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Understanding Process and Affective Factors
in Small Group versus Individual Learning with Technology

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Abstract

This meta-analysis quantitatively synthesized 198 independent findings from 71 empirical studies that compared the effects of small group versus individual learning on several process and affective outcomes when students learned with computers. On average, students learned with computers in small groups attempted a greater amount of task ($d_+ = +0.15$), used more learning strategies ($d_+ = +0.36$), had more positive attitude toward small group learning ($d_+ = +0.54$), but needed more task completion time ($d_+ = -0.21$) as compared to students learned with computers individually. No significant difference was found on student attitude toward instruction whether they learned in small groups or individually. However, effect sizes varied significantly, ranging from extremely positive to extremely negative in each of the outcomes analyzed. Significant predictors concerning technology and task characteristics included type of programs, instructional control, feedback, and task structure. Significant predictors concerning grouping and learner characteristics included group learning strategy, group work experience, and group size.

Whether to have students work individually or in small groups when they learn with computers is a question that teachers face frequently in this technology and information age. Recommendations concerning when to use small group or individual learning, however, appeared varied. While several earlier researchers (e.g., Rysavy & Sales, 1989; Light & Blaye, 1990) recommended individual use for tutorials and drill-and-practice software and small group use for more complex exploratory programs, a recent meta-analysis of 122 studies (Lou, Abrami, & d'Apollonia, 2001) found that the effects of small group learning on individual achievement were more positive when students learned with tutorial and practice programs than exploratory and tool programs. This study attempts to provide a better understanding of the factors that moderate the effects of small group versus individual learning with computers through a comprehensive meta-analysis of the empirical literature on several process and affective outcomes.

Computer as Individualized Tutor and Cognitive Tool

One major argument that supports individual learning with computers is that a learner working on his own can maximize learning from the individualized instruction, practice, and feedback commonly designed in instructional software or can have more control by proceeding at his/her own pace (Kinzie, 1990). Educational software, especially computer-assisted instruction (CAI) such as tutorials and drill-and-practice programs, is often perceived as an individualized tutor capable of responding to each learner's learning events with direct and immediate feedback (Rysavy & Sales, 1989). This capability of accommodating to individual learner differences can overcome the limitation of whole class instruction, where a teacher is often able to cater his/her instruction to the average students only. With its interactive capability,

a computer can act as a partner in learning, which is different from working alone in paper and pencil work (Carrier & Sales, 1987).

Computer technology is also perceived as cognitive tools for individual knowledge construction (Papert, 1980). Cognitive tools may include exploratory programs such as microworlds (e.g., Logo), simulations, and hypertext-based or hypermedia-based learning environments that are designed to encourage active student exploration and discovery learning. For example, children use Logo to construct and test hypothesis and mathematical reasoning through design and experimentation (Papert, 1980). Cognitive tools also refer to general purpose computer tools such as word processing, spreadsheet, data-analysis software, presentation and electronic communication media, which are used to accomplish tasks such as writing, organizing information, analyzing data, synthesizing and presenting results. Cognitive tools engage and facilitate cognitive processing, critical thinking, and higher order learning (Kommers, Jonassen, & Mayes, 1992; Jonassen, 1994; Jonassen, Wilson, Wang, & Grabinger, 1993). They support, guide, and extend the thinking processes and therefore can function as a mind-extension tool to re-organize and amplify our mental capacity (Cobb, 1997; LaJoie & Derry, 1993; Pea, 1985). With the help of technology as cognitive tools, learners may be more actively engaged in knowledge construction and creation (Jonassen, 1994; Salomon, Perkins, & Globerson, 1991; Salomon, 1993b). Through engaging in tasks such as exploring, analyzing, and interpreting information, solving complex problems, and communicating effectively what they know to others, learners are enabled to take active control of their learning, and to construct knowledge rather than to reproduce it (Reeves, 1998).

Extensive research has been conducted on the effects of learning with computer technology. While results are generally positive, effects on student achievement appeared varied

for different types of programs. Although tutor programs have received less enthusiasm in recent years for focusing on discrete knowledge and the reputation of “drill-and-kill” student motivation, their effects on student achievement were mostly positive as indicated by several meta-analyses (e.g., Kulik, 2003; Kulik & Kulik, 1991; Niemiec, Samson, Weinstein, & Walberg, 1987). Effects of exploratory and tool programs appeared more mixed, but many offer promising and inviting educational vignettes (Coley, Cradler, & Engel, 2000).

Differential effects were also noted for other technology and task features such as different types of instructional control, embedding of cognitive strategies, feedback, and instructor facilitation. For example, in their review, Sivin-Kachala and Bialo (1994) found that the effects of CAI were more positive when students learned under mainly learner-control conditions than mainly system-control conditions and that embedding cognitive strategies such as repetition, rehearsal, paraphrasing, outlining, cognitive mapping, drawing analogies and inferences in computer programs facilitated student learning. Azevedo and Bernard’s (1995) meta-analysis of feedback effects found that the effects of CAI were more positive when students received elaborate feedback with explanation than evaluative feedback only. Lundgren-Cayrol (1996) studied the effects of different levels of facilitation in computer conferences that supported an undergraduate distance learning course. She found that students who learned under the higher level of facilitation achieved significantly higher than those who learned under the lower level of intervention.

Small Group Learning with Computers

Arguments that support small group learning with computers may be practical or theoretical. Although the student-to-computer ratio has gone down dramatically in the recent years, few classrooms have sufficient technological resources to afford all students individual

access to computers at will. Thus, having students work in small groups provides a practical solution. In addition, research on cooperative learning (Johnson & Johnson, 1989; Slavin, 1989) and several theories such as constructivism (Jonassen, 1994), socially constructed cognition (Resnick, Levine & Teasley, 1991), distributed cognition (Salomon, 1993) support the concept that students learn well together. For example, peer collaboration, exposure to multiple perspectives, and revising one's own thinking can be important processes in the learner's construction of knowledge. In other words, regardless of practical constraints, it may be advisable for students to collaborate when using computers for learning.

Considerable studies have been conducted investigating the effects of small group versus individual learning with computers. Several reviewers have attempted to synthesize the empirical findings. Earlier attempts consisted of narrative reviews only. Most of these reviews were very limited in scope. The two most comprehensive narrative reviews were conducted by Rysavy and Sales (1989) and Shlechter (1991).

