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ABSTRACT

This study investigated whether cooperative learning groups with the highest mean levels of knowledge of the research process, as measured via midterm and final examination scores, produced the best cooperative learning projects, as measured by the quality of research article critiques and proposals. It also explored whether heterogeneity was related to the quality of the group projects, and whether the size of the group was related to the quality of the output produced. Participants were 275 graduate students enrolled in several sections of an introductory level educational research course who, through a modified stratified random assignment procedure, formed 70 groups ranging in size from 2 to 7. Using group as the unit of analysis revealed a small-to-moderate positive relationship between the mean midterm and final examination scores and scores on the article critiques and proposals, a finding suggesting a "Matthew Effect" with respect to group outcomes. A positive relationship was found between degree of group heterogeneity at the midterm level and scores on the projects. Also, a quadratic trend defined the relationship found between group size and performance on the article critique. Finally, a treatment (i.e. group heterogeneity level) times aptitude (i.e., mean midterm group performance) was found with respect to the article critiques produced. (Contains 1 figure and 65 references.) (Author/SLD)

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Treatment By Aptitude Interactions as a Mediator of Group Performance in Research Methodology Courses

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Abstract

This study investigated whether (a) cooperative learning groups with the highest mean levels of knowledge of the research process, as measured via mean midterm and final examination scores, produce the best cooperative learning projects, as measured by the quality of research article critiques and proposals; (b) degree of heterogeneity is related to the quality of these group projects; and (c) size of the group is related to quality of output produced.

Participants were 275 graduate students enrolled in several sections of an introductory-level educational research course who, through a modified stratified random assignment procedure, formed 70 groups ranging in size from 2 to 7. Using group as the unit of analysis revealed a small-to-moderate positive relationship between the mean midterm and final examination scores and scores on the article critiques and proposals--the former suggesting a "Matthew Effect," with respect to group outcomes. A positive relationship was found between degree of group heterogeneity at the midterm level and scores on the projects. Also, a quadratic trend defined the relationship found between group size and performance on the article critique. Finally, a treatment (i.e., group heterogeneity level) x aptitude (i.e., mean midterm group performance) was found with respect to the article critiques produced.

Treatment By Aptitude Interactions as a Mediator of Group Performance in Research Methodology Courses

Cooperative learning is one of the most common techniques utilized by educators throughout the United States at every tier of the educational process. This method represents the instructional use of small groups in which students collaborate either formally or informally to maximize their own learning, as well as those of their fellow group members (Johnson, Johnson, & Smith, 1991a). Theoretical support for this instructional strategy is based on the social interdependence, cognitive-developmental, and behavioral learning theories (Johnson, Johnson, & Smith, 1998).

Social interdependence theory, based on the work of Morton Deutsch and Kurt Lewin (Deutsch, 1949; Lewin, 1935), posits that cooperation is the result of positive interdependence among individuals' goals. According to this theory, positive interdependence (i.e., cooperation) leads to promotive interaction as students within a cooperative learning group encourage and facilitate each group member's learning and output. On the other hand, negative interdependence often results in dysfunctional interaction as group members impede and discourage each other's efforts to perform (Johnson et al., 1998). In other words, social interdependence positively influences individual interaction with a given situation, which subsequently affects the outcomes of that interaction (Johnson & Johnson, 1989).

Theoretical Perspectives

According to cognitive-developmental theory, cooperation is paramount for cognitive growth. Jean Piaget theorized that when individuals interact with society, positive socio-

cognitive contradictions occur that induce a state of cognitive disequilibrium (Johnson et al., 1998). This disequilibrium, in turn, promotes perspective-taking ability and, hence, cognitive development. Dialectical theories, also cognitive-developmental in nature, assert that knowledge is social, constructed by society and conveyed to the individual. Experiences during adulthood lead to questions, doubts, and contradictions that may culminate in further re-organization of thought in which conflicting viewpoints are integrated into a larger framework (Kramer, 1983; Labouvie-Vief, 1985).

Dialectical theories first became popularized when psychologists from the then Soviet Union were searching for a model that would be compatible with the Marxist ideology. Its major advocate, Lev S. Vygotsky, shortly after the Russian Revolution, proposed a way of conceptualizing human development in which mental activities take shape within a social framework (cf. Vygotsky, 1978). Vygotsky contended that cooperative efforts to learn, to understand, and to solve a wide range of problems are central for constructing knowledge and transforming the different perspectives into efficient mental functioning (Johnson et al., 1998). Vygotsky, like Piaget, believed that learning cooperatively with more-able peers and instructors culminates in cognitive growth and intellectual development (Johnson et al., 1998). Indeed, the cooperative learning concept of *scaffolding* (i.e., less skillful students actively collaborating with more competent peers, thereby enabling the former to develop more complex levels of understanding and skill) is a by-product of these cognitive-developmental theories.

Behavioral learning theorists posit that students will maximize their performance levels on tasks for which a reward of some sort follows; conversely, students will minimize

their efforts on tasks that yield minimal or no reward, or even punishment (Johnson et al., 1998). Cooperative learning involves the provision of incentives for members of a group to collaborate with their group colleagues. Albert Bandura, one of the earliest proponents of social-learning theory, emphasized the importance of imitation and modeling in the learning process (Bandura, 1969). B.F. Skinner, known for his theory of operant conditioning, advanced the use of group contingencies in promoting learning (Skinner, 1938).

