Category B expresses task-related opinions, suggestions, and information. Giving opinions may be a statement like "it's too long", giving a suggestion may be "go forward 15", and giving information may be "it was 15".

Category C in a sense is the opposite of B in that it refers to questions that may or may not lead into interactions categorized as B. The following is included under C: Asks for information, asks for opinion, and asks for suggestion. The coding for this area is quite easy as the interactions usually are in the form of a question punctuated by a question mark.

Category D pertains to the negative socio-emotional interactions. This category is comprised of disagrees, shows tension, and seems unfriendly. In the text, these may be indicated by an exclamation mark. As in category A, disagrees may refer to task-related interactions although it is included as a negative socio-emotional interaction. Examples are "oops", indicating tension; "no", indicating disagreement; and "you dummy", indicating unfriendliness.

3) LIST OF OFTEN ENCOUNTERED EXPRESSIONS

The students in this study were required to produce a picture in the computer programming language LOGO. The following is a list of LOGO commands that you may encounter in the transcripts. Most of these will be printed in capital letters. The abreviation of each, where applicable, is in parentheses:

backward {BK}

CIRCLEL

CIRCLER.

clearscreen {CS}

forward {FD}

hideturtle {HT}

home

left {LT}

pendown {PD}

penerase {PE}

penup {PU}

pol -

repeat -[FD - RT -]

right {RT}

showturtle {ST}

splitscreen

textscreen

You may also encounter words like "return", "space" and various numbers dealing with the length of lines, spaces, and the size of circles. Phrases like "Not enough inputs to..." and "I don't know how to... " refer to the computer's means of telling the students that what they have inputed to the computer is not correct according to the LOGO programming language.

The first task that the students were required to program consisted of a picture of a truck, the second of a snowman. Included in the second was also a Christmas tree and a fork.

4) EXAMPLES OF CATEGORY CODING

The following lists some (typical and atypical) interactions followed by the letter representing the category which is appropriate. Where needed an explanation is also provided.

who cares	D	indicates tension
let's do ...	B	suggestion
ya	A	indicates agreement
I forgot that	B	information given
oh boy!	D	indicates dismay
Henry!	D	indicates dismay
FD	B	information given
where's the K?	C	asks for information
too big	B	gives opinion
space	B	gives information
ya circle	A	indicates agreement
wait a minute	B	gives a suggestion
alright	A	indicates agreement
down	B	gives information
oops!	D	indicates dismay
it doesn't matter	B	gives opinion

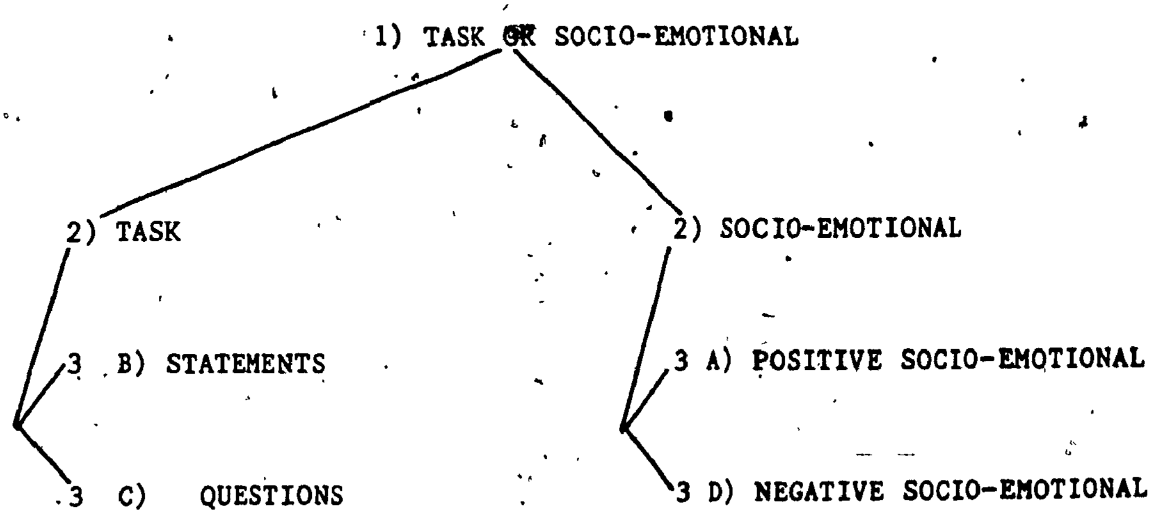
RT 180	B	gives information
oh my God!	D	indicates dismay
you dummy	D	deflates other's status
are you crazy	D	indicates antagonism
oh shoot!	D	indicates dismay or tension
sorry	A	consiliatory statement
excuse me	A	asking pardon
trust me	A	tension release
see	B	gives a suggestion
see!	D	indicates tension

5) INSTRUCTIONS TO CODERS

Please code every line except those within these symbols <>, as the interaction delineated by these symbols was produced by the experimenter.

