Pergamon

Computers in Human Behavior, Vol. 13, No. 3, pp. 285–304, 1997
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Printed in Great Britain
0747-5632/97 $17.00 + 0.00

PII: S0747-5632(97)00010-1

The Effects of Cooperative Training and Ability Grouping on Microcomputer Learning

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Abstract — *A total of 276 subjects from Grades 5 and 6 participated in a study investigating the effects of cooperative training and ability grouping on microcomputer learning. Approximately half the sample underwent three half-hour sessions of cooperative training prior to microcomputer learning. Cooperative training included social cohesion techniques such as team-building and self-evaluation, while positive interdependence was also built into the design. In addition, subjects were divided into either homogeneous or heterogeneous ability groups. During five half-hour sessions, subjects worked in groups of four on both a drill-and-practice and a tutorial software program. Results on four measures of achievement did not strongly support the effects of cooperative training or ability grouping on microcomputer learning. Where there are significant findings, the results are mixed, reflecting the ambivalent nature of results in other work in the area. Significantly, mixed-ability groupings did not have any particularly debilitating effects on either high or low ability subjects. Results are discussed in light of the motivationalist and cognitive–developmental positions concerning group learning, and implications for future research are proposed. © 1997 Elsevier Science Ltd*

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The current study utilized a combination of motivationalist practice (e.g., manipulation of the reward structure) and social cohesion techniques to investigate the effects of cooperative training and ability grouping of Grade 5 and Grade 6 students on group computer-assisted instruction (CAI). Previous research (Baron & Abrami, 1992a,b; Carrier & Sales, 1987; Hooper, 1992a; Hooper & Temiyakarn, 1992) has demonstrated that learning in groups does not hinder the individualized learning effects of CAI. In two studies by Johnson, Johnson, and Stanne (1985, 1996), Grade 8 students were assigned to a cooperative, competitive, or individualistic CAI treatment. The results seemed to favor computer-assisted cooperative instruction.

Table 1 describes pertinent CAI-related studies and summarizes their findings.

Ability Grouping and Student Achievement

Meta-analytic and narrative reviews of the literature ("best-evidence synthesis") suggest that within-class ability grouping for some subject areas (chiefly in an elementary school environment) may be effective if the number of groups is kept small (Slavin, 1987). Five of the seven studies on regrouping reviewed by Slavin demonstrated the benefits of putting students into homogeneous groupings for reading or maths. Of the eight studies on within-class ability grouping, seven were maths-related, most involved upper elementary classes, and all indicated the positive effects of homogeneous versus heterogeneous grouping. In addition, there was no indication that ability grouping favored any one ability group over another, although the median effect size for low ability subjects was higher than that for average or high ability students. Slavin did point out that certain tasks, particularly those in which skills build upon one another, lend themselves better to homogeneous grouping of students.

In high school and college studies in which the material to be learned was the same for all ability groups, no significant differences between types of grouping were uncovered (Slavin, 1987). In addition, Webb (1982b) has shown that medium ability subjects in homogeneous groups outperform their counterparts in heterogeneous groups. The ambivalence evinced by the previous ability grouping studies in general is clear. In contrast to Slavin's findings, and taking a more cognitive approach, peer tutoring literature has demonstrated that both high and low ability students benefit from heterogeneous small groups (Baron, 1991; Swing & Peterson, 1982; Webb, 1982a,c).

Recent research has added more discussion to the ability-grouping debate. Studying intragroup interactions with Grades 5 and 6 children using a mathematics tutorial program, Hooper (1992a) found that both achievement