As summarized by Johnson et al. (1998), social interdependence theorists believe that cooperation is based on intrinsic motivation induced by interpersonal components, with a collaborative desire to achieve being central toward achieving cooperative goals. Cognitive-developmental theorists assert that cooperative efforts lead to disequilibrium and cognitive reorganization, which promote group goals. Finally, proponents of behavioral learning theory posit that cooperative efforts are influenced by extrinsic motivation to achieve rewards and positive reinforcement. All theories predict that cooperative learning environments foster higher academic achievement levels than do competitive or individualistic settings (Johnson et al., 1998).

Although Slavin (1990) proposed a two-element theory of cooperative learning comprising positive interdependence and individual accountability, it is the five-component theory of D.W. Johnson, R.T. Johnson, and their colleagues (Johnson, Johnson, & Holubec, 1991; Johnson et al., 1991a; Johnson, Johnson, & Smith, 1991b) that presently is the most utilized. According to this conceptualization, the following five elements are essential for maximizing the success of the cooperative learning endeavor: (a) positive interdependence, (b) face-to-face promotive interaction, (c) individual accountability, (d) social skills, and (e)

group processing. Positive interdependence refers to each student recognizing that she/he is interconnected with all other group members in such a way as the student cannot be successful unless all the remaining group members are. Face-to-face promotive interaction involves students enhancing each other's goals by utilizing such techniques as supporting, praising, encouraging, and scaffolding. Individual accountability places the onus on the student to master the assigned task. In so doing, *coat-tailing* and *social loafing* (i.e., disproportionately benefiting from another's work) is assumed to be minimized (Johnson et al., 1991; Johnson et al., 1991a; Johnson et al., 1991b). Social skills requires a positive interaction among all group members. Skills such as effective communication, building and maintaining trust, and constructively resolving conflicts, are emphasized. Finally, group processing refers to students being able to assess how well their group is working toward achieving its goals. As noted by Johnson and Johnson (1991), these five elements help to promote a successful cooperative learning experience for students.

According to Smith, Johnson, and Johnson (1992), the variety of cooperative learning activities can be classified into the following three group types: informal learning groups, formal cooperative learning groups, and cooperative base groups. Informal learning groups, which are the least structured and short-term, require students to complete a task often associated with a lecture. Formal cooperative learning groups, which are longer in duration, comprise small groups established by the instructor to create a final product, such as a term assignment. Finally, cooperative base groups are stable, long-term, peer support groups created to enhance students' learning and to increase participation in larger lecture classes.

Cooperative Learning at the College Level

Since 1924, there have been more than 168 studies conducted that have compared the relative efficiency of cooperative, competitive, and individualistic learning on the achievement of individuals in college and adult settings (Johnson et al., 1998). These investigations indicate that cooperative learning techniques lead to higher levels of academic achievement than do either competitive (effect size = 0.49) or individualistic (effect size = 0.53) methods (Johnson et al., 1998). Additionally, Qin, Johnson, and Johnson (1995), in a review of 46 studies at the post-secondary level, found positive effects on problem solving associated with the cooperative learning model in 55 of the 63 outcomes.

However, virtually all of the cooperative learning studies undertaken on adults have been at the associate or baccalaureate levels, or the like. As noted by Slavin (1991), scant research exists in the area of cooperative learning at the graduate level. Indeed, an extensive review of the literature revealed only four studies examining the effects of cooperative learning in graduate-level research methodology courses. This is extremely surprising bearing in mind that (1) virtually all graduate educational programs require students to enroll in at least one research methodology course as a part of their degree programs (Onwuegbuzie, 1997); and (2) recently, there has been an increase in the number of research methodology instructors who utilize cooperative learning techniques in their courses (Onwuegbuzie & DaRos, in press). As such, little is known about the effectiveness of cooperative learning techniques impacting student performance at the graduate level. Even among the four extant investigations in this area, the findings were inconclusive. Specifically, Wilson (1998) found that encouraging students to work in groups when used

in combination with strategies was helpful in reducing levels of anxiety among graduate students enrolled in educational research courses. These strategies involved addressing student anxiety about course content, using humor, applying statistics to real-world situations, and reducing fear of evaluation. Unfortunately, the cooperative techniques were not isolated from the other methods. Thus, it was beyond the scope of the inquiry to determine the individual effect of cooperative learning on statistics anxiety.

Second, Onwuegbuzie and DaRos (in press) utilized a mixed-methodological equivalent-status research design (Tashakkori & Teddlie, 1998) to investigate the effects of cooperative learning on levels of achievement and attitudes in research methodology courses. These researchers found that students enrolled in classes in which cooperative base groups were formed (n = 81) had statistically significantly lower performance levels at the midpoint of the course (effect size = 0.48), as measured by the midterm examination, than did students who were enrolled in sections in which all assignments were undertaken and graded individually (n = 112) . Interestingly, although students in the cooperative learning groups still had lower levels of performance than did their counterparts with respect to the final examination, this difference was not statistically significant. No overall difference in course average was found between these two groups. Furthermore, qualitative (i.e., phenomenological) analysis of reflexive journals indicated that 70.2% of the students tended to have positive overall attitudes towards their cooperative learning experiences, 19.2% of the students tended to have negative overall attitudes, and 10.6% tended to be ambivalent.