Please mark an A, B, C, or D after each utterance according to the category which you think is most appropriate.

SUMMARY OF INSTRUCTIONS



6) DESCRIPTIONS OF THE IPA CATEGORIES

INTRODUCTION

The following describes the four Bales (1950) IPA categories lettered A through D. Sub-categories are numbered 1 through 12. Within each sub-category sub-sub-categories are indicated by lower case letters and specific instances of verbal behavior falling within each subcategory are marked by Roman Numerals followed by examples, within quotation marks where appropriate.

A. POSITIVE SOCIAL EMOTIONAL INTERACTION

1) SEEMS FRIENDLY, SHOWS SOLIDARITY, RAISES OTHER'S STATUS, REWARDS

a) Initial and responsive acts of active solidarity and affection, includes:

i) saying hello or other friendly greeting, extending an invitation to participate in the group, or any verbal symbol of solidarity and acceptance,
"Come and help us solve this problem."

ii) the recipient's counteraction such as accepting an offer, thanking the other or saying goodbye,
"Alright, I'll help you with the problem."

iii) any indication of good will towards the other,
"You're always good at this type of problem."

iv) a friendly comment to "break the ice",
"You look well today."

v) a comment indicating hospitality or comaradary,
"We always work well together."

vi) the expression of sympathy,

"I can see how you feel."

vii) indication that a relationship is developing at a more intimate level (e.g., the use of first names, the use of we when not used previously),

"We'll solve this soon."

viii) indication that the speaker confides or identifies with another,

"I can understand how that could happen."

ix) forming an allience with the other,

"We can do it together."

x) any indication that the speaker is attracted to the other,

"You're my favorite partner."

b) Initial and responsive status-raising acts; the speaker has the specific aim of raising or enhansing the other's status. This includes:

i) praising, rewarding, boosting the other, giving approval or encouragement,

"That's fine,"; "You've done a good job,"; "Swell"

ii) complimenting, congratulating, showing approval of the other, giving credit to other, showing enthusiasm for views of other, applauding or cheering him/her,

"I think that is a very good idea."

iii) expressions of gratitude or appreciation, admiration, respect, or reverence,

"Thank you for helping me debug this program."

iv) emulation by the speaker of others,

"I'll try it your way next time."

c) Behavior in which the speaker offers assistance to the other, volunteers, assumes a duty on behalf of the groups or a member of the group. This includes:

i) sharing or distributing something, invitations to participate in reward,

"You can have a turn now."

ii) trading or loaning something,

"I´ll let you use the manual now."

iii) altruistic, generous, or self-sacrificing attitude,

"I´ll type in the long part."

iv) giving a gift,

"Your can have this list."

v) defending of or advancing the interests of another by the speaker,

"I think his ideas are quite interesting."

vi) giving support, encouragement, sympathy,

"Your doing fine."

vii) attempts to calm the other or gratifying needs of any kind,

"Don´t worry, you´ll be able to do it."

viii) attitude of nurturance, benevolence, or charity,

"I´ll give you the help you need."

d) Interaction occuring after or during conflict situations. The following are included:

i) urging of pacification,

"Let´s calm down and get back to work."

ii) speaker urges unity or harmony, agreement, cooperation, mutual obligation or expresses the values of solidarity,

"Let's work together to get the job done."

iii) suggestion of compromise,

"I think that I'll help you with that part if you help me with this."

2) DRAMATIZES, SHOWS TENSION RELEASE, JOKES, LAUGHS, SHOWS SATISFACTION

a) Spontaneous indications of relief; including the following:

i) expressions of feeling better after a period of tension, satisfaction, gratification, enjoyment, relish, zest, enthusiasm, pleasure, delight, joy, happiness,

"I'm glad that we finally resolved our differences."

ii) positive responses to a compliment,

"Thank you very much for saying that."

iii) indication that the speaker is thrilled, elated, euphoric,

"That's wonderful!!!"

b) Joking; includes:

i) friendly jokes, trying to amuse or entertain, any frivolous, humorous remark,

(Context dependent)

ii) clowning and kidding the other in a friendly fashion,

"Joe always types the 'o' instead of the 'p'."

iii) active horseplay as long as is not perceived as aggressive,

(Context dependent)

c) Laughing; includes:

i) positive responses to joking such as laughing, "ha, ha that certainly is funny."