Table 1. Details of Reviewed Studies on Group Microcomputer Learning

	Participants				Treatments					
Authors	*N*	Grade level	Group size	Research interest	Independent variables	Dependent variables	Cooperative training	Ability grouping	Software type	Results
1. Baron & Abrami, 1992a	254	5, 6	1, 2,4	to study the effects of group size and exposure time using drill-and-practice software	group size; exposure time	achievement	no	no	drill-and-practice	no effects of group size; effects of exposure time
2. Baron & Abrami, 1992b	272	5, 6	1, 2, 4	to study the effects of group size and exposure time using tutorial software	group size; exposure time	achievement	no	no	tutorial	no effects of group size; effects of exposure time
3. Carrier & Sales, 1987	36	college	1, 2	to explore the effects of group size on achievement	group size	achievement; social interactions	no	no	tutorial	no effects of group size
4. Hooper, 1992a	115	5, 6	1, 2	to compare individual versus group learning and ability grouping	ability grouping	achievement; efficiency; social interactions	yes (generic)	yes	tutorial	dyads outperformed individuals; highest scores for homogeneous-grouped high ability and lowest for homogeneous-grouped average ability
5. Hooper & Hannafin, 1988	40	8	3, 4	achievement of high and low ability students working cooperatively in different group compositions	ability grouping	achievement	yes (generic)	yes	tutorial	no significant differences on achievement; low ability heterogeneous groups outperformed low ability homogeneous groups
6. Hooper & Hannafin, 1991	125	6, 7	2	to study the effect of cooperative learning, group composition, ability and learning accountability	ability grouping; accountability	achievement; instructional efficiency; social interactions	yes (structured & generic)	yes	tutorial	no Ability × Group Composition interaction for achievement; highest interactions for heterogeneous-grouped and homogeneous-grouped high ability, cooperation related to achievement in heterogeneous groups

(Table 1 continued overleaf)

Authors	Participants				Treatments					Results
	N	Grade level	Group size	Research interest	Independent variables	Dependent variables	Cooperative training	Ability grouping	Software type	
7. Hooper & Temiyakarn, 1992	175	6	1, 2	to investigate the effects of studying alone or in cooperative groups on high and average ability students; to explore effects of learner and program control; to investigate students' attitudes toward the instructional content, group learning, and partners	grouping (individual/ cooperative); ability; source of control	achievement; time to completion; efficiency; attitudes	yes (structured & generic)	yes	tutorial	high ability students demonstrated increased achievement (on high level learning tasks), worked more efficiently in groups, took less time, held more positive attitudes toward learning and the group after cooperative learning; average ability students completed instructions faster and held more positive attitudes toward cooperative learning after working in groups; grouping and learner control had no effect on performance
8. Johnson, Johnson, & Stanne, 1985	71	8	4	to compare cooperative vs. competitive vs. individualistic CAI	group structure; gender	achievement; social interactions; sociometry; attitudes	yes (structured)	no	simulation	highest scores for cooperative condition
9. Johnson, Johnson, & Stanne, 1986	74	8	4	to compare cooperative vs. competitive vs. individualistic CAI	group structure; gender	achievement; social interactions; sociometry; attitudes	yes (structured)	no	simulation	highest scores for cooperative condition
10. King, 1989	34	4	3	to identify problem solving behaviors which relate to success in small CAI groups	ability grouping	problem solving; social interactions	no	yes	problem solving	no relationship between success and ability; successful groups asked more task-related questions, spent more time on strategy, and reached higher levels of strategy elaboration than unsuccessful groups; high ability students made greater number of long task statements; time on strategy significantly related to use of long statements and frequency, variety, and elaboration of strategies

Table 1. Continued

Authors	Participants				Treatments					Results
	N	Grade level	Group size	Research interest	Independent variables	Dependent variables	Cooperative training	Ability grouping	Software type	
11. Mitterer & Krasnor, 1985	96	6	2	to investigate the effects of learning LOGO on a variety of social and cognitive tasks	computer-based vs. noncomputer-based problem solving treatment	problem solving; social interactions	no	no	programming/ problem solving	LOGO did not enhance general problem solving skills; LOGO group exhibited a higher frequency of overt planning; high level of social interaction evident at the computer
12. Nastasi & Clements, 1992a	48	3	2	comparing LOGO to word-processing, to investigate the causal link between social–contextual experiences, effectance motivation and perceived competence; to explore the relationship between teacher and self-ratings of effectance motivation on cognitive performance	software type	social interactions; perceived scholastic competence; teacher ratings of social competence, metacomponential score	no	no	programming/ problem solving; word-processing	LOGO led to greater chance for interactions related to effectance motivation and perceived competence; LOGO group experienced failure or difficulty to complete projects; LOGO group requested more approval and feedback from teacher; Time × Group interactions nonsignificant for all social–contextual variables; mediational effects of LOGO on ratings of self-efficacy partially confirmed
13. Nastasi & Clements, 1992b	48	3	2	to examine group differences in social–cognitive behavior during collaborative interactions in two computer environments and the relationship between these behaviors and subsequent cognitive performance	software type	social interactions; metacomponential score	no	no	programming/ problem solving; word-processing	LOGO group exhibited more work-related and off-task behavior; information-seeking from partner, and cognitively based resolution of cognitive conflicts; word-processing group exhibited more typing and social negotiation of cognitive conflict; some support for more mediational role of social–cognitive behaviors