Third, Courtney, Courtney, and Nicholson (1992) found no difference in statistics achievement between graduate students who were taught using a cooperative learning

method and those who were taught using a traditional method. However, their qualitative data suggested that cooperative learning techniques positively influenced student motivation, self-efficacy, level of anxiety, and sense of social cohesiveness. Fourth, most recently, Onwuegbuzie (in press) found a small but statistically significant relationship between peer orientation and achievement, with students who were more oriented towards cooperative learning attaining lower levels of achievement than did those who did not have an orientation towards cooperative learning.

Group Composition in Cooperative Learning

One question that has yet to be resolved at the college level in general, and at the graduate level in particular, is the role of group size and group homogeneity on the efficacy of cooperative learning partnerships. Indeed, debate exists at all levels about how to compose cooperative teams. With respect to the size of cooperative learning groups, Johnson and Johnson (2000) cautioned that (a) as the size of the group increases, resources needed for the group to be successful subsequently increases; (b) the shorter the period of time available to complete the task, the smaller the learning group should be; (c) the larger the group, the easier it is for them to avoid contributing their share of work (i.e., social loafing) (Stephan & Mishler, 1952); (d) the larger the group, the less likely that members will perceive their contribution to the group as being important to the group's chances of success (Kerr, 1989; Olson, 1965); (e) the larger the group, the less the individual accountability (Messick & Brewer, 1983; Morgan, Coates, & Rebbin, 1970); (f) the larger the group, the more skillful the group members must be; (g) the larger the group, the less the interaction and communication that exists among members (Gerard, Wilhelmy, &

Conolley, 1968; Indik, 1965); (h) the group size is dependent on the materials available and the specific nature of the task; (I) the larger the group, the more difficult it is to identify any difficulties students have in collaborating with group members (Fox, 1985); (j) the larger the group, the more likely students are to strive collectively for unanimity that overshadows members' motivation to examine all perspectives in a critical manner (i.e., groupthink; Bales & Strodtbeck, 1951; Janis, 1972); and (k) the larger the group, the stronger the positive independence among the members must be.

Johnson and Johnson (2000) also noted that groups will be less effective (a) the larger the discrepancy between the functional group size is; (b) the less group members perceive their individual efforts as being crucial for group success; (c) the less the effort is expended by each member; (d) the more complex the group structure is, (e) the more time it takes for the group to coordinate efforts; (f) the less the members identify with the group; and (g) the less members follow the group's norms.

It appears that most cooperative learning groups range from two to four (Johnson & Johnson, 2000) or from three to five (Magney, 1997) students. Interestingly, Bray, Kerr, and Atkin (1978) found that the groups in their study did not solve problems appreciably more quickly than did the fastest problem-solver in two-person groups. Further, Watson and Johnson (1972) noted that in groups of more than eight or nine members, some participants are likely to assume passive roles. However, with the exception of these and a few other studies, although the general rule of thumb is that small groups are better than large groups (Johnson & Johnson, 2000), scant empirical research has investigated the effects of group size on performance.

Whereas some researchers advocate that homogeneous groups be formed, others recommend heterogeneous groups (Dalton & Kuhn, 1998). Unfortunately, scant research has investigated the effect of group composition on performance (Johnson & Johnson, 2000). As such, "little is known about precisely how group composition and tasks interact to affect performance" (Johnson & Johnson, 2000, p. 461). According to Johnson and Johnson (2000), of the prevailing studies, the degree of homogeneity-heterogeneity among students' demographic attributes, personal attributes, and abilities and skills has been assessed with respect to (a) performance on clearly-defined production tasks, (b) performance on cognitive or intellectual tasks, and (c) creative generation of ideas and decision making pertaining to ambiguous judgmental tasks.

Two studies found performance on production tasks to be higher in cooperative groups whose members were homogeneous with regard to personal attributes (Clement & Schiereck, 1973; Fenelon & Megaree, 1971), whereas one investigation (Terborg, Castore, & DeNinno, 1976) found that the degree of heterogeneity pertaining to attitudes did not have an effect on performance on group-based land-surveying tasks. In a meta-analytic review, Wood (1987) found 12 studies in which objective performance results (i.e., speed and accuracy) was not significantly higher for mixed-gender groups than for same-gender groups of either gender. Similar results were reported for more complex learning tasks (Johnson, Johnson, Scott, & Ramolae, 1985; Peterson, Johnson, & Johnson, 1991). On the other hand, Cumming (1983) concluded that mixed-ability groups were more effective than were groups homogeneous in ability. For decision-making tasks, Hill (1982), who reviewed several published studies in this area, found that heterogeneous groups performed at levels

less than their potential. In contrast, however, Bantel and Jackson (1989) found that the more heterogeneous decision-making bank management teams were with regard to job expertise, the more frequently the bank adopted innovative initiatives. With respect to cognitive performance, as noted by Johnson and Johnson (2000), "there are too few studies on intellectual tasks to make a conclusion" (p. 459) about the impact of group heterogeneity. Thus, clearly, the findings pertaining to performance on clearly-defined tasks and decision-making tasks are contradictory.