3) AGREES, SHOWS PASSIVE ACCEPTANCE, UNDERSTANDS, CONCURS, COMPLIES

a) Speaker is perceived as modest, humble, respectful, and unassertive,

"I'll do what you tell me to."

b) Speaker appears to have come to some decision or adopt a plan of action,

"Yes, that's what I'll do."

c) i) Speaker agrees to a course of action,

"Let's do that."

ii) Speaker complies with a request or suggestion,

"Okay, I'll do that."

iii) carrying out something agreed upon by the group,

"Yes, I'm copying that."

iv) yielding, obeying, or following a request,

"I'll do what you say."

d) giving specific signs of attention to what the other is saying, showing comprehension, or insight,

"I see." "Sure, now I get it."

e) admitting an error or oversight, or asking the other's pardon,

"It was my fault, I'm sorry."

f i) speaker accepts someone as he/she is regardless of their performance on the task,

"Don't worry about not being able to finish the drawing."

ii) forgives, or pardons others from blame,

"Don't worry about it, we can fix it."

h) speaker is submissive, pliant, meek, in response to aggression directed toward him/her,

"You dummy, you touched the keyboard and ruined the program."

"I won't do it again."

B. STATEMENTS

4) GIVES SUGGESTION, DIRECTION, IMPLYING AUTONOMY FOR OTHER

a) The process of cooperative action including all acts suggesting concrete ways of attaining a desired goal, such as proposing a solution, modifying a solution, and indicating where to start towards a solution,

"We should start there and work up till we finish."

b i) Speaker proposes or suggests how the situation is to be defined, the purpose and nature of the roles to be taken, gives instructions or makes proposals about the task showing where, when, how, why, something is to be done,

"Consider for a moment what would happen if..."

ii) direct attempts to guide others regarding some activity, to prevail upon them, persuade them, exhort them, urge them to join you, or inspire them to take some action,

"Let's do that so we will finish soon."

iii) the speaker, as a recognized leader, requests others to do things as part of the routine mechanics of group management,

"Keven, can you write down the commands?"

iv) the speaker assigns tasks or roles,

"Susan can type in the commands."

v) the delegation of authority or initiative,

"Dave you be in charge of checking for mistakes."

vi) simple requests,

"Would you hand me that sheet of paper."

5) GIVES OPINION, EVALUATION, ANALYSIS, EXPRESSES FEELING, WISH

a i) statement of a hypothesis or expression of understanding resulting from inferential and evaluative processes,

"I think that overall it will look quite good."

ii) any expression of desire, want, liking, wishing, or hoping, any expression of policy, intention, or guiding principles, or law referring to the future yet unimplemented at present,

"I wish we could fix it so that..."

iii) any expression of ambition or aspiration,

"I hope to be an expert at programming after this course."

b) any evaluation of the speaker's own previous actions,

"I think that I could have done a better job on that."

c) the speaker attempts by inference or reasoning, in an objective way, to understand, diagnose or interpret the other, his motivation or activity,

"I think that I know why you did that."

d) statements about the nature of the environment facing the group as a whole, which are essentially inferential, hypothetical, a matter of opinion or plausible interpretation, not immediately observable,

"Well, let's see. Two times the square root of this second term is..."

6) GIVES INFORMATION, ORIENTATION, REPEATS, CLARIFIES, CONFIRMS

a i) speaker focuses the attention of others on communication to follow,. (e.g., calling other's name, mentioning problem to-be-discussed),

"Well, let's review what we have to do."

ii) any looking back on a past activity of the group,

"That's how we did it yesterday."

iii) the speaker reports without inference some past thought, feeling, action, or experience of his/her own, either spontaneously or in response to questions,

"Yesterday I was sure we couldn't do it."

c) the speaker repeats, or clarifies something said previously without resorting to inference or interpretation beyond that originally given,

"In sum, we must combine all the parts."

d) statements of fact about the nature of the outer situation facing the group which are essentially objective, straightforward, non-inferential, non-emotionally toned, descriptive observations of empirical generalizations which are recognized as generally established or easily confirmed by observation, "We just have 30 minutes left."

C. QUESTIONS

7) ASKS FOR INFORMATION, ORIENTATION, REPETITION, AND CONFIRMATION

a i) speaker indicates lack of knowledge needed for some course of action,

"Can you give me more information about the size?"

ii) puzzelment or bewilderment on the part of the speaker,

"What exactly do you mean by that?"

b i) Direct questions requiring the giving of a factual rather than an inferential answer,

"How long is that line?"

ii) indefinite expression of a lack of knowledge,

"I don't know about this."