Rysavy and Sales' (1989) review included 13 studies that compared small group versus individual learning with computers on student achievement and attitudes, and a few observation studies of group interaction that were published between 1982 and 1988. The reviewers concluded that the findings on achievement outcomes were mixed with about one half showing positive effects and the other half no significant difference on student achievement. In the observation studies, positive learning processes and attitudes when students learned with computers in small groups were noted. These included: cognitive elaboration and scaffolding, peer tutoring, emotional support, social interchanges, improved attitudes toward instruction, subject matter, and computers, motivation to seek elaborate feedback built in the software, and motivation to persist in striving to accomplish the learning goal. Some differences in gender and

ability levels were also noted in some studies with more positive attitudes and learning benefits of small group learning for female students and for lower ability students.

Shlechter's (1991) review included 20 comparison studies and 16 grouping studies that were published between 1969 and 1991. After listing the characteristics and major findings of each of the 20 comparison studies, the author concluded that while small group use of computers was cost effective when resources were limited, there were no consistent effects of small group or individual learning with computers on student achievement. In the studies that compared different types of groupings, the author noted that lower ability students benefited more from heterogeneous ability grouping and that students exhibited differential amount of helping behaviors when they learned with different types of computer programs.

More recently, Lou, Abrami, and d'Apollonia (2001) conducted a comprehensive meta-analysis synthesizing 122 studies that compared the effects of small group versus individual learning with computers. They found that the effects of small group learning with computers were significantly more positive as compared to individual learning with computers on both group task performance ($d+ = +0.31$) and individual achievement ($d+ = +0.15$). Consistent with earlier narrative reviews, the findings were significantly heterogeneous across the studies. Further exploration of the findings through study feature analyses indicated that the inconsistencies were systematically related to a few technology, task, grouping, and learner characteristics in the studies. Students learning in groups achieved more when they: 1) had group work experience or instruction for cooperative group work; 2) worked in pairs than in 3-5 member groups; and 3) worked with tutorial or drill-and-practice programs than exploratory or tool programs. While the findings concerning group work experience or instruction appeared consistent with the cooperative learning literature, the ones concerning type of programs

appeared quite different from what some researchers had predicted. For example, Light and Blaye (1990) and Rysavy and Sales (1989) suggested that individual learning would be more effective and suitable for drill-and-practice due to the capability of individualized practice and feedback, ensuring a progressive build-up of skills and understanding. Johnson, Johnson, and Stanne (1986) suggested that benefits of cooperative learning with computers would be more evident with more complex and exploratory software.

Lou, Abrami, and d'Apollonia (2001) also estimated the mean effects of small group learning versus individual learning with computers on several process and affective outcomes. They found that, on average, students learning in groups had a significantly higher frequency of positive peer interaction, a higher frequency of using appropriate learning or task strategies, were more perseverant on tasks, had more positive attitude toward group work and toward classmates. Students learning individually on average interacted more with computer programs, requested significantly more help from the teacher or monitor, accomplished tasks faster than those working in groups. No significant differences were found between groups and individuals on task attempted, attitudes toward computer, subject, instruction, or academic self-concept. However, while many of these findings were based on small number of studies, a few with larger sample sizes such as task attempted, task completion time, attitude toward small group learning, and attitude toward instruction indicated significant variability among the findings analyzed. These significantly inconsistent findings suggest that the effects of small group versus individual learning with computers may be systematically related to different study features.

Purpose of the Study

The purpose of the present study was to gain a further understanding of the moderating factors of small group versus individual learning with computers through analyses of the

variability in several of the heterogeneous process and affective outcomes including: task attempted, task completion time, use of learning strategies, attitude toward instruction, and attitude toward small group learning.

According to systems theory, any learning situation consists of a number of factors and processes that are related to each other, influencing each other, and impacting on whether or how much learning takes place (Boyd, 1993). These interrelated factors may include learner characteristics, technology design characteristics, task characteristics, and social structure. For example, while the design characteristics may influence whether the learner is motivated enough to work individually, group learning strategy and group cohesiveness may influence whether students working in groups will have positive attitude toward small group learning. Literature on motivation (e.g., Atkinson, 1966; Weiner, 1992) suggests that learners' attitudes play an important role in their learning. More positive attitudes tend to produce more effort; negative attitudes tend to be associated with avoidance behavior.

Since learning processes and affective outcomes may be directly related to cognitive learning, examining the moderating factors may shed light on how and why different amount of learning occurs under different conditions. Specifically the research questions asked were:

1) What factors moderate the effects of small group versus individual learning with computers on task attempted, task completion time, use of learning strategies, attitude toward instruction, and attitude toward small group learning?

2) What is the pattern, if any, in the moderating factors on process, affective, and cognitive outcomes that may explain the differential effects of small group versus individual learning with computers?

Method

Identification of Studies

The studies used in this meta-analysis were located through a comprehensive search of the literature from 1965 to 2003. Electronic searches were performed on the following databases: *Dissertation Abstracts*, *Education Abstracts*, *ERIC*, *ProQuest*, *PsycInfo*, and *Social SciSearch*. Manual searches were performed on *Educational Technology Abstracts*. Although search strategies varied depending on the tool used, search terms generally included: “computer” and any terms related to small group learning such as “cooperative or collaborative learning”, or “small group”, or “team”. Other citations were identified through branching from primary studies and review articles.

To be included in this meta-analysis, each study had to meet all of the following inclusion/exclusion criteria:

(1) The study had to involve situations where students learned using computers (i.e., students are directly involved in using computers for learning, whether learning computer skills or using computer to learn other subjects).

(2) The study had to have employed an experimental design which allowed for the comparison of small group learning with computers versus individual learning with computers. More specifically, the investigation must involve comparing learning with computers in small groups (i.e., with two or more students per computer on the same task in a face-to-face setting, or two or more students collaborating either synchronously or asynchronously on the same task electronically) versus learning with computers individually (i.e., with one computer per student, each working on his /her own task).

(3) The minimum group size was 2 and the maximum group size was 10 (Ten was used as an inclusion criteria when coding the studies. However, the largest group size found in any of the studies was 5).

(4) Each study had to report measured outcomes for both experimental and control groups. Studies with insufficient data for effect size calculations (e.g., with means but no standard deviations or no inferential statistics) were excluded.

Using the above inclusion and exclusion criteria, abstracts from electronic searches, references from primary studies and review articles were examined to identify potential studies for inclusion. If there was doubt, the study was collected. Next, the collected studies were read independently by two researchers for possible inclusion. Any study that was considered for exclusion by one researcher was checked by the other.