(Table 1 continued overleaf)

Table 1. Continued

	Participants				Treatments					
Authors	*N*	Grade level	Group size	Research interest	Independent variables	Dependent variables	Cooperative training	Ability grouping	Software type	Results
14. Shade, Nida, Lipinski, & Watson, 1986	29	preschool	—	to investigate the nature of preschoolers' social interactions, key-boarding and microcomputer skills, and the need for teacher structure; children's reactions to the microcomputer and their perceptions of the experience	degree of teacher structure	social interactions; attitudes	no	no	drill-and-practice	children's behaviors moved from positioning for turns to helping each other; child–child behaviors increased during teacher-interactive phase; children preferred working in dyads
15. Webb, Ender, & Lewis, 1986	30	ages 11–14 years	2	to investigate the planning and debugging strategies and group processes that predict learning of computer programming in small groups	aptitude and cognitive style	achievement; social interactions	no	no	programming	aptitude and cognitive style did not predict planning, debugging, or verbal interaction; giving and receiving explanations, receiving responses to questions, and verbalizing aloud was related to achievement

Note. CAI = computer-assisted instruction.

and efficiency (as measured by time-on-task) were highest for high ability homogeneously grouped students and lowest for average ability homogeneously grouped students. In addition, heterogeneously grouped low ability students tended to outscore their homogeneous counterparts, although not significantly so.

Cooperative Computer-Assisted Instruction

An alternative to ability grouping is cooperative learning (Slavin, 1987). In contrast to competitive or individualistic learning situations, cooperative learning is structured so that the reward structure among group members is linked (Johnson, Johnson, & Stanne, 1986). Research on cooperative learning has indicated that achievement is affected positively when team success (group goals) and individual accountability are built into the learning experience (Slavin, 1987, 1990, 1993). Also, Johnson, Maruyama, Johnson, Nelson, and Skon's (1981) meta-analysis uncovered positive effects of cooperative learning over competitive or individualistic goal models.

Slavin (1990) revealed that in 57% of reported studies in the area, cooperative learning methods led to significant differences in achievement over traditional learning. Cooperative learning of any type rarely has negative effects (Slavin, 1983). In addition, the research indicates that cooperative learning techniques are of benefit to all ability students (Slavin, 1990). Slavin's position is that group learning does not necessarily lead to the benefits of more structured cooperative learning experiences, particularly those with built-in group rewards (Slavin, 1993). It is his premise, and that of others in the cooperative learning field who take a more motivationalist as opposed to cognitivist position, that simply putting students into learning groups does not necessarily lead to the kinds of interactions that expedite learning and cooperation.

In contrast to this position and in support of a more cognitive–developmental approach, several studies have indicated that microcomputer learning without a built-in reward structure can work to encourage cooperative interaction and achievement (Carrier & Sales, 1987; Mitterer & Krasnor, 1985; Shade, Nida, Lipinski, & Watson, 1986; Webb, Ender, & Lewis, 1986). King's (1989) research emphasized the potential of group CAI for encouraging positive metacognitive challenges (e.g., perspective taking and dealing with cognitive conflict) while Hawkins (1987) has attributed the increased collaboration in group CAI both to Vygotsky's scaffolding (where the expert emerged to help the less skilled), and to other cooperative strategies (e.g., role definition) that surfaced during group CAI.

Enhancing cooperative CAI work by including an ability grouping dimension, Hooper and Hannafin (1988) studied the effects of heterogeneous

versus homogeneous grouping of Grade 8 students in a cooperative, tutorial, microcomputer learning context. The cooperative component consisted of alternating the roles of group members (e.g., decision maker, advisor, typist) as controlled by the computer program. Although no significant differences between groups or for the Ability × Grouping interaction surfaced, trends indicated that low ability subjects grouped heterogeneously consistently outperformed their homogeneously grouped counterparts; whereas high ability subjects were not disadvantaged by being placed in heterogeneous groups. Additionally, using sixth- and seventh-grade children as subjects, Hooper and Hannafin (1991) found that ability grouping qualified the effects of cooperative training. Cooperative training did have a positive effect on heterogeneous ability groups, but did not for either homogeneous high or low ability subjects. This effect was most pronounced with low ability subjects.