A few disadvantages have been reported for homogeneous groups. Specifically, too many members with similar thoughts and opinions may (a) induce groupthink (Janis, 1972); (b) induce risk-avoidant behaviors (Bantel & Jackson, 1989); (c) enhance mediocrity, thereby stunting effective decision-making and creative thinking; and (d) find it difficult to adapt to changing circumstances. However, constructing diverse groups does not automatically guarantee positive results. In fact, too much diversity can lead to lower group performance levels due to communication and organizational difficulties (Johnson & Johnson, 2000). Thus, it is clear that more research is needed regarding the effective of group composition on achievement, especially that pertaining to intellectual tasks.

Most recently, using qualitative techniques, Onwuegbuzie and DaRos (in press) found that the most heterogeneous groups tended not to function as well as did homogeneous groups. However, this finding has not been tested empirically in research methodology courses. Consequently, the purpose of this investigation was to determine whether (a) groups with the highest mean levels of knowledge of the research process, as measured via mean midterm and final examination scores, produce the best cooperative

learning projects, as measured by the quality of research article critiques and proposals; (b) degree of heterogeneity is related to the quality of these group projects; and (c) size of the group is related to quality of output produced.

Unfortunately, even though much research exists on the effect of cooperative learning, most of these studies have contained a serious analytical flaw. Specifically, in the majority of inquiries in this area, the treatment was given to each small group of students but then the individual students were inappropriately used as the unit of analysis, without taking into account any of the possible confounding factors (McMillan, 1999). Rather in these studies, it is the groups that should have formed the unit of analysis (McMillan, 1999; Onwuegbuzie, 2000a). In particular, in utilizing a unit of analysis at the individual level, researchers have failed to realize that "the idiosyncratic nature of how each group progresses, based on who is in the group, is likely to be a primary determinant of the results" (McMillan, 1999, p. 3). Because cooperative learning groups are designed such that students within each team influence one another, it is likely that using unit of analyses at the individual level to assess group efficacy leads to the independence assumption being grossly violated, as well as to the creation of systematic error (McMillan, 1999). As noted by McMillan (1999), the effect of the non-independence of observations on the unit of analysis is an increase in the Type I error rate, a reduction in statistical power, and a decrease in both internal and external validity. Therefore, it was hoped that the present investigation would provide more internally and externally valid findings than has been typically the case in cooperative learning research.

Method

Participants

Participants were 275 graduate students from a number of disciplines (e.g., elementary education, middle grades, secondary education, speech language pathology, and psychology) who were enrolled in several sections of a introductory-level research methodology course at a southern university over a three-year period. the majority of participants was female (84.0%), ranging in age from 21 to 55 (M = 29.9, SD = 7.9), and with a mean grade point average of 3.64 (SD = 0.38). The racial composition was 94.2% Caucasian-American and 5.5% African-American. These students (n = 275) formed 70 groups ranging in size from 2 to 7 (M = 3.99, SD = 1.27). The same instructor taught all sections of the research methodology course, thereby minimizing any *implementation threat* to internal validity resulting from *differential selection of instructors* (Onwuegbuzie, 2000a).

Setting

All graduate students enrolled in social and behavioral science degree programs were required to take the introductory-level educational research course. For each semester, which lasted for 16 weeks, class sessions were conducted for three hours, once per week. The fact that all classes were held at the same time in the evening (i.e., 5 pm to 8 pm) minimized any *implementation threat* to internal validity resulting from *differential time of day* (Onwuegbuzie, 2000a).

Research proposals. One of the main requirements of the course was the completion of a research proposal. The objective of this proposal was to prepare students throughly to be able to write proposals for theses and dissertations, and for seeking external funding. As

such, the research proposals provided authentic assessment (Onwuegbuzie, 2000a; Wiggins, 1990). These research proposals were undertaken using cooperative learning groups.

Research proposals had to be unique, realistic, have educational significance, and extend the knowledge base. A completed group-developed research proposal, which could represent either quantitative or qualitative research on a topic selected by the group members, consisted of a title, a one-page proposal summary, an introduction section, a review of the related literature, a methodology section, an analysis section, a bibliography, and an appendix section including a biography of each group member, timetable, budget, consent form(s), and author-designed instrument(s). Each group proposal had to be typed, following guidelines specified by the American Psychological Association ([APA],1994). The writing style of each proposal (e.g., grammar, punctuation, clarity, and application of the APA (1994) criteria) also was assessed. All proposals had to include an in-depth review of the literature, and thus extensive library usage was required. Indeed, although many research methodology instructors appear to require what could be conceptualized as a *mini-proposal*, the research proposal in this course was required to be comprehensive, containing a minimum of 20 references--the majority of which were to be obtained from refereed research journals.