8) ASKS FOR OPINION, EVALUATION, ANALYSIS, EXPRESSION OF FEELING

a) Open-ended, non-directive leads and questions exploring the other's feelings, values, intentions, and inclinations. Generally this encourages statements or reactions without limiting the nature of the response, except in a very general way,

"Well, how do you feel today."

b i) the speaker produces questions, statements, or responses which serve an interpretation, hypothesis, diagnosis, or further analysis of some idea from another person, his definition of the situation or opinion on some topic in an objective manner,

"What do you think will happen if we move this over there?"

ii) the speaker may wish to get the other's interpretation or opinion as an aid where there is no known answer and only conjecture is possible,

"How long do you suppose it will be?"

9) ASKS FOR SUGGESTION, DIRECTION, POSSIBLE WAYS OF ACTION

a) includes all questions or requests, explicit or implicit, for suggestions as to how action shall proceed through the utilization or concrete ways and means to goals,

"I wonder what we can do about this?"

D. NEGATIVE SOCIAL EMOTIONAL INTERACTIONS

10) DISAGREES, SHOWS PASSIVE REJECTION, FORMALITY, WITHHOLDS RESOURCES.

a) The speaker displays an attitude which the observer considers over-cool, frigid, inexpansive, unresponsive to a situation where an emotional response is expected including:

i) passive forms of rejection, such as remaining silent or uncommunicative in the face of overtures of another,

"How would you do that Jim?

(no response by Jim)

ii) any passive withholding of friendship,

(Context dependent)

iii) any indication that the speaker is detached, isolated, disinterested, impersonal, aloof, formal, disant, unsocial, reserved, unapproachable, or exclusive,

"I think that we should work on this independenly."

iv) working at something other than the problem with which the group is concerned,

"I'll be reading while you solve the problem."

v) speaking or paying attention to outsiders, such as observers,

to observer, "Why are you writing every thing down?"

b) speaker appears to be skeptical, or cautious about accepting a proposal, hesitant, critical, suspicious, or untrustful,

"I don't know about doing it that way."

c i) speaker mildly disagrees, disbelief, astonishment, amazement, or incredulity regarding reports, observations or interpretations of others,

"I don't see how you could have made it that way."

ii) speaker amends or corrects another's description of a situation, his/her interpretation or diagnosis, or contradicts something the other has said,

"I think that what you wrote is wrong, it should be this way."

d i) speaker withholds resources,

"I'll keep all the copies myself."

ii) possessive or secretive attitude on the part of the speaker,

"I won't let you see it now."

iii) speaker refuses to let another participate in an activity,

"You can't do the typing Jim."

11) SHOWS TENSION: ASKS FOR HELP, WITHDRAWS OUT OF THE FIELD

a) Diffuse tension; includes any indication of impatiance on the part of the speaker,

"Hurry up!"

b) Diffuse anxiety; includes:

i) speaker appearing to be startled, alarmed, dismayed, concerned or has misgivings about something he/she has done or intends to do,

"I can't believe that's the way that I did that!"

ii) any verbal expressions of fear, apprehension, or panic,

"Oh no we have to be finished by one o'clock."

iii) any indication that the speaker does not want to preceed because of fear of failure,

"We shouldn't go on since we probably can't finish."

iv) speaker's intense fear of blame, or of provoking opposition or hostility,

"It's not my fault that the program bombed."

c) Shame and guilt; includes:

i) admission of ignorance or incapacity,

"I just don't know enough about programming in LOGO."

ii) admission of unfairness to another,

"I guess that you should have had another turn."

iii) blamming oneself,

"I pushed the wrong button."

iv) self-critical, depreciating, accusing, condemning, humiliating, or self-convicting,

"I will never be able to get it to run."

d) Frustration; includes:

i) speaker indicates that an effort has failed resulting in frustration,

"After two hours it still doesn't work!"

ii) speaker indicates being deprived in some way,

"I didn't have all the information."

iii) unhappiness and discouragment on the part of the speaker,

"I'm just fed up!"

e) Asking for help, permission; including:

i) speaker's emotional requests for permission or help,

"Come on, let me do it!"

ii) speaker places responsiblity for his/her problems on others,

"It's your fault, you should have told me that's the wrong button."

iii) speaker flatters, or attempts to appease another through insincere means,

"I'm sure that you're the best."

iv) speaker insincerely abases himself/herself to obtain some ends,

"Well you can do that so much better than me, so you'd better do it."

v) speaker attempts to shame another into some kind of desired behavior by acting as if injured, or put upon,

"I always have to do these things; you never do."

vi) speaker pleads, or begs another for a favour,

"Please, do this for me."

vii) any attempt to arouse sympathy through the telling of misfortune, and hardship,

"My hand hurts so much I can hardly type."

viii) any manifestation of a craving for attention,

"I want to give the teacher the finished copy."

f) Withdrawl out of the field; includes:

i) speaker indicating that he/she is psychologically withdrawn from the problem at hand,

"I can't think about this right now."

ii) overt withdrawl from the group, such as resigning,

"You finish it, I don't want to."