Outcome Measures and Effect Size Extraction

Table 1 describes the five process and affective outcomes extracted and analyzed in this meta-analysis. Task attempted is a measure of group process, including number of words attempted, number of responses produced, etc. Task completion time is defined as the total amount of time a group spent in completing their task, including both on-task and off-task time. Use of learning strategies is a frequency measure of each student's use of self-regulating strategies, appropriate task strategies, perseverance, giving and receiving help, praise, encouragement, etc. Attitude toward instruction measures each student's attitude toward the subject matter or instruction. Attitude toward small group learning measures each student's perception or preference for small group learning.

----- Insert Table 1 Here -----

Only one finding per outcome was extracted from each study unless they represented different subjects. This approach enables one to examine different outcomes while ensuring independence among the findings for each outcome (Gleser & Olkin, 1994). Multiple effect sizes provided by the same subjects for the same outcome were averaged.

The basic index for the effect size calculation is the mean of the experimental group minus the mean of the control group divided by the pooled standard deviation (PSD). That is, the effect size is a measure of the superiority of learning with computers when working in a group *versus* working alone. The main reason for using the PSD is that the assumption of homogeneity of variance in the population is often reasonable; in which case, the PSD is more stable and provides a better estimate of the population variance than the control group SD alone (Hedges & Olkin, 1985; Hunter & Schmidt, 1990; Rosenthal, 1991). Another reason for the choice of the PSD is that estimated effect sizes based on incomplete results (e.g., t values, F values, ANOVA tables, or p levels) are more readily comparable to calculated effect sizes.

Effect sizes from data in the form of t value, F value, p level, frequencies, r value, etc. were computed via formulas provided by Glass, McGaw, and Smith (1981) and Hedges, Shymansky, and Wordworth (1989). For studies that reported only a significance level, effect sizes were estimated. When the direction of the effect was not available, an estimated effect size of zero was used. When the direction was reported, a "midpoint" approach was taken to estimate a representative t value (i.e., midpoint between 0 and the critical t value for the sample size to be significant) (Sedlmeier & Gigerenzer, 1989).

The study findings were extracted by two coders separately and then checked for reliability. The initial agreement was 92%. Disagreements between the coders were resolved through subsequent discussion and further review of the disputed findings.

Study Features Coding

The purpose of coding study features was to identify methodological and substantive characteristics that may be responsible for significant variations in the findings. Three steps were followed in developing the codebook. First, based on the review of the related literature, including research on computer-based learning, small group cooperative learning, and small group learning with computers, a broad coding scheme was developed outlining four categories of substantive study features that might interact with the effects of social context when learning with computers. These four categories are technology, task, grouping, and learner characteristics. In addition, methodological features were also outlined in the coding scheme. Next, using the broad scheme as a framework, a random sample of 25% of the primary studies was nomologically coded to identify salient study features in the literature as well as salient categories within each study feature so as to avoid researcher bias (Abrami, Cohen, & d'Apollonia, 1988; Abrami, d'Apollonia, & Cohen, 1990). Finally, based on the nomological coding, the original coding scheme was revised and developed into a codebook.

Table 2 includes the 24 methodological and substantive study features coded for each study. Methodological features included student equivalence, type of publication, and measure source. Substantive features were coded in four categories: technology, task, grouping, and learner characteristics. Technology characteristics included type of programs, design orientation, feedback, instructional control, teacher support, and setting of collaboration. Task characteristics included subject, type of tasks, task structure, task familiarity, and task difficulty level. Grouping characteristics included group composition, presence of others, group learning strategy, group work experience or instruction, group size, and number of sessions. Learner characteristics included grade level, relative ability level, gender, and computer experience.

----- Insert Table 2 Here -----

Study features coding was performed by two coders independently. Their initial coding agreement was 86%. Disagreements between the two coders were resolved through discussion and further review of the disputed studies.

Data Analysis

For each outcome, the unit of analysis was the independent study finding. Data screening was first performed using the frequency and descriptive procedures in *SPSS* for Windows. Several study features with almost no variability (e.g., measure source, design orientation, setting of collaboration) or with over 90% missing data (e.g., teacher support, task familiarity, presence of others, computer experience) were dropped from further analysis. Categories within some variables (e.g., group size, group composition, subject, and grade level) were combined based on frequency distributions, conceptual meaning, and the preliminary results from the homogeneity analyses. Outlier analyses were performed using standardized residual procedures (Hedges & Olkin, 1985). No outlier with standardized residuals larger than ± 2.00 was identified.

Effect sizes within each outcome were then aggregated and tested for homogeneity according to Hedges and Olkin (1985) using a meta-analysis software, *Comprehensive Meta-Analysis*TM (Biostat, 2000), and *SPSS* for Windows. Each effect size was first corrected for bias and weighted by the inverse of the sampling variance. Thus, more weight was given to findings that were based on larger sample sizes. The weighted effect sizes were then aggregated to form an overall weighted mean estimate of the small group learning effects (d_+). The significance of d_+ was judged by its 95% confidence interval. If the confidence interval did not contain zero, d_+ was considered significantly positive or negative depending on the sign of the mean value. To determine whether the findings shared a common effect size, the set of effect sizes was tested for

homogeneity by the homogeneity statistics (Q_T). When all findings share the same population effect size, Q_T has an approximate chi-square distribution with $k-1$ degrees of freedom, where k is the number of effect sizes. If the obtained Q_T value is larger than the critical value, the findings are determined to be significantly heterogeneous, meaning that there is more variability in the effect sizes than chance fluctuation would allow. Study features analyses were then performed to identify moderating factors.

Each study feature is tested through two homogeneity statistics, between-class homogeneity (Q_B) and within-class homogeneity (Q_W). Q_B tests for homogeneity of effect sizes across classes. It has an approximate chi-square distribution with $p-1$ degrees of freedom, where p is the number of classes. If Q_B is greater than the critical value, it indicates a significant difference among the classes of effect sizes. When a study feature has more than two classes, Scheffé post-hoc comparisons were performed to control for Type I error rate. Q_W indicates whether the effect sizes within each class are homogeneous. It has an approximate chi-square distribution with $m-1$ degrees of freedom, where m is the number of effect sizes in each class. If Q_W is greater than the critical value, it indicates that the effect sizes within the class are heterogeneous.

Student equivalence, a methodology study feature, was first analyzed in each dataset. In several datasets, this study feature was identified as a significant moderator of the effect sizes aggregated. Thus, the decision was made to remove 16 findings that did not use either experimental or statistical control from further analysis so that the results would represent best evidence from higher quality studies.