Historically, over the years, research proposals in this course typically ranged from 25 to 40 pages, with the literature review section usually ranging from 5 to 15 pages. Students in each group were encouraged to begin the process of developing their research proposals from the first class meeting. Moreover, groups were required to formulate their

research questions by the second class meeting and to start obtaining literature sources by the third class meeting.

Article critique. The second major course requirement that was undertaken via cooperative learning groups involved a detailed written critical evaluation of a published research report (i.e., article critique). The primary goal of the article critique was to provide an opportunity for students to develop skills in evaluating published research articles utilizing principles of the scientific method. In order to facilitate this process, students were required to select several articles to critique, and to bring them to the second class meeting for advice from the instructor as to their appropriateness (i.e., article content utilizing principles of the scientific method). Furthermore, students were required to make their final selection as to which article to critique by the third week of the semester. The article critiques provided performance assessment (Hutchinson, 1995; Onwuegbuzie, 2000b).

Formation of cooperative learning groups. On the first day of class, students, in turn, were asked to introduce themselves to the class, delineating their major, educational attainments and aspirations, current professional status, and interests. Following these introductions, students were asked to form groups comprising 3-6 students. Group formation was guided by asking students to choose group members based on similar majors, professional background, and proximity to each other's homes. These criteria for group assignment were not directly related to aptitude or ability. Such assignment of groups by preferences is referred to as a *modified stratified random assignment* (Johnson & Johnson, 2000).

Nine groups involved pairs. These pairs were formed when two students lived close

to one another, but a significant distance from other students in the class, or when the major of two students in the class (e.g., music) was different to all other class members. Two groups of seven students also were formed because these groups represented students who were admitted to their degree program as a cohort. Members of these seven-group teams lived close to one another but a significant distance (more than 90-minute drive) from the university they attended (i.e., where the current investigation took place).

Base groups. The cooperative learning group that was utilized involved the use of base groups (Smith et al., 1992). The aim of these base groups was to promote stable membership whose foremost responsibility was to provide each member of the group the support, encouragement, and assistance as needed to comprehend course content. In addition, the cohesiveness provided by membership in the group was (a) to promote the successful completion of the course assignments and (b) to prepare students for the in-class individual examinations. Students were encouraged to stay together during the entire course. Additionally, students were expected to takes notes for and to distribute any instructor handouts to any group member who was unable to attend a class session. That is, students were expected to provide peer tutoring to their absent group members. Although they were allowed to change groups if any conflicts or unresolvable problems arose among group members, no student requested such a change. Students were asked to exchange telephone numbers and e-mail addresses and information about their schedules so that they could meet outside class. Students were encouraged to take notes for and to collect class handouts for any absent group members, as well as to provide peer tutoring of any new concepts that were covered by the instructor during the missed session. Each base group

undertook one research proposal and one article critique.

The instructor informed students of the following basic group skills: group activities should be distributed as equally as possible, or at least according to the strengths of group members; students should respect the opinions of all group members, no students should dominate group discussions; and every student should be aware of all tasks undertaken by group members and be prepared to provide constructive criticism. Students were not assigned specific group roles; however, they were presented with different models for the division of labor (e.g., each student writing a section of the research proposal and article critique; each student individually undertaking all sections of these assignments and then comparing their work with other group members with the goal of merging all responses). Additionally, as discussed by Garfield (1993), students were made aware of the importance of assigning different roles at each group meeting (i.e., moderator/organizer, summarizer, recorder, strategy suggester, seeker of alternative methods, mistake manager, and an encourager) that prevented any one person from undertaking a disproportionate amount of the work. This discussion of group roles was undertaken in an attempt to maximize *positive interdependence*, *promotive interaction*, and *social skills*, as recommended by Johnson and Johnson (1991).

Course organization. The first part of each class period typically consisted of a review of the material presented the previous session, and the middle portion of each class lesson generally involved the presentation of new material. All students were provided with a complete set of the instructor's lecture notes at the beginning of the course. However, instead of a lecture-based review of the material, each base group reviewed the material

that was presented earlier by the instructor. During this phase, students rearranged desk-chairs into groups within the classroom. While students worked in groups, the instructor observed, answered questions posed by students, facilitated discussion among all group members, identified and praised group successes, and informed the class of any insights gained from circulating among the groups. These techniques were utilized by the instructor in an attempt to enhance *positive interdependence*, *promotive interaction*, and *social skills* (Johnson & Johnson, 1991). As time permitted, students in the cooperative groups were given class time toward the end of the period to discuss their research proposals and article critiques and to engage in *group processing* (Johnson & Johnson, 1991). Again, the instructor served as a facilitator.

Due to the comprehensiveness of the article critique and the research proposal, the instructor attempted to make himself as available as possible to all students outside class time and office hours, encouraging them to contact him at his home between 10 am and 10 pm, on any day of the week (including weekends and holidays), if they had any questions about the assignments. Many students took advantage of this opportunity. In fact, it was common for the instructor to receive a conference call involving some or all members of a cooperative learning group. Indeed, on many occasions, the cooperative group that had telephoned their professor used a speaker phone in order that all group members could hear their instructor's responses to their questions.