In another study, Hooper and Temiyakarn (1992) examined the effects of cooperative grouping versus individual learning on the performance of high and average ability Grade 4 students in a microcomputer learning environment. Groups consisted of mixed ability pairs of students. Results demonstrated that cooperative grouping benefited the high ability children on tests of higher level learning. High ability subjects also worked more efficiently in groups than alone. However, cooperative learning did not benefit average ability subjects on the achievement measures. Yet, across both levels, cooperative groups held more positive attitudes about CAI and cooperative learning than did individuals, despite the fact that all students had cooperative training prior to the microcomputer learning experience. Working in dyads appeared to reinforce the cooperative experience. Unfortunately, the results of Hooper and Temiyakarn's study are limited to group (cooperative) versus individual learning. Although the cooperative component expands on previous research comparing groups and individuals, a third, untrained group would have served as a valuable control.

For the purposes of this research, cooperative CAI was distinguished from group CAI (no cooperative training). In the former, students were trained in team-building skills and a reward structure of positive interdependence was built into the design. The latter involved ad hoc groups of subjects. Unfortunately, some recent reports have misleadingly used the terms cooperative CAI and group CAI interchangeably. The intent of this study was to investigate differences between these two treatment conditions specifically to draw inferences related to the effects of cooperative training within the microcomputer context. Distinguishing between cooperative groups and ad hoc groups is a distinct feature of this study that is not particularly evident in other work in the area. In addition, this research expands on the majority of other work by including both ability grouping

and cooperative training as factors, and does so while also focusing on two different software types. Finally, the sample size for this study is considerably larger than has been used in previous work.

Taking into account previous work related to cooperative training, ability grouping, microcomputer learning, and achievement, this study predicted that cooperative training would augment achievement. Further, the assumption was that cooperative training would interact with ability grouping leading to higher achievement scores. Taking an approach supported by the peer tutoring literature, this study also predicted that both high and low ability children would benefit from being in heterogeneous learning groups.

METHOD

Participants

Participants included 276 Grade 5 (n = 140) and Grade 6 (n = 136) students from four, English-first-language schools in the Montreal area. The participants were primarily English-first-language children, and the schools were from a predominantly middle-income area. There were 148 boys and 128 girls in the study. Only those subjects for whom parental permission was given participated.

Materials

Software. A drill-and-practice language arts program, Word Attack (Davidson & Eckert, 1983), and a tutorial software program, Analogies Tutorial (1983), were used during the treatment condition. Software selection was conducted in a systematic manner as part of the pre-research activity described in Baron and Abrami (1992a,b).

Word Attack is a four-part program designed to increase vocabulary, word meanings, and word usage. Grade equivalent words are used within the program. Baron and Abrami (1992a,b) provide a detailed description of the pilot-testing procedures used to choose the words for Word Attack. In 10 lessons, Analogies Tutorial introduces the learner to various types of analogies in a hierarchical fashion (e.g., from synonym/synonym analogies to grammar analogies). Practice of the different types of analogies is built into the program.

Pretests. Pretests used in previous Baron and Abrami (1992a,b) work were administered to all subjects prior to the treatment. The pretest included the Basic Word Vocabulary Test (1975; BWVT), which measures vocabulary

development. The median correlation coefficient between the BWVT and such standardized tests as the Sequential Tests of Educational Progress is .76. The internal consistency reliability of the BWVT is .96.

Posttests. Posttests included (a) a 50-item analogies achievement test (POSTANA) developed by the research staff and based on concepts taught in the Analogies Tutorial (pilot testing, Baron & Abrami, 1992b, involved an item analysis that eliminated test items which more than 50% of participants correctly identified), (b) a 25-item Multiple Choice Word Attack Test (MCWA), (c) a 10-item Word Attack Sentence Completion Test (SEN-TEST), and (d) a Word Attack Word Definition Test (DEFTEST) which used the same items as (c). All Word Attack achievement tests were based on the words and vocabulary building skills taught in the software program. Baron and Abrami (1992a) describe in detail the item analysis procedures used to select the level of difficulty of the words used in the Word Attack treatment and achievement tests. Adverbs and adjectives were eliminated, as were words that were too easy (i.e., over 60% of participants recalled them after only one half-hour session).

In addition to the above measures, a 14-item Cooperative Learning Questionnaire developed by the research staff was given to all subjects following the microcomputer learning experience. This assessed more general attitudes toward the group CAI experience, and examined whether cooperative strategies (e.g., listening to others, turn-taking) were present in the microcomputer learning experience.