Results

A total of 214 independent findings were extracted from 80 studies comparing the effects of small group learning with computers versus individual learning with computers on task attempted, task completion time, use of appropriate learning strategies, attitudes toward instruction, and attitude toward small group learning. The total number of findings was reduced to 198 from 71 studies representing 9734 students after removal of 16 findings that did not use either experimental or statistical control. Table 3 presents a breakdown of the findings by different types of publications before and after removal of the less well-controlled findings.

----- Insert Table 3 Here -----

Table 4 presents the weighted mean effect sizes, the 95% confidence intervals, and overall homogeneity statistics for each outcome. On average, there was a moderate positive effect of small group learning on use of learning strategies ($d_+ = +0.36$) and attitude toward small group learning ($d_+ = +0.54$), a small positive effect on task attempted ($d_+ = +0.15$), no significant effect on attitude toward instruction ($d_+ = +0.07$), and a small negative effect on task completion time ($d_+ = -0.21$). These results indicate that students working with computers in small groups on average used significantly more strategies, expressed more positive attitude toward small group learning, and attempted a larger amount of task than those working with computers individually. Whether working with computers in small groups or individually, students had similar attitude toward instruction. However, those working with computers in small groups on average needed more task completion time than those working with computers individually ($d_+ = -0.21$).

----- Insert Table 4 Here -----

Homogeneity statistics indicate that the effect sizes in each dataset were significantly heterogeneous, ranging from about two standard deviations less positive (i.e., favoring students

learning individually) to about three standard deviations more positive (i.e., favoring students learning in small groups). Study feature analyses were, therefore, performed to identify methodology, technology, task, grouping, and student characteristics that significantly modified the effects of small group versus individual learning with computers.

Methodology Study Features

Type of publication was a significant predictor on four outcomes: task attempted, task completion time, use of learning strategies, and attitude toward small group learning ($Q_B = 5.55, 5.30, 5.49, \text{ and } 25.86$, respectively). For each outcome, the mean effect size was significantly more positive in published journal articles than in unpublished reports or dissertations (see Table 5). For task attempted and task completion time outcomes, either published journal articles or unpublished reports and dissertations showed a small significant mean effect. For use of learning strategies and attitude toward small group learning outcomes, both types of publications reported significantly positive effects of grouping when students learned with computers.

----- Insert Table 5 Here -----

Technology Study Features

Table 6 presents the number of independent findings, weighted mean effect sizes, and direction of difference for three technology study features that significantly moderated the effects of grouping on one or more process and affective outcomes when students learned with computers.

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Type of programs was significantly related to the variability in each of the five process and affective outcomes, including task attempted, task completion time, use of learning strategies, attitude toward instruction, and attitude toward small group learning ($Q_B = 4.96, 4.68,$

10.65, 3.87, and 26.80, respectively). When working with tutorial or practice programs, there was no significant effect of grouping on task attempted, a small negative effect on task completion time, a moderate positive effect on use of learning strategies, a small positive effect on attitude toward instruction, and a moderate positive effect on attitude toward small group learning ($d_+ = +0.04, -0.18, +0.73, +0.12, \text{ and } +0.76$, respectively). When working with exploratory or tool programs, there was a small positive effect on task attempted, a moderate negative effect on task completion time, a small positive effect on use of learning strategies, but no significant effect on student attitude toward instruction and toward small group learning ($d_+ = +0.28, -0.38, +0.24, 0.00, \text{ and } +0.16$, respectively).

Type of instructional control was significantly related to the variability on task attempted, task completion time, use of learning strategies, and attitude toward small group learning ($Q_B = 6.25, 13.71, 12.26, \text{ and } 8.71$, respectively). The pattern of moderating effects was very similar to that for type of programs. When programs were mostly system-controlled, there was no significant effect of grouping on task attempted and on task completion time, but there was a large positive effect on use of learning strategies and a large positive attitude on student attitude toward small group learning ($d_+ = +0.06, +0.06, +0.85, \text{ and } +1.07$, respectively). When programs were mostly learner-controlled, there was a small positive effect on task attempted, a small negative effect on task completion time, a small positive effect on use of learning strategies, and a moderate positive effect on student attitude toward small group learning ($d_+ = +0.24, -0.29, +0.25, \text{ and } +0.49$, respectively).

Type of feedback was significantly related to the variability in the findings on student attitude toward group learning with computers ($Q_B = 15.34$). When programs provided elaborate feedback, there was a large positive effect of grouping on student attitude toward small group

learning ($d_+ = +0.86$). When programs provided no or minimal feedback, there was a moderate positive effect of grouping on student attitude toward small group learning ($d_+ = +0.45$).

Task Study Features

Table 7 presents the number of independent findings, weighted mean effect sizes, and direction of difference for four task study features that significantly moderated the effects of grouping on one or more process and affective outcomes when students learned with computers.

----- Insert Table 7 Here -----

Type of subject was significantly related to the variability in the findings on task attempted, use of learning strategies, and attitude toward small group learning with computers ($Q_B = 4.76, 25.51, \& 5.65$, respectively). In math and sciences, there was no significant effect of grouping on task attempted, but there was a moderate positive effect on student use of learning strategies and a positive effect on student attitude toward small group learning ($d_+ = +0.51, +0.66$, respectively). In subjects other than math and science, there was a moderate positive effect on task attempted, a small positive effect on use of learning strategies, and a moderate positive effect on student attitude toward small group learning ($d_+ = +0.38, +0.27, +0.40$, respectively).

Task structure was significantly related to the variability in the findings on use of learning strategies and attitude toward small group learning ($Q_B = 19.22 \& 8.02$, respectively). When task structure was close-ended, there was a large positive effect of grouping on use of learning strategies and a large positive effect on student attitude toward small group learning ($d_+ = +1.05 \& +0.86$, respectively). When task structure was open-ended, there was a small positive effect of grouping on use of learning strategies and a moderate positive effect on student attitude toward small group learning ($d_+ = +0.24 \& +0.49$, respectively).

Task difficulty was significantly related to the variability in the findings on use of learning strategies and attitude toward small group learning with computers ($Q_B = 12.84$ & 37.12 , respectively). When tasks were moderately difficult, there was a large positive effect of grouping on use of learning strategies and a large positive effect on student attitude toward small group learning ($d_+ = +0.93$ & $+1.41$, respectively). When task difficulty was unknown, there was a small positive effect of grouping on use of learning strategies and a moderate positive effect on student attitude toward small group learning ($d_+ = +0.26$ & $+0.42$, respectively).