Instruments

A scoring rubric was used to evaluate the research proposals and article critiques (cf. Wilson & Onwuegbuzie, 1999), with detailed feedback provided by the professor. Students

received group scores for these assignments. Conceptual knowledge, which involved students' knowledge of research concepts, methodologies, and applications, was measured individually via comprehensive written midterm and final examinations. These examination forms consisted of open-ended questions, involving items which required knowledge of the research process (e.g., "What is the difference between inductive and deductive research?"). All of the items in the midterm examination form pertained to content from the first half of the course and were chosen from the instructor's item bank to ensure that the examination was typical of past examinations given by the instructor. The final examination also was constructed by the course instructor and paralleled the format of the midterm examination, yet covered the complete course content. Both the midterm and the final examination were administered under untimed conditions, and were scored on a 100-point scale by the instructor, using a key that specified the number of points awarded for both correct and partial-credit answers.

Additionally, students were required to complete a peer evaluation form to assess the level of cooperativeness of their group members. This peer evaluation form consisted of a 10-point rating scale containing 10 items, with scores ranging from 10 to 100. High scores on the scale indicated a favorable cooperative rating from a fellow group member. Items on the peer evaluation form included the following: (a) " ____ was willing to do his/her fair share of the work"; (b) "_____ listened to the opinions of others in the group"; and (c) " ____ provided assistance to other members of our group." For each student, scores on the peer evaluation form were averaged across team members to obtain an overall cooperativeness rating. Thus, the score for the article critique and research proposal for the group to which

the student belonged was weighted by her/his participation score, such that if a student received 100% of the participation points available, her/his individual score would be exactly equivalent to the group score. If the student receives 90% of the participation points available, her/his individual score will be worth 90% of the group score, and so forth. The midterm and final examinations, as well as the peer evaluation forms, were administered in an attempt to ensure *individual accountability* (Johnson & Johnson, 1991).

Results

The individual midterm scores ranged from 51 to 100 (M = 79.54, SD = 11.21), whereas the individual final examination scores ranged from 55 to 100 (M = 82.79, SD = 9.33). Further, the mean midterm scores for each group ranged from 62.67 to 99.00 (M = 79.35, SD = 7.08). Additionally, the group variances of the midterm scores ranged from .71 to 18.34 (M = 8.73, SD = 4.28). The mean final scores for each group ranged from 69.33 to 93.33 (M = 82.59, SD = 5.10), whereas the group variances of the final scores ranged from 2.63 to 19.09 (M = 8.63, SD = 3.69). Interestingly, the relationship between the mean group midterm and the mean group final examination scores was statistically significant (r = .63, $p < .05$) and large (Cohen, 1988).

Using group as the unit of analysis revealed statistically significant moderate positive relationships between the mean midterm scores and scores on the article critiques (r = .26, $p < .05$) and proposals (r = .35, $p < .01$). Similarly, moderate-to-large (statistically significant) positive relationships were found between the mean final scores and scores on the article critiques (r = .31, $p < .01$) and proposals (r = .46, $p < .001$).

Additionally, a statistically significant positive relationship was found between degree

of group heterogeneity at the midterm level (i.e., group aptitude) and scores on the group article critique (r = .25, p < .05), although no relationship was found between degree of midterm heterogeneity and scores on the group proposal (r = .11, p > .05). Also, no association was noted between degree of group heterogeneity at the final level (i.e., group ability) and scores on both the group article critique (r = .05, p > .05) and proposal (r = .18, p > .05).

No relationship was found between group size and group performance on the article critique (r = .14, p > .05) and proposal (r = .05, p > .05). However, a trend analysis (removing the two seven-group teams from the analysis) revealed no linear (F [1, 67] = 1.99, p > .05), cubic (F [1, 67] = 0.31, p > .05), or quartic (F [1, 67] = 1.90, p > .05) trend. Conversely, a quadratic trend (F [1, 67] = 4.43, p < .05) emerged, with the article critique scores peaking at a group size of 6 (i.e., M = 95.50, SD = 5.21). However, Scheffé's test revealed no pairwise differences in article critique group means, although it should be noted that this lack of statistically significant difference between group means may have been the result of the low statistical power, bearing in mind that there was a 12-point difference between the three-group and the six-group teams, in favor of the latter. Figure 1 illustrates the quadratic trend. Interestingly, no linear (F [1, 67] = 1.11, p > .05), quadratic (F [1, 67] = 0.01, p < .05), cubic (F [1, 67] = 3.98, p > .05), or quartic (F [1, 67] = 1.37, p > .05) trend was found with respect to the scores on the research proposals.

Insert Figure 1 about here

Most interestingly, a treatment (i.e., group heterogeneity level at the midterm level) x aptitude (i.e., mean midterm group performance) interaction (F [1, 66] = 4.73, $p < .05$, ω^2 = .27) was found with respect to group article critique scores. Moreover, this interaction was ordinal in nature, in which the difference in article critique scores between cooperative learning groups in the upper half of the distribution with respect to midterm scores (i.e., high-aptitude groups) (M = 88.72, SD = 9.87) and those in the lower half of the distribution (i.e., low-aptitude groups) (M = 78.18, SD = 8.47) was statistically significantly larger for groups in lower half of the midterm score distribution with respect to heterogeneity (i.e., low-heterogeneous groups) than the difference between high-aptitude groups (M = 90.00, SD = 5.49) and low-aptitude groups (M = 87.72, SD = 6.82) for high-heterogeneous groups.