12) SHOWS ANTAGONISM, DEFLATES OTHER'S STATUS, DEFENDS OR ASSERTS SELF

a) Autocratic control; includes:

i) attempts to control or regulate in an autocratic manner,

"You're going to do it my way!"

ii) the arbitrary assignment of a role,

"Tom, you only write down the commands."

iii) defining or restricting the powers of another,

"Come here, you must stay right here!"

iv) speaker is overbearing or dogmatic, inconsiderate or servere,

"You must do this!"

v) arbitrary attempts to lay down principles of conduct, standards, or laws,

"You can't go until this is finished."

vi) arbitrary attempts to settle an argument, to give a decision, to force, compel, coerce, subdue, subject, master, dominate,

"I'll decide who is right."

vii) the speaker prohibits the other from doing something, represses the other, prescribes some activity,

"You have to do this."

b) Autonomy; includes:

i) speaker is noncompliant, unwilling, ignores directions or requests,

"I won't do it that way!"

ii) speaker is negativistic, stubborn, resistant, or sulky,

"I'll only do it the way that I want!"

iii) also carping, harping, griping, nagging, badgering, harassing, annoying, perturbing, disturbing, or pestering another,

"Come on, do it this way."

vi) speaker is disrespectful, discourteous, impudent, bold, sausy, flippant, unashamed, or unrepentant when justly accused,

"We all saw you do it, Dave."

"I don't care, I can do what I want."

c) Status deflating; includes:

i) conspicuous attempts to override another in conversation, interrupting another, interfering with his/her speaking, gratuitously finishing off sentences for him/her when the other does not want help,

(Context dependent)

ii) any implication of inferiority or incompetence on the part of the other, such as belittling, ridiculing, minimizing the other, or making fun of him/her,

"You were never good at this."

iii) speaker being maliciously sarcastic, satirical, ironical,

"So you thought you could solve the problem eh."

iv) teasing, taunting, heckling, gloating, jeering, scoffing, mocking, sneering, baiting, or provoking another to say something indiscreet or damaging,

"I finished before you!"

v) damning another, finding fault with him/her, complaining, criticizing another,

"It's so hard working with you."

vi) making charges against another, blaming him/her, prosecuting, ill-treating or browbeating,

"I know that Jim is the one who ruined it."

vii) any act of gossip, any libel, slander, smirching of another's character, demeaning him/her, informing against him/her, exposing him/her, or undermining his/her position, or discrediting him/her,

"I heard he was just as bad at the last session."

viii) tricking, hoaxing or humiliating another,

"You just can't get anything right."

ix) any indication that the actor is indignant, offended, insulted, affronted,

"I've always had my programs run, until now."

x) pomposity, self-importance, self-righteousnes, self-satisfaction, or smogness,

"I'm the one who made all the right decisions."

xi) pride, vanity, arrogance, snobbish, self-conceitedness, presumptuousness, or condescention,

"You didn't do it as well as I did."

d) Status defending; includes:

i) speaker saying something that would indicate that he/she has a chip on their shoulder,

"It didn't work because of your meddling."

ii) refusal to admit guilt, inferiority or weakness,

"Well don't blame it on me."

e) Status seeking; includes:

i) spectacular or conspicuous statements,

(Context dependent)

ii) attempts to excite, amaze, fascinate, entertain, shock, intrigue, or amuse another as a means of raising one's own status,

(Context dependent)

iii) speaker showing off, seeking applause, playing the clown,

(Context dependent)

iv) applauding, or advertising one's self,

"I'm the best one to do that."

v) speaker tries to outdo another,

"I can do that better that you."

f) Diffuse aggression; includes:

i) speaker is aggressive, or quarrelsome,
(Context dependent)

ii) speaker shows annoyance, irritation, anger, or temper tantrum,
"I´m really fed up."

iii) any indication of intolerance, or malevolence,
"I won´t put up with this."

iv) any indication of cruelty, vendictiveness, or retaliation,
"I´ll do the same thing to you when I have a chance."

v) when speaker indicates envy, avarice, or attempts to take something away from another,
"I wish that I had a color monitor."