Grouping Study Features

Table 8 presents the number of independent findings, weighted mean effect sizes, and direction of difference for five grouping study features that significantly moderated the effects of grouping on one or more process and affective outcomes when students learned with computers.

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Group learning strategy was significantly related to the variability in the findings on use of learning strategies and attitude toward small group learning ($Q_B = 7.14$ & 67.52). When cooperative learning strategies such as turn-taking and agreeing-on-answers were employed and students were encouraged to work together, there was a moderate positive effect of grouping on use of learning strategies and a moderate positive effect on student attitude toward small group learning ($d_+ = +0.48$ & $+0.76$, respectively). When no specific group learning strategies were employed, there was no significant effect of grouping on use of learning strategies and a moderate negative effect on student attitude toward small group learning ($d_+ = -0.39$).

Group work experience was significantly related to the variability in the findings on task completion time and attitude toward small group learning with computers ($Q_B = 6.96$ & 36.03). When students had group work experience, there was no significant difference in the task

completion time between groups and individuals, but there was a moderate positive effect of grouping on student attitude toward small group learning ($d_+ = +0.75$). For other findings where student group work experience was unknown, there was a moderate negative effect of grouping on task completion time and no significant effect on student attitude toward small group learning ($d_+ = -0.32$ & 0.02 , respectively).

Group ability composition was significantly related to the variability in the findings on student attitude toward small group learning ($Q_B = 31.84$). When groups were heterogeneous in ability, there was an average large positive effect of grouping on student attitude toward small group learning ($d_+ = +0.86$). When groups were composed based on other considerations, there was a small positive effect on student attitude toward small group learning ($d_+ = +0.25$).

Group size was significantly related to the variability in the findings on task attempted, and student attitude toward group learning ($Q_B = 4.61$ & 49.55 , respectively). When students learned with computers in pairs, there was no significant difference between groups and individuals on task attempted, but there was a large positive effect of grouping on student attitude toward small group learning ($d_+ = +0.80$). When group size was three-to-five members, there was a significant moderate positive effect on task attempted, but no significant effect on student attitude toward small group learning ($d_+ = +0.37$ & 0.01 , respectively).

Number of sessions was significantly related to the variability in the findings on use of learning strategies, task attempted, task completion time, and attitude toward small group learning with computers ($Q_B = 5.59$, 13.33 , 22.47 , & 24.95 , respectively). When group learning was implemented for only one session, there was a moderate positive effect of grouping on task attempted, a moderate negative effect on task completion time, a moderate positive effect on use of learning strategies, and a large positive effect on student attitude toward small group learning

($d_+ = +0.31, -0.52, +0.32, +1.11$, respectively). When group learning lasted more than one session, there was no difference between groups and individuals on task attempted and task completion time, but there was a moderate positive effect on use of learning strategies and a moderate positive effect on student attitude toward small group learning ($d_+ = +0.64$ & $+0.37$, respectively).

Student Characteristics Study Features

Table 9 presents the number of independent findings, weighted mean effect sizes, and direction of difference for three student characteristics study features that significantly moderated the effects of grouping on one or more process and affective outcomes when students learned with computers.

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Grade Level was significantly related to the variability in the findings on the use of learning strategies, task completion time, and attitude toward small group learning ($Q_B = 22.57, 14.11, 6.24, \& 16.02$, respectively). For k-12 students, there was no significant difference between groups and individuals in task completion time, but there was a moderate positive effect of grouping on use of learning strategies, a small positive effect on student attitude toward instruction, and a moderate positive effect on student attitude toward small group learning ($d_+ = -0.05, +0.55, +0.17, +0.76$, respectively). For college and adult learners, there was a moderate negative effect on task completion time, no significant effect on use of learning strategies, no effect on student attitude toward instruction, but a moderate positive effect on small group learning ($d_+ = -0.37, -0.14, -.02, \& +0.33$, respectively).

Relative ability level was significantly related to the variability in the findings on task attempted ($Q_B = 8.67$). There was a moderate positive effect of grouping for low ability students

($d_+ = +0.33$), a moderate negative effect for medium ability students ($d_+ = -0.35$), and no significant effect for high ability students ($d_+ = 0.00$).

Gender was significantly related to the variability in the findings on task completion time ($Q_B = 5.09$). For female students, there was no significant difference between groups and individuals on task completion time ($d_+ = +0.11$). For male students, there was a moderate negative effect of grouping on task completion time ($d_+ = -0.31$). Few studies provided separate information for males and females on other outcomes. Only one study reported separate results on use of learning strategies with a moderate positive effect for female students ($d_+ = 0.67$) and no significant effect for male students ($d_+ = +0.05$). Two studies reported an average large positive effect of grouping on student attitude toward small group learning for female students ($d_+ = +1.43$).

Discussion

This study quantitatively synthesized the empirical literature of small group versus individual learning on task attempted, task completion time, use of learning strategies, attitude toward instruction, and attitude toward small group learning when students learned with computers. Based on 198 independent findings from 71 studies with experimental or statistical controls, the results of this meta-analysis indicate that on average there was a significant moderate positive effect of small group learning on use of learning strategies ($d_+ = 0.36$, $k = 23$), a significant moderate positive effect on student attitude toward small group learning ($d_+ = 0.54$, $k = 24$), and a small positive effect on task attempted ($d_+ = 0.15$, $k = 39$). No significant difference was found on student attitude toward instruction ($d_+ = 0.07$, $k=51$) whether they worked in small groups or individually with computers. However, students learning with

computers in small groups generally needed more task completion time than those learning with computers individually ($d+ = -0.21$, $k=61$).

Significant variability existed in each of the process and affective outcomes, indicating that the mean effect sizes are not representative of all the findings aggregated. Published journal articles generally reported more positive results than unpublished reports and dissertations. Analyses of substantive study features indicated two sets of significant predictors of grouping effects: one consisting of several related technology and task features, and one consisting of several grouping and learner characteristics.

Technology and Task Moderating Factors

Type of programs, instructional control, task structure, and subject matter exhibited a similar pattern of moderating influence on the grouping effects, especially on use of learning strategies and attitude toward small group learning. Effects of grouping were significantly more positive on use of learning strategies and attitude toward small group learning when: programs were tutorials or drill-and-practices than exploratory environments or tools; more system-controlled than learner-controlled; tasks were close-ended than open-ended; and subjects were math or science than language arts or social sciences. However, it should be noted that except for exploratory/tool program where there was no significant effect on student attitude toward small group learning, effect sizes were significantly positive on both outcomes for all other conditions. When programs were tutorial or practice-based, system-controlled, close-ended, especially in math and science subjects, groups generally attempted a similar amount of task, needed a similar or slightly more task completion time than those working individually, each member on average exhibited more frequent use of learning strategies and expressed more positive attitude toward instruction and toward small group learning. When programs were used as exploratory

environments or as tools for tasks that were mostly learner-controlled and open-ended, groups tended to attempt a larger amount of task and need more task completion time. Although each student also exhibited a small increase in the use of learning strategies as compared to those working with computers individually, there was no or less significant effect of grouping on student attitude toward instruction and toward small group learning.