In addition to the aptitude x treatment interaction observed for article critique scores, both the aptitude main effect (F [1, 66] = 11.37, $p < .001$, ω^2 = .42) and the heterogeneity main effect (F [1, 66] = 8.10, $p < .01$, ω^2 = .35) were statistically significant. Both these effect sizes were large (Cohen, 1988). With respect to the former main effect, high-aptitude groups (M = 89.32, SD = 8.02) produced significantly better article critiques than did the low-aptitude groups (M = 83.09, SD = 8.97). With respect to the latter, the quality of article critiques was higher for high-heterogeneous groups (M = 88.79, SD = 6.24) than for low-heterogeneous groups (M = 83.60, SD = 10.54).

With respect to research proposals, no treatment (i.e., group heterogeneity level at the midterm level) x aptitude (i.e., mean midterm group performance) interaction (F [1, 66] = 0.66, $p > .05$, ω^2 = .02) was found. Similarly, no heterogeneity main effect (F [1, 66] = 0.80, $p > .05$, ω^2 = .02) emerged. However, there was an aptitude main effect (F [1, 66] = 4.65,

$p < .05$, $\omega^2 = .11$). This effect was small (Cohen, 1988).

Discussion

A decision that faces every college instructor who implements cooperative learning in his/her class relates to group composition. Specifically, these instructors must decide upon the optimal group size and composition within the context of the assigned material or project. Unfortunately, the research base does not make clear the optimal group size or group composition at any level of the educational process (i.e., primary, secondary, or tertiary). The few studies that have examined the role of group size and composition in cooperative learning have yielded mixed findings (Dalton & Kuhn, 1998). Thus, the purpose of the present inquiry was to investigate the effect of these factors on the academic performance of cooperative groups enrolled in a graduate-level research methodology course. Surprisingly, although researchers have analyzed the effectiveness of cooperative learning in college classrooms since 1924, there has been a paucity of such studies at the graduate level.

Several important findings emerged from the present research. First and foremost, contrary to Johnson et al. (1991a), who assert that allowing students to select their own groups leads to homogeneous groups, the student-selected groups in the current investigation were extremely heterogeneous in their performance levels, with the mean group standard deviation for both midterm and final scores being close to nine percentage points. In other words, each cooperative learning group, on average, contained students who differed in individual examination performance scores by nearly one grade. Indeed, students in some groups varied in individual performance by as much as two grades, with

Grades of "A," "B," and "C" being attained, for example, by students in these groups. The fact that many of the groups were heterogeneous may have resulted from the selection criteria, which were based on academic major, professional background, and proximity to each other's homes, and not based on aptitude and ability considerations. Thus, it appears that use of these three criteria (i.e., a modified stratified random assignment procedure) was effective in producing heterogeneous groups. Nevertheless, the fact that the group mean midterm examination scores ranged from a Grade "D" (i.e., 62.8%) to Grade "A" (i.e., 99.0%) suggests that the cooperative groups differed substantially with respect to performance levels of the individual group members.

One of the most important results of the present inquiry was the statistically significant moderate-to-large positive relationships between the mean midterm scores and scores on the article critiques and proposals, as well as those between the mean final scores and scores on the article critiques and proposals. These combined results suggest a "Matthew effect," whereby groups that contained higher-achieving students on an individual level tended to produce better group outcomes than did their lower individual-achieving counterparts. Interestingly, the large positive relationship between midterm examination scores and final examination scores provides further support for the Matthew effect with respect to group outcomes.

The Matthew effect was coined by Merton (1968) after the Biblical statement that "For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken away even that which he hath" (Gospel according to Matthew, XXV:29). Merton described the Matthew effect with respect to scientific productivity as

representing the accumulation of greater increments in recognition for specific scientific works to scientists of notoriety, and the withholding of such recognition from scientists who have not yet established themselves in the field. Merton's idea of the "rich getting richer" was subsequently observed and described in educational settings by Walberg and his associates (Walberg, Strykowski, Rovai, & Hung, 1984; Walberg & Tsai, 1983). In particular, Walberg and Tsai (1983) described a "fan-spread" when educational outcomes are plotted against time such that "rates of gain are relative and proportional to initial endowment" (p. 361). Later, Stanovich (1986) suggested that the Matthew effect should be considered in understanding the role of initial reading level on later reading performance.

According to Walberg et al. (1984), the Matthew effect implies that "rather than the one-way causal directionality usually assumed in educational research, reverberating or reciprocal states may cause self-fulfilling or self-reinforcing causal processes that are highly influential in determining educational and personal productivity" (p. 92). In the current research, the fact that groups consisting of individually higher-achieving students tended to produce better article critiques and research proposals than did other cooperative learning teams may be the result of a self-fulfilling prophecy in which higher individual-achieving groups possess higher levels of academic motivation and self-esteem, and other affective components, than do their counterparts. Indeed, Onwuegbuzie and DaRos (in press) reported that most students in cooperative learning groups experience increases in motivation, persistence, self-esteem, self-efficacy, anxiety, social cohesion, problem solving adeptness, and metacognitive awareness. However, it is likely that these gains were largest for the higher individual-achieving groups. Also, it is possible that students in the highest

individual-achieving groups were the least likely to procrastinate on their group assignments.