APPENDIX C: BEHAVIORAL OBSERVATION INSTRUMENT

Group CAL

Group _____

Task _____

Behavior

Minutes	Turns at Keyboard	Turns Writing	Simulating Turtle Movements	Monopolizing Equipment	Removing Self from Group
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

Group CAL

Group _____ Task _____

Behavior

Minutes	Turns at Keyboard	Turns Writing	Simulating Turtle Movements	Monopolizing Equipment	Removing Self from Group
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					

Appendix D: Inter-coder Reliability Coefficients for the IPA Categories and Final Score

Table 1

Inter-coder Correlation Coefficients Across Tasks

Positive Social	.935
Negative Social	.945
Answers	.995
Questions	.960
Final Score	.917

Table 2

Inter-coder Correlation Coefficients for Task One

Positive Social	.938
Negative Social	.960
Answers	.999
Questions	.968
Final Score	.978

Table 3

Inter-coder Correlation Coefficients for Task Two

Positive Social	.924
Negative Social	.909
Answers	.971
Questions	.869
Final Score	.797

Appendix E: Raw Data for Male, Female, and Mixed Groups on Tasks One and Two

Table 1

Raw Data for Male Groups for Task One

	GROUPS									
	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10
Process Data										
turns at keyboard	41	20	56	57	46	12	13	34	24	66
turns, writing on paper	00	00	09	00	00	00	00	00	00	00
simulating turtle movements	21	02	41	18	32	14	14	12	08	14
monopolizing equipment	00	03	00	00	00	00	00	00	00	01
removing self from group	00	00	00	00	00	00	00	00	00	06
Interaction Data										
positive social	28.0	14.5	23.5	33.5	24.5	40.0	51.5	30.5	44.0	34.0
negative social	27.0	14.0	39.0	55.0	34.5	37.5	53.0	33.5	24.5	39.0
statements	152.5	074.5	205.5	151.5	182.0	184.5	181.0	136.0	162.5	143.0
questions	31.0	09.0	28.0	36.0	17.5	24.0	15.0	30.0	08.0	31.0
number of interactions	246	109	294	289	263	300	308	291	242	273
Product data										
number of minutes	45	17	44	34	28	12	13	21	14	40
no. of commands	124	109	080	081	095	069	039	089	067	139
final score	057.5	100.0	095.0	087.5	100.0	100.0	100.0	097.5	097.5	057.5

Table 2

Raw Data for Female Groups on Task One

	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10
Process Data										
turns at keyboard	15	54	60	70	68	38	39	20	26	45
turns writing on paper	00	00	00	01	00	00	00	00	00	00
simulating turtle movements	07	01	16	36	20	14	15	05	16	27
monopolizing equipment	00	00	00	00	00	00	00	00	00	00
removing self from group	00	00	00	00	00	00	00	00	00	00
Interaction Data										
positive social	25.0	33.0	33.0	20.5	44.5	57.5	18.0	34.0	45.0	35.5
negative social	33.5	19.5	29.0	38.5	57.0	20.0	30.5	18.0	44.0	36.0
statements	111.0	160.0	213.5	233.0	133.0	194.5	225.5	192.5	237.0	193.5
questions	22.5	28.0	56.0	28.0	18.5	14.0	34.0	34.5	34.5	18.0
number of interactions	204	300	348	330	259	294	330	300	375	298
Product data										
number of minutes	15	36	31	41	44	34	22	17	19	29
no. of commands	114	139	151	116	160	169	076	079	113	109
final score	097.0	072.5	092.5	047.5	095.0	100.0	100.0	092.5	097.5	095.0

Table 3

Raw Data for Mixed Groups on Task One

	GROUPS									
	MF1	MF2	MF3	MF4	MF5	MF6	MF7	MF8	MF9	MF10
Process Data										
turns at keyboard	31	33	68	69	77	32	29	29	38	20
turns writing on paper	00	10	00	00	00	00	00	00	00	00
simulating turtle movements	11	00	34	41	42	08	11	04	04	08
monopolizing equipment	00	00	00	00	00	00	00	00	00	00
removing self from group	00	01	00	00	00	00	00	00	00	00
Interaction Data										
positive social	33.5	12.5	40.0	---- *	49.0	25.0	20.0	16.5	15.0	39.5
negative social	13.0	26.5	56.5	---- *	53.0	32.0	30.5	43.0	14.5	37.5
statements	123.5	192.5	218.0	----- *	212.0	120.0	140.0	112.0	182.5	234.0
questions	25.0	18.5	17.5	----	24.5	08.5	24.5	29.5	15.0	37.5
number of interactions	201	247	342	--- *	351	193	223	218	234	340
Product data										
number of minutes	19	30	38	39	45	25	15	22	31	14
no. of commands	064	083	169	129	119	110	073	098	132	078
final score	097.5	090.0	090.0	040.5	097.5	100.0	097.5	097.5	100.0	100.0