These results appeared consistent with the individual achievement and group performance findings in Lou, Abrami and d'Apollonia (2001), where effects of grouping on individual achievement were found to be more positive for tutorial and drill-and-practice programs than exploratory and tool programs. The consistent moderating effects of these technology and task study features on use of learning strategies, attitude toward small group learning, and achievement appeared to suggest a positive relationship between use of learning strategies, attitude toward small group learning, and individual achievement, but a negative relationship between these, task attempted, and task completion time. Use of appropriate strategies may make learning more effective, task completion more efficient and, therefore, more successful learning, and more positive attitude.

Theories and research on cooperative learning (Johnson & Johnson, 1989, 1994; Abrami et al., 1995) and distributed cognition (Salomon, 1993a) have all pointed out the importance of small group learning in facilitating cognitive interactions among students and help them learn from multiple perspectives. Webb's (1984, 1997) research on peer interaction indicate the importance of providing and receiving explanation on student learning. Based on these theories and research on cooperative learning and the results of this meta-analysis, it is speculated that when working with tutor programs that are system-controlled with close-ended tasks, especially at k-12 grade levels, each group member may have both the opportunities to watch how their

group members work and the opportunities to try out themselves, benefiting from correcting each other's errors, providing and receiving explanations, and modeling of strategies use. These positive interactions help increase student attitude toward instruction, toward small group learning, and achievement. Furthermore, although tutorials and drill-and-practice programs are often designed for individual learning, they have the tendency to "drill-and-kill" student motivation. Working together with peers may make learning more interesting and fun as well as more engaging cognitively.

More open-ended and learner-controlled exploratory tasks may make it more likely for group members to focus on actions and results rather than taking the time to articulate their mental processes or provide explanations for their actions (Daiute, 1989). It is also possible that such tasks often take relatively longer period of time, making it less likely for each member to try out their own hypotheses or following their own perspectives. Constructivist learning theories emphasize the importance of student cognitive engagement and construction of knowledge based on one's own prior experiences and perspectives (Jonassen, 1999). Without the opportunity to construct one's knowledge through following one's own perspectives, each student may not be able to benefit as much from group learning, although group performance may be of higher quality than individuals'. Furthermore, if each group had the opportunity of following only one member's or a joint perspective, the group is limited to one possible solution only. Since open-ended, learner-controlled exploratory tasks tend to base solution path on different perspective or hypothesis, each individual student is left to follow their own devise when their perspectives and hypotheses differ from the group during individual achievement testing. More effective means for students to share strategies within and perhaps across groups are needed to help students to better benefit from small group collaborative learning using exploratory or tool programs.

The result of significantly more positive attitude toward small group learning under elaborate feedback condition than minimal or no feedback condition is consistent with Lou, Abrami and d'Apollonia (2001) findings on individual achievement and task performance findings. These results suggest that under elaborate feedback condition, having group interaction tends to better motivate and help students construct and retain knowledge than the feedback on the screen alone.

Grouping and Student Moderating Factors

The results of this study show that a number of grouping and student characteristics study features were significantly related to the size of grouping effects on one or more process and affective outcomes when students learned with computers. Effects of grouping were significantly more positive when: 1) specific cooperative learning strategies such as turn-taking and agreeing on answers were used; 2) students had group work experience; 3) group size was small with only two members; 4) especially for k-12 grade students; and 5) female students.

When specific cooperative learning structures such as turn-taking and agreeing-on-answers were used, there was a moderate effect of grouping on use of appropriate strategies and on attitude toward small group learning; when specific cooperative learning strategies were not reported, there was no significant effect on use of learning strategies and a significant negative effect on student attitude toward small group learning. Students with group work experiences needed a similar amount of time as those working individually and had significantly more positive attitude toward small group learning; students with unknown group experiences needed

more task completion time and there was no significant effect on attitude toward small group learning. Pairs generally attempted a similar amount of task as those working individually and had significantly more positive attitude toward small group learning; larger 3-5 member groups generally attempted a larger amount of task than individuals, but students worked in larger groups generally expressed less positive attitudes toward small group learning than those worked in pairs although both were positive.

The value of cooperative group learning has been repeatedly noted and recommended by a number of researchers (e.g., Johnson & Johnson, 1989, 1994; Lou et al., 1996). Results from this meta-analysis provide evidence and explanations for the positive effects of cooperative learning, group experience, and small group size on student achievement when students learn with computers. They appeared to provide process and affective explanations for the achievement findings in Lou, Abrami, and d'Apollonia (2001) that although larger groups may result in better group performance than pairs, each student on average learned more when working with computers in pairs and when they had group work experiences and specific cooperative learning strategies were employed. The similar pattern of moderating influence suggests that the larger effects on individual achievement may be due to the use of appropriate strategies by each student, which lead to effective learning engagement, group cohesion and more positive attitude toward small group learning.

The analysis of student characteristics study features found that the effects of grouping were more positive for K-12 students than college students or adult trainees. These findings appeared consistent with those concerning type of programs, instructional control, and task structure in that more tutorial and practice programs with system-controlled and close-ended tasks may be used at K-12 levels than at college and adult training. Another possible reason for

larger positive effects at K-12 levels is that college students and professionals may be more mature and independent learners and therefore possess more self-regulating and learning strategies. According to adult learning literature (Knowles, 1978), adult learners are also more concerned with time. Thus, when working in small groups required more time they may feel less positive about small group learning.

Few studies provided separate results for students at different relative ability levels and for male and female students. The few findings analyzed seemed to indicate that low ability students attempted a larger amount of task working in small groups than individually; that medium ability students attempted a larger amount of task working individually than in small groups; and that higher ability students attempted a similar amount of task working in small groups or individually. Female students appeared to require a similar amount of task completion time working individually or in small groups, and those worked in small groups with computers expressed more positive attitude toward small group learning. Due to the small number of findings extracted, the results may not be stable.