Cooperative Training

Cooperative training consisted of three half-hour sessions covering such social cohesion techniques as team-building, group self-evaluation of cooperative group procedures, and self-concept building. Social cohesion techniques have been shown to augment learning in cooperative groups (Yager, Johnson, Johnson, & Snider, 1986). The reward structure was manipulated by telling subjects in the cooperative condition that they would be held individually accountable for the scores of their group on tests following the microcomputer learning sessions (i.e., positive interdependence).

Session 1. The first session's objectives included (a) making children aware of the advantages and disadvantages of cooperative grouping; (b) making children aware of the need for taking turns, listening to others, and for successful grouping; and (c) having children share strategies that lead to success in group work.

Children were asked to brainstorm on reasons why they like or dislike working in groups. The facilitator then put the responses on the blackboard. After subjects were divided into groups of four and given a number of letters, they were asked to put on the blackboard as many words as they could form from the letters. The experimenter encouraged the groups to avoid behaviors of group work that they had already stated they did not like. Once the task was completed, the group with the longest list read their words, and shared the strategies they used as a group to achieve their success. The facilitator then wrote the strategies on the blackboard. Any problems encountered in the groups were then discussed with the class as a whole.

The groups were then asked to write on the blackboard as many reasons they could think of as to why tests should be given in schools. In order to encourage respect for individual opinions, each member of a group took a turn responding to the task, and could not speak once her/his turn was over. Whole class discussion followed.

Finally, the groups were asked to list the most important things they had learned about working in groups during the first session. The facilitator then discussed the responses with the class.

Session 2. The objectives of Session 2 were to (a) teach students about the need for validating each other, (b) make children aware of the role of "checker", and (c) teach children role assignment. To meet these objectives, children were read the *Walter Story*; a tale about how a young boy, Walter, had his "I am lovable and capable" (IALAC) sign torn apart by others as he went through his daily routine. Following the story reading, the children were asked to supply examples of how people build or tear apart each other's IALAC signs (figuratively, of course!). Discussion took place concerning how such validation procedures can be used in group microcomputer learning, and some of the validation phrases were put on the blackboard.

The Broken Circles Puzzle (Cohen, 1986), a nonverbal activity, was then introduced to individuals in their groups. Briefly, children cannot solve their puzzles without sharing pieces of their own puzzle with other members of their group. The game encourages sacrificing individual success for the benefit of the group.

The groups were asked to conclude the session by taking turns listing on the blackboard what they had learned from the day's exercises. One group member was assigned the "writer" role, and put the responses on the blackboard while another was assigned the "reader" role, and read the responses to the whole class. Throughout, children were reminded to validate and listen to each other. They also were reminded of the reward structure

they would encounter in their microcomputer learning groups (i.e., individual success counts toward a group score).

Session 3. Session 3 included (a) helping children realize the need for the participation of everyone in the group for the success of the group, and (b) more practice in role assignment. This session's main purpose was an exercise in team-building.

After the groups reviewed the roles of "reader", "checker" (checks for group consensus), "turngiver", and "writer" (or "keyboarder"), groups were asked to complete the Survival in the Desert exercise. Individually and then as a group, the children were asked to rank a list of items according to their importance to survivors of a plane crash. Roles were assigned within the groups (these roles were rotated), and the children were again reminded about validating and listening to each other. The groups concluded the session by listing on the blackboard what they had learned from the Survival in the Desert exercise.

Procedure

Classes were randomly assigned to either a cooperatively trained or untrained group, evenly split by grade. Six classes participated in the cooperative training sessions while six represented the untrained control group. The latter followed their normal curricular routine. Using scores from the BWVT, which was administered after the training sessions, students were then randomly assigned within each ability grouping and by classroom into groups of four, to either a high ability, medium–high ability, medium–low ability, or low ability, mixed-gender group. A total of 21 mixed ability groups (81 subjects) were formed from those students not chosen to be in the homogeneous groupings. Subjects worked within their grouping throughout the CAI experience.

After the ability group assignments, the microcomputer sessions were conducted in a microcomputer laboratory in each of the target schools. Instructions for either Word Attack or the Analogies Tutorial were put on the blackboard and standardized across all classrooms. Four quads worked in the laboratory at any one time. All subjects participated (in their assigned groups) in five half-hour microcomputer sessions. Three sessions were on the Analogies Tutorial while two sessions were devoted to Word Attack. The order in which the software was introduced to individual classes was randomly counterbalanced. Six classes had Word Attack first, while six classes were exposed to the Analogies Tutorial first. Although the total CAI experience remained constant across all classes, as school schedules were a

factor, the length of time it took to gather data for any one class ranged from 1 to 2.5 weeks.