* = missing data

Table 4

Raw Data for Male Groups on Task Two

	GROUPS									
	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10
Process Data										
turns at keyboard	47	43	69	69	66	33	40	49	47	67
turns writing on paper	01	00	00	00	04	00	00	00	00	00
simulating turtle movements	13	03	38	37	42	09	20	09	15	20
monopolizing equipment	00	00	00	00	00	00	00	01	00	01
removing self from group	04	10	00	00	00	00	00	06	00	16
Interaction Data										
positive social	28.0	14.0	28.0	46.0	41.0	22.0	35.0	20.5	46.0	19.5
negative social	49.5	10.5	35.5	33.0	43.0	26.5	22.5	24.0	26.5	24.0
statements	110.5	031.5	201.5	153.5	217.5	139.0	135.0	098.0	218.0	111.0
questions	29.5	07.0	25.0	30.0	34.0	23.0	20.5	25.0	09.5	13.0
number of interactions	218	080	308	314	402	235	239	182	307	231
Product data										
number of minutes	45	39	45	45	45	24	31	35	27	45
no. of commands	137	199	221	171	197	149	170	100	159	209
final score	080.5	083.5	097.5	043.5	095.0	092.5	095.0	095.0	100.0	090.5

Table 5

Raw Data for Female Groups on Task Two

	GROUPS									
	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10
Process Data										
turns at keyboard	44	76	80	61	54	41	40	23	50	38
turns writing on paper	00	11	00	00	00	00	00	00	00	00
simulating turtle movements	06	01	41	36	42	14	20	11	31	18
monopolizing equipment	00	00	00	00	00	00	00	00	04	00
removing self from group	00	00	00	00	00	00	00	00	00	00
Interaction Data										
positive social	26.0	43.0	24.0	15.0	40.0	20.5	24.0	37.0	38.0	23.5
negative social	49.5	10.5	35.5	33.0	43.0	26.5	22.5	24.0	26.5	24.0
statements	144.0	131.5	246.5	160.0	151.5	150.5	216.0	206.5	165.5	122.5
questions	12.5	23.0	29.0	28.5	22.5	09.0	30.5	25.0	18.0	12.0
number of interactions	241	218	345	243	267	219	300	309	355	192
Product data										
number of minutes	40	45	42	44	45	36	25	23	43	25
no. of commands	150	192	260	171	285	170	136	145	216	110
final score	087.5	081.0	080.0	085.0	092.5	092.5	087.5	090.0	073.0	066.0

Table 6

Raw Data for Mixed Groups on Task Two

	GROUPS									
	MF1	MF2	MF3	MF4	MF5	MF6	MF7	MF8	MF9	MF10
Process Data										
turns at keyboard	31	40	82	50	73	57	36	53	26	41
turns writing on paper	00	29	00	03	01	00	00	01	02	00
simulating turtle movements	11	00	19	46	38	03	11	05	12	13
monopolizing equipment	00	03	00	00	00	02	00	02	00	00
removing self from group	00	00	00	00	02	03	00	01	00	00
Interaction Data										
positive social	30.0	13.0	28.5	24.5	37.0	12.5	31.0	07.5	24.0	37.5
negative social	20.5	20.0	52.0	43.0	51.0	09.0	38.5	15.5	16.5	32.0
statements	144.5	182.5	146.0	145.0	170.5	064.5	157.5	054.0	215.0	211.5
questions	22.0	14.5	17.5	19.5	40.5	13.0	19.0	13.5	23.0	30.0
number of interactions	201	226	247	245	311	106	253	095	288	332
Product data										
number of minutes	19	39	45	44	45	41	18	45	26	31
no. of commands	064	142	252	112	214	210	111	162	126	147
final score	085.0	061.0	085.0	066.0	097.5	092.5	097.5	061.0	095.0	097.5

Appendix F: Social Interaction and Achievement Data as Coded by Two Independent Coders for Each Task

Table 1

Social Interaction and Achievement Data For Male Groups

on Task One as Coded by Coder One

	GROUPS									
	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10
positive social	21	14	34	37	32	42	57	31	47	31
negative social	27	13	42	56	38	39	58	34	27	40
statements	158	075	202	146	177	181	173	135	157	133
questions	32	10	23	37	18	25	15	30	08	31
final score	060	100	095	090	100	100	100	100	100	060

Table 2

Social Interaction and Achievement Data for Female Groups on Task One as Coded by Coder One

	GROUPS									
	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10
positive social	26	35	37	26	45	58	14	38	53	38
negative social	32	20	32	41	61	20	32	19	46	37
statements	171	158	203	225	127	194	222	188	227	189
questions	22	28	58	28	20	14	35	29	35	19
final score	095	075	095	055	100	100	100	090	100	100