Predictors and Relationships among Process, Affective, and Cognitive Outcomes

A general pattern of relationships among the grouping effects on process, affective, and cognitive outcomes appeared to emerge from the results of this meta-analysis and those in Lou, Abrami, and d'Apollonia (2001). The most important process in small group learning with computers versus individual learning with computers appears to be the use of learning strategies, which showed a consistently similar pattern of moderating influence from technology, task, grouping and learner characteristics as it did on student attitude toward small group learning and on individual achievement.

Technology and task characteristics may determine whether there are opportunities for explanation, strategy sharing among the group members, and application of the strategies by each member. This may be more likely when students learn with tutorials and practice programs, which are mostly system-controlled with close-ended tasks, making it easier for members to rotate roles and take turns. Grouping and learner characteristics predict whether strategies sharing will take place and be valued by the group members. This may be more likely when instructors provided specific instructions for cooperative learning, when students have group work experience, and when they work in pairs.

With successful use of learning strategies, group learning will be more effective and efficient, which may help improve student attitude toward small group learning, especially for college and adult learners. Successful use of appropriate learning and task strategies may improve student attitude toward instruction and individual knowledge construction.

Implications for Practice

The following are recommendations for pedagogical practice when considering small group versus individual learning with computers based on the process and affective results of this meta-analysis as well as the cognitive results in Lou, Abrami, and d'Apollonia (2001).

1. When having students learn with tutorial or practice programs on tasks that are mostly system-controlled and close-ended, it is more effective cognitively and affectively to have students learn in pairs than individually, especially at k-12 grade levels.
2. When having students learn with exploratory programs such as simulations and hypermedia resources for discovery learning or general purpose tool programs such as Microsoft Word for writing, it is important to emphasize discussions and the opportunity for each member to

use learning strategies and to articulate, explain, and understand a variety of possible hypotheses and solutions.

3. When having students work with computers in small groups, it is important to provide them with specific cooperative learning structures and to encourage them to work together and to use appropriate learning strategies.
4. Students should be trained to develop group work experience. Small group learning with computers will be more effective when students have group work experience than when they do not.
5. Attention should be paid to student attitude toward small group learning, which may be a good indicator of their learning gains.
6. Attention should be paid to group task completion time, which may be negatively associated with use of learning strategies and student attitude toward small group learning. Students may need to be instructed on how to work in small groups more effectively and efficiently, especially when learning with exploratory or tool programs.

Implications for Educational Software Design

The majority of the programs were designed with individual orientation or with no special design for group work. This did not appear to be a problem for tutorials and practice-focused programs, where students working in small groups appeared to exhibit more use of learning strategies, had more positive attitude toward instruction and toward small group learning, and learned more. More effective designs for group use with exploratory programs may be needed. For example, an exploratory program that is designed for small group use may provide built-in opportunities for each member to articulate and compare choice of task solutions and rationales.

Strengths, Limitations, and Directions for Future Research

This review employed weighted regression meta-analytic techniques in quantitatively synthesizing the effects of small group learning on five process and affective outcomes when students learned with computers. It not only provided mean estimates of the grouping effects on various process and affective outcomes, it also analyzed variability in each outcome and has identified a set of technology, task, grouping, and student characteristics that moderated the effects of grouping. The results of this meta-analysis extend our knowledge on the effects and factors involved in small group learning with computers on learning processes, affective, and cognitive outcomes when students learn with different types of computer programs, under different task and grouping conditions, and with different learner characteristics.

Readers should be aware, however, that this meta-analysis, like others, has several limitations. First, the extent of the analyses is limited by the data available in the original empirical studies. Several study features (e.g., design orientation, task familiarity, etc.) could not be analyzed due to missing information or almost no variability. Therefore, it is possible that other factors not analyzed in this study may explain additional variance in the findings. Second, because meta-analysis is correlational in nature, strong causal explanations are not warranted. Finally, results of this meta-analysis may be limited by the design quality of the programs used in the empirical studies.

Future empirical studies should consider the significant predictors identified in this meta-analysis and provide comprehensive and detailed descriptions of all relevant study features concerning technology, task, grouping, and learner characteristics.

Future research investigating the effects of small group learning with technology is also encouraged to study process, affective, and cognitive outcomes together, which would allow the testing of process, affective, and cognitive outcomes within the same studies.

Research is needed to study more effective ways of small group collaboration when students learn with exploratory or tool programs, especially when tasks are open-ended and learner-controlled. For example, one way to facilitate small group learning is to structure debriefing opportunities during or after a computer session for members of a group to articulate and explain the strategies they are using and to discuss alternatives. This may be done through face-to-face discussions or online interactions. Another way to enhance small group learning is to structure opportunities for between group collaboration (Lou, in press; Lou & MacGregor, 2002). For example, groups may be paired up to exchange their strategies and solutions through either face-to-face discussions or online forums.

Future research should also examine the effects of small group versus individual learning on higher order skill development such as critical thinking and creative thinking, which may be more conducive to effective small group learning with exploratory programs.

Conclusion

Viewed from a systems perspective, any learning situation consists of a number of factors that are related to each other, influencing each other, and impacting on whether or how much learning takes place. Successful design of small group learning with technology must consider technology, task, and learner characteristics and provide effective group learning structures such as cooperative learning instructions and small group size to ensure that students have the opportunities to explain and share strategies and to learn more effectively, efficiently, and enjoyably.

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Table 1

Outcomes Included in this Meta-Analysis

Outcomes	Description
Task attempted (G)	Task attempted refers to amount of task attempted such as number of words attempted, number of responses produced, etc.
Task completion time (G)	Total amount of time spent in completing the task, including both on-task and off-task time.
Use of learning strategies (I)	Including use of self-regulating strategies, appropriate task strategies, perseverance, giving and receiving help, praise, encouragement, etc.
Attitude toward instruction (I)	Attitude toward the subject being learned or attitude toward instruction or learning the subject matter with computers.
Attitude toward group work (I)	Attitude toward learning in small groups.

Notes. G = group measure for those learning in groups; I = individual measure, that is, all students were assessed individually.