Posttests were given after completion of each software type. At the final session, the Cooperative Learning Questionnaire was administered. The time between the last CAI session for each group and posttesting varied slightly between classes as this was dependent on classroom schedules.

RESULTS

The design was a 2 (Grade) × 2 (Training) × 2 (Group Composition) × 2 (Ability Level) between-subjects analysis of variance, with MCWA, SENTEST, DEFTEST, and POSTANA as the dependent measures. The original design included four groups within ability level. However, small sample sizes within each cell of the design warranted collapsing ability level into two groups, high and low. Those individuals labeled high and high–medium comprised the high group, whereas the low group consisted of low and low–medium ability subjects.

To determine whether pretest differences existed between trained and untrained groups, individual BWVT scores were analyzed using a 2 × 2 × 2 × 2 between-subjects analysis of variance. Results showed a significant main effect for ability level, $F(1, 273) = 336.83$, $p < .001$, and grade, $F(1, 273) = 77.07$, $p < .001$, in the expected direction; that is, high ability subjects performed better than low ability subjects and subjects in Grade 6 outperformed subjects in Grade 5. Results also revealed a significant Training × Grade × Ability interaction, $F(1, 273) = 11.13$, $p < .001$. Bonferroni corrected t tests conducted separately for grade within the low ability level indicated that group differences did not exist between trained and untrained groups on the BWVT in either Grade 5 or Grade 6. However, within the high ability level, untrained groups outperformed trained groups in Grade 5, $t(64) = 4.28$, $p < .001$, and trained groups scored higher than untrained groups in Grade 6, $t(67) = 3.39$, $p < .001$.

Due to the Training × Grade × Ability interaction on the BWVT, two analytical strategies were undertaken. The first strategy involved using the BWVT as a covariate, in order to adjust the pretest differences between the trained and untrained groups within the high ability level. This eliminated ability level as a grouping factor, because Grades 5 and 6 were now equated on the BWVT. However, training and group composition were maintained as grouping factors for the analysis of posttest measures, thus permitting a partial examination of the effects of cooperative training on microcomputer learning.

Prior to conducting the ANCOVAs, Pearson product–moment correlations were calculated between BWVT and the dependent measures; correlations ranged from .62 to .66, indicating that the BWVT shared sufficient variance with the dependent measures to act as a covariate. Results of the 2 (Training) × 2 (Group Composition) ANCOVAs on individual scores showed a significant main effect of training on SENTEST, with untrained groups ($M = 9.37$, $SD = 5.52$) scoring higher than trained groups ($M = 6.80$, $SD = 5.56$), $F(1, 269) = 23.46$, $p < .001$. A main effect of group composition on SENTEST indicated that homogeneous groups ($M = 8.84$, $SD = 5.55$) scored higher than heterogeneous groups ($M = 7.29$, $SD = 5.46$), $F(1, 269) = 4.78$, $p < .05$. Results on the other dependent measures were not significant.

A second analytical strategy involved conducting separate analyses for the high and low ability levels, thereby allowing an assessment of the role of ability and group composition in microcomputer learning. Because there were no pretest differences on the BWVT for the trained and untrained groups in the low ability level, 2 (Grade) × 2 (Training) × 2 (Group Composition) between-subjects ANOVAs were conducted on the individual posttest scores. Main effects for grade were found for each of the four dependent measures, with low ability subjects in Grade 6 scoring higher than Grade 5 subjects on MCWA, $F(1, 138) = 23.83$, $p < .001$; SENTEST, $F(1, 138) = 11.44$, $p < .001$; DEFTEST, $F(1, 138) = 7.84$, $p < .01$; and POSTANA, $F(1, 138) = 8.45$, $p < .05$. Training differences were only found on SENTEST where untrained groups ($M = 7.05$, $SD = 3.69$) scored higher than trained groups ($M = 3.88$, $SD = 3.65$), $F(1, 138) = 29.31$, $p < .001$. Group composition emerged as a significant main effect on DEFTEST, with heterogeneous groups ($M = 7.49$, $SD = 4.70$) outperforming homogeneous groups ($M = 5.92$, $SD = 4.57$), $F(1, 138) = 4.21$, $p < .05$. Group composition also interacted with grade on POSTANA, $F(1, 138) = 9.71$, $p < .01$. Bonferroni corrected t tests indicated that heterogeneous groups scored