Table 3

Social Interaction and Achievement Data for Mixed Groups

on Task One as Coded by Coder One

	GROUPS									
	MF1	MF2	MF3	MF4	MF5	MF6	MF7	MF8	MF9	MF10
positive social	35	12	42	--	53	30	20	16	15	42
negative social	57	32	58	--	57	32	32	44	15	39
statements	120	193	214	--	203	116	138	110	182	230
questions	25	19	18	--	27	09	26	31	15	21
final score	100	095	090	040	100	100	100	100	100	100

Table 4

Social Interaction and Achievement Data for Male Groups on Task Two as Coded by Coder One

	GROUPS									
	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10
positive social	27	14	30	51	41	21	37	22	50	20
negative social	31	19	42	66	45	41	44	30	33	29
statements	117	031	199	158	216	138	129	098	212	107
questions	31	07	25	35	34	23	21	25	10	13
final score	071	086	100	044	100	095	100	100	100	086

Table 5

Social Interaction and Achievement Data for Female Groups on Task Two as Coded by Coder One

	GROUPS									
	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10
positive social	30	49	27	18	43	19	27	41	43	24
negative social	51	11	37	33	46	28	24	24	35	24
statements	138	120	241	155	146	145	210	201	155	122
questions	13	23	29	30	22	09	32	26	20	13
final score	090	086	085	085	095	090	090	095	066	095

Table 6

Social Interaction and Achievement Data for Mixed Groups on Task Two as Coded by Coder One

	GROUPS									
	MF1	MF2	MF3	MF4	MF5	MF6	MF7	MF8	MF9	MF10
positive social	31	13	34	27	38	14	32	07	20	38
negative social	21	19	52	45	51	09	40	15	17	31
statements	142	183	139	147	171	065	155	055	214	211
questions	23	25	19	20	41	13	19	14	23	31
final score	085	061	085	066	095	095	100	061	095	095

Table 7

Social Interaction and Achievement Data for Male Groups on Task One as Coded by Coder Two

	GROUPS									
	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10
positive social	35	15	23	30	17	38	46	30	41	30
negative social	27	15	336	54	31	36	48	33	22	38
statements	147	074	209	157	187	188	189	137	168	153
questions	30	08	33	35	17	23	15	30	08	31
final score	055	100	095	085	100	100	100	095	095	055

Table 8

Social Interaction and Achievement Data for Female Groups on Task One as Coded by Coder One

	GROUPS									
	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10
positive social	24	31	29	15	44	57	22	30	38	33
negative social	35	19	26	36	53	20	29	17	42	35
statements	111	162	224	241	139	195	229	197	247	198
questions	23	28	54	28	17	14	33	40	34	17
final score	095	070	090	045	090	100	100	095	095	090

Table 9

Social Interaction and Achievement Data for Mixed Groups on Task One as Coded by Coder One

	GROUPS									
	MF1	MF2	MF3	MF4	MF5	MF6	MF7	MF8	MF9	MF10
positive social	32	13	38	--	45	20	20	17	15	37
negative social	13	23	55	--	49	32	29	42	14	36
statements	127	192	222	---	221	124	142	114	183	238
questions	25	18	17	--	22	08	23	28	15	21
final score	095	085	090	035	095	100	095	095	100	100

Table 10

Social Interaction and Achievement Data for Male Groups

on Task Two as Coded by Coder Two

	GROUPS									
	MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8	MM9	MM10
positive social	29	14	26	41	41	23	33	19	42	19
negative social	33	28	41	77	42	38	37	33	30	24
statements	104	028	204	149	219	140	141	098	224	113
questions	28	07	25	33	34	23	20	25	09	13
final score	090	081	095	043	095	090	090	090	100	095

Table 11

Social Interaction and Achievement Data for Female Groups on Task Two as Coded by Coder Two

	GROUPS									
	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10
positive social	22	37	21	12	37	22	21	33	33	23
negative social	12	23	29	27	23	09	29	24	28	24
statements	150	143	252	165	157	156	222	212	176	123
questions	12	23	29	27	23	09	29	24	16	11
final score	085	076	075	085	090	095	085	085	066	057

Table 12

Social Interaction and Achievement Data for Mixed Groups on Task Two as Coded by Coder Two

	GROUPS									
	MF1	MF2	MF3	MF4	MF5	MF6	MF7	MF8	MF9	MF10
positive social	29	13	23	22	36	11	30	08	28	37
negative social	20	21	52	41	51	09	37	16	16	33
statements	147	182	153	143	170	064	160	053	216	212
questions	21	14	16	19	40	13	19	13	23	29
final score	085	061	085	066	100	090	095	061	095	100