Table 2

Study Features Coded

Study features	Description
<i>Methodology features</i>	
Student equivalence	Was random assignment or statistical control used to achieve the equivalence of students in the experimental and control conditions?
Type of publication	Was the study published in journals or unpublished conference reports or dissertations?
Measure source	Was the outcome measure standardized, researcher-made, or teacher-made?
<i>Substantive features</i>	
<i>Technology characteristics</i>	
Type of programs	What type of computer programs was used? Was it a tutorial, drill-and-practice, exploratory environment (e.g., simulations, microworlds, hypermedia, and hypertext), tool for other tasks (e.g., word processor for writing, e-mail or computer-conference for course assignments), or programming languages?
Design orientation	Was the program designed for individual use or group use?
Feedback	Did the program provide no, minimal, or elaborate feedback?
Instructional control	Was the instruction more learner-controlled or more

	system-controlled?
Teacher support	Was teacher or monitor present to provide technical or content support?
Setting of collaboration	Was collaboration in the face-to-face setting or via electronic means?
<i>Task characteristics</i>	
Subject	What was the subject area studied by the students?
Type of tasks	Did the task involve problem solving or factual learning?
Task structure	Was the task open or closed?
Task familiarity	Were the students familiar with the task?
Task difficulty	Was the task easy, moderately difficult, or difficult?
<i>Grouping characteristics</i>	
Group composition	On what bases were students assigned to groups?
Presence of others	Were other peers working close by?
Group learning strategy	Was there a specific cooperative strategy used in the experimental condition?
Group work exp. / instruction	Did students have previous group work experience or were they provided with training /instructions for effective group work?
Group size	What was the average number of students in a group?
Number of sessions	What was the length of the experimental treatment?
<i>Learner characteristics</i>	
Grade level	What was the students' grade level? If post-secondary,

were the students in college, military, or corporate training?

Relative ability level

What was the relative ability level of the students in the class?

Gender

What was the gender of the students?

Computer experience

Did the students have previous computer experience?

Table 3

Total Number of Findings before and after Removal of the Less Well-Controlled Findings by Different Types of Publications

Type of Publications	Before Removal	After Removal
Journal articles	94	87
Reports and dissertations	120	111
Total	214	198

Table 4

Overall Effects of Small Group vs. Individual Learning with Computers on Process and Affective Outcomes

<i>Type of Outcomes</i>	<i>K</i>	<i>d₊</i>	<i>95% CI</i>	<i>Q_T</i>
Task attempted	39	+0.15	+0.04 / +0.26	97.47*
Task completion time	61	-0.21	-0.13 / -0.29	248.47*
Use of learning strategies	23	+0.36	+0.23 / +0.49	64.97*
Attitude toward instruction	51	+0.07	-0.01 / +0.14	103.16*
Attitude toward group learning	24	+0.54	+0.44 / +0.65	273.53*
Total	198	+0.22	+0.18 / +0.26	846.25*

* $p < .05$

Table 5

Mean Effect Sizes by Type of Publication

	Task attempted d_+ (k)	Task Completion Time d_+ (k)	Use of Learning Strategies d_+ (k)	Attitude toward Small Group Learning d_+ (k)
Type of publication (Journal articles vs. reports and dissertations	0.26*>0.01 (20) (19)	-0.10>-0.29* (28) (33)	0.60*>0.26* (8) (15)	0.92*>0.34* (8) (16)

* $p < .05$

Table 6

Small Group vs. Individual Learning with Computers: Significant Moderating Technology

Characteristics

	Task attempted		Task Completion Time		Use of Learning Strategies		Attitude toward Instruction		Attitude toward Small Group Learning	
	$d_+ (k)$		$d_+ (k)$		$d_+ (k)$		$d_+ (k)$		$d_+ (k)$	
Type of programs (tutor vs. expl/tool)	0.04 < 0.28*	(19) (20)	-0.18* > -.38*	(35) (22)	0.73* > 0.24*	(7) (16)	0.12* > 0.00	(35) (16)	0.76* > 0.16	(14) (6)
Instructional control (system vs. learner)	-0.06 < 0.24*	(10) (29)	0.06 > -0.29*	(19) (28)	0.85* > 0.25*	(4) (19)			1.07* > 0.49*	(5) (11)
Type of feedback (elaborate vs no/minimal)									0.86* > 0.45*	(8) (5)

* $p < .05$

Table 7

*Small Group vs. Individual Learning with Computers: Significant Moderating Task**Characteristics*

	Task Task attempted d_+ (k)	Task Completion Time d_+ (k)	Use of Learning Strategies d_+ (k)	Attitude toward Instruction d_+ (k)	Attitude toward Small Group Learning d_+ (k)
<hr/>					
Subject					
(math/science vs. other)	0.12 < 0.38* (25) (13)		0.51* > 0.27* (15) (7)		0.66* > 0.40* (11) (13)
Task structure					
(closed vs. open- ended)			1.05* > 0.24* (3) (20)		0.86* > 0.49* (11) (6)
Task difficulty					
(moderate vs unknown)			0.93* > 0.26* (4) (19)		1.41* > 0.42* (5) (19)

* $p < .05$

Table 8

*Small Group vs. Individual Learning with Computers: Significant Moderating Grouping**Characteristics*

	Task	Task	Task	Use of	Attitude	Attitude
	attempted	Completion	Time	Learning	toward	toward Small
	d_+ (k)	d_+ (k)	d_+ (k)	Strategies	Instruction	Group
				d_+ (k)	d_+ (k)	Learning
						d_+ (k)
<hr/>						
Learning strategies						
(coop. vs. no specific)				0.48* > 0.11		0.76* > -0.39*
				(15) (8)		(20) (4)
Group experience		-0.10 > -0.32*				0.75* > 0.02
(yes vs. unknown)		(19) (42)				(17) (7)
Group composition						0.86* > 0.25*
(hetero. ability vs. other)						(17) (7)
Group size	0.08 < 0.37*					0.80* > 0.01
(pairs vs. 3-5)	(31) (8)					(20) (4)
Number of sessions	0.31* > 0.12	-0.52* < -0.10		0.32* < 0.64*		1.11* > 0.37*
(one vs. more)	(32) (14)	(31) (26)		(13) (9)		(10) (12)

* $p < .05$

Table 9

Small Group vs. Individual Learning with Computers: Significant Moderating Student

Characteristics

	Task attempted	Task Completion	Use of Learning Strategies	Attitude toward Instruction	Attitude toward Small Group Learning
	d_+ (k)	D_+ (k)	d_+ (k)	d_+ (k)	d_+ (k)
Grade level					
k-12 vs. college/adult)		-0.05 > -0.37*	0.55* > -0.14	0.17* > -0.02	0.76* > 0.33*
		(30) (31)	(16) (7)	(26) (25)	(16) (8)
Relative ability					
(low vs. med. Vs. high)	0.33* > -0.35* < 0.00				
	(4) (5) (4)				
Gender					
(female vs male)		0.11 > -0.31*			
		(4) (6)			

* $p < .05$