Table 2. Means (and Standard Deviations) for Low Ability Subjects on POSTANA

	Group composition	
	Homogeneous	Heterogeneous
Grade 5		
M (SD)	28.36 (10.79)	34.45* (8.41)
n	50	24
Grade 6		
M (SD)	35.48 (6.53)	32.11 (8.08)
n	46	19

* Means significantly different at the Bonferroni corrected alpha level of $p < .025$.

significantly higher than homogeneous groups in Grade 5, $t(72) = 2.43$, $p < .05$, whereas the groups did not differ in Grade 6 (Table 2).

Within the high ability level, separate t tests were conducted for Grades 5 and 6 which compared heterogeneous and homogeneous groups on each of the dependent measures. Results revealed a significant difference on MCWA in Grade 5, with homogeneous groups ($M = 20.93$, $SD = 4.04$) outperforming heterogeneous groups ($M = 17.74$, $SD = 5.17$), $t(65) = 3.46$, $p < .05$. Homogeneous groups in grade 5 ($M = 10.17$, $SD = 6.21$) also scored higher than heterogeneous groups ($M = 5.55$, $SD = 5.16$) on SENTEST, $t(65) = 4.15$, $p < .001$. No other t tests in either of the grades reached significance.

In summary, the analyses found little effect of cooperative training on microcomputer learning, but uncovered some effects of ability level and group composition; that is, there is some evidence that low ability children exposed to CAI in heterogeneous groups performed better on posttest achievement measures, whereas high ability children exposed to CAI in homogeneous groups outperformed their peers.

DISCUSSION

This work sought to explore the effects of cooperative training on microcomputer learning and to examine the effects with different ability groupings and types of software. However, this study's findings do not strongly support the use of cooperative training or ability grouping as factors that enhance achievement in a microcomputer learning situation. These results were gathered across four measures of achievement and apply to both a drill-and-practice and a tutorial software program suitable for upper elementary students. Where there are significant findings, the results are typically mixed, reflecting the controversial nature of research in this area (Rysavy & Sales, 1991). For example, in looking at grouping effects and considering the more difficult nature of a task such as the Word Attack Sentence Completion Test where one would have expected peer tutoring to take place in mixed ability groups, homogeneous groups significantly outperformed the heterogeneous groups. On the other hand, the opposite occurred on the Word Attack Word Definition Test and Analogies Tutorial Post Analogies Test (with Grade 5 subjects) where low ability subjects in heterogeneous groups significantly outscored their homogeneous counterparts.

One might suspect that either ease of task may have moderated the results across most of the factors tested in this work or that the CAI experience itself may have counteracted any effects of training and/or grouping. In other words, while previous work (Baron & Abrami, 1992a,b) demonstrated that

the drill-and-practice and tutorial programs utilized in this study were conducive to group learning, it is possible that the chosen software may not have been complex enough to tease out any effects that cooperative training or ability grouping may have supplied. Furthermore, while item analyses were carried out to insure that the words used in the drill-and-practice and tutorial program were difficult enough for the majority of children prior to treatment (Baron & Abrami, 1992a,b), instruction on the microcomputer may have tempered any benefits that heterogeneous grouping or cooperative training may have given subjects.

For high ability Grade 5 children, homogeneous groups scored significantly higher on the Multiple Choice Word Attack Test and Word Attack Sentence Completion Test. Across the remaining two dependent measures, whether high ability children were in heterogeneous or homogeneous groups made no difference to their success. In other words, being grouped with lower ability children was not debilitating. In examining the overall results on grouping, it is also possible that including medium ability subjects may have weakened any effects on very high and very low ability children. The possibility that ability grouping by class also may have influenced the results was examined. This concern was alleviated when data did not reveal that any particular class had very high or very low ability subjects relative to the other classes.

Cooperative Training

One third of the studies reviewed by Slavin (1983) found no significant differences between cooperatively trained and untrained groups. A number of possible explanations come to mind as to why the cooperative groups in this study may not have performed at optimal levels. First, the cooperative training may not have been intense enough for transfer to the microcomputer learning situation even though individual accountability was built into the design. As Salomon and Globerson (1989) have suggested, social interdependence takes time to develop in groups. Second, the cooperative training was neither task specific, nor content-dependent (Hooper, 1992b). Not only were the team-building skills taught to the children more generic in nature, but also the subjects were trained in cooperative skills in their larger classroom groups prior to working on the microcomputer. If training had been more specific to microcomputer learning, the effect of cooperative training may have been stronger.