With respect to Johnson et al.'s (1991a) assertions regarding the five elements that underlie successful cooperative learning groups, it is clear that, at the very least, the highest-scoring groups displayed the highest individual accountability. That is, members of these groups were the most responsible in completing the assignments. It is also possible that these successful groups tended to enforce the other four elements (i.e., positive interdependence, face-to-face promotive interaction, social skills, and group processing) of cooperative learning to a greater extent than did the less successful teams. However, it was beyond the scope of the present investigation to determine this. Consequently, future research, utilizing qualitative research methodologies should explore the role of these four elements in promoting a Matthew effect in cooperative learning groups.

The moderate positive relationship found between degree of group heterogeneity at the midterm level (i.e., group aptitude) and scores on the group article critique, as well as the large *Heterogeneity effect* (vis-á-vis individual midterm scores) observed for article critique scores in favor of high-heterogeneous groups, contradicts the qualitative observations of Onwuegbuzie and DaRos (in press); however, these current results are consistent with Johnson et al. (1991a), who recommend that instructors maximize the heterogeneity of groups by placing low-, medium-, and high-achieving students in the same cooperative group. According to these authors, "more elaborative thinking, more frequent giving and receiving of explanations, and greater perspective taking in discussing material seem to occur in heterogeneous groups, all of which increase the depth of understanding, the quality of reasoning, and the accuracy of long-term retention" (pp. 60-61). The findings

from the present investigation clearly indicate that research methodology instructors should incorporate heterogeneous cooperative learning groups in their instructional format at the graduate level.

The treatment x aptitude interaction found with respect to the article critiques indicated that the difference in quality of article critiques produced between the high-aptitude groups and low-aptitude groups was greater for the low-heterogeneous groups than for the high-heterogeneous groups. Thus, the Matthew effect was strongest for the more homogeneous groups, thereby providing incremental validity to the contention that instructors should maximize the heterogeneity of cooperative learning groups (Johnson et al., 1991a). Interestingly, the treatment x aptitude interaction that emerged in the present investigation is consistent with Onwuegbuzie and DaRos (in press), who, using qualitative techniques, found evidence of such an interaction.

That a Heterogeneity effect and a Treatment by Aptitude effect was found with respect to the quality of group article critiques, but that these effects were not noted with regard to the quality of group research proposals, may have arisen because the article critique was a more complex assignment than was the research proposal. As noted by Burns and Grove (1987), critiquing a research article involves first identifying the study elements and understanding the nature, significance, and meaning of both implicit and explicit components. Second, article critiques require the interpretation of meanings of the terms and concepts used in the report in the same way as the researcher(s) used them. Third, it is important that students have extensive knowledge of what each step of the research process comprises in order to evaluate the extent to which the article follows this

process. Fourth, it is imperative that the student is able to identify the expressed and unexpressed assumptions of the researcher, as well as to examine the abstract dimensions of the study. In doing this, students must be cognizant of the links between the elements of the study, as well as links between elements of the study and previous research. Finally, conceptual clustering (Werley & Fitzpatrick, 1985) must be undertaken, which maximizes the meaning attached to research findings, highlights gaps in the knowledge base, and generates new research questions. The above five steps of the critique process, namely, comprehension, comparison, analysis, evaluation, and conceptual clustering, must occur in sequence, with each step presuming accomplishment of the previous step (Burns & Grove, 1987). Thus, critiquing an article involves even more complex processing than acquiring conceptual understanding of research or being able to write a research proposal. Indeed, evaluation is the highest level of learning in Bloom's taxonomy of cognitive objectives (Bloom, 1956). This may help to explain why the treatment x aptitude effect occurred only for article critiques.

With respect to group size, no trend was found with respect to the scores on the research proposals; however, a quadratic trend was observed for scores on the article critiques. Although replications are needed to assess the generalizability of these findings, these results suggest that the size of the group may make a difference, especially when the complexity of the group task (i.e., article critique) is at a premium. Interestingly, groups containing six students, on average, obtained the highest scores on their article critiques. Yet, it should be noted that this was the largest group compared. Thus, it is not clear whether groups of this size produced the best quality article critiques because they

displayed the greatest group cohesion or because they had the highest probability of having one or more functional members who did the bulk of the work. In other words, it is beyond the scope of the present investigation to determine whether the degree of social loafing was more prevalent in six-student groups than in other combinations of groups. Indeed, Watson and Johnson (1972) asserted that in very large groups, a few members are apt to dominate and the remaining members are likely to assume passive roles. Moreover, as the size of cooperative groups increases, (a) members are less likely to deem their own personal contributions to the group as being essential to the group's level of achievement (Kerr, 1989; Olson, 1965); (b) individual accountability is less likely to prevail (Messick & Brewer, 1983); (c) individual group members typically communicate less frequently, thereby affecting the amount and quality of information utilized to make group decisions (Gerard et al., 1968; Indik, 1965); and (d) groupthink