The possibility of "free rider" effects was partially examined through a questionnaire given to subjects at posttest. Subjects were asked how much effort they put into the CAI experience and achievement tests. The evidence appeared to indicate that no one group took advantage of being a member of

a particular group composition. Even though the cooperative group members held more positive attitudes about working in a group (as assessed by the Cooperative Learning Questionnaire), lack of training effects seems to indicate that effort was not pooled in the cooperatively trained groups. Further work should focus on the nature of the relationship between attributional interdependence and group effort or mindfulness (Salomon & Globerson, 1989). Finally, drill-and-practice and tutorial software may just not demand cooperative group interaction.

Slavin (1987) takes a motivationalist approach in support of cooperative groups over ad hoc groups. His approach is not supported here, giving some credence to the more cognitive–developmental, peer tutoring perspectives which advance the premise that peer interaction in itself is effective. Future research, with extensive analysis of sequences of behavior at the microcomputer, would lend further insight into what actually happens in the groups.

Although this study's premise was that the reward structure presented to the children would have motivated high ability children to help lower ability children, Training × Group Composition interactions did not occur. This supports the earlier work of Hooper and Hannafin (1988), but is in contrast to more recent studies (Hooper & Hannafin, 1991; Hooper & Temiyakarn, 1992).

Ability Grouping

The findings on group composition are inconsistent across training, task, and grouping factors. Such inconsistency and the few significant findings regarding group composition is also found in other work (Hooper, 1992a; Hooper, Ward, Hannafin, & Clark, 1989; Slavin, 1987; Webb, 1982b). While some evidence exists that low ability children benefited from being in heterogeneous groups and high ability children from being in homogeneous groups, notably, except for these limited findings, no grouping strategy had particularly debilitating effects on either high or low ability children. This is in contrast to Hooper and Hannafin's (1991) work which found that high ability subjects were disadvantaged in heterogeneous groups.

The work on grouping identified by Slavin (1987) generally promotes homogeneous grouping for certain subject areas (e.g., reading and maths) and for both high and low ability students. In contrast, the peer tutoring literature tends to favor heterogeneous groups for both high and low ability students. Slavin suggested that homogeneous grouping may be better than heterogeneous for hierarchically arranged tasks and those in which students are able to pace themselves. The Analogies Tutorial program is hierarchically arranged, and yet the opposite effect surfaced for low ability fifth graders

who benefited from being with high ability students. Again, the contradictory data suggest the need for further study.

Exposure time is also an important consideration in microcomputer learning (Baron & Abrami, 1992a,b). The short exposure to the software in this study may have mitigated any advantages that a particular group composition may have had.

Conclusion and Practical Implications

In conclusion, Gamoran's (1987) point, and the Aptitude–Treatment–Interactionist position, concerning the nature and context of the learning situation and structure of the learning task in reducing the effects of grouping seem to be supported by the mixed results in this work. Ultimately, our ability to take advantage of the power of emerging technologies will depend on our understanding of the relationship between these media and learning. The above mixed findings underscore the fact that there are a variety of factors at play in a group CAI experience. We must now move beyond the input–output studies, and focus our attention on the social–cognitive dimensions of group CAI if it is to be considered an efficient and effective learning environment.

Finally, those professionals working directly with children are advised not only to attend to whatever achievement gains may be made with particular group configurations, but also to be sensitive to the affective side of the issue. Hallinan (1984) refers to the social and emotional effects of labeling children or placing unrealistic expectations on them. As such issues as mainstreaming and inclusion continue to be at the forefront of educational concerns, educators must not ignore these affective considerations.

Acknowledgments — The research was supported by the Social Science and Humanities Research Council of Canada (Grant #410-87-0199) and Concordia University. The author gratefully acknowledges the contributions of Dr Philip Abrami, Ms Patricia Peters, and Ms Jacky Boivin to the research, and Dr Joyce Barakett, Dr Miranda D'Amico, and Ms Beth Sissons for their feedback on earlier drafts. The author also thanks Davidson & Associates, Inc. and Hartley Courseware, Inc. for their generous contribution of the software used in this study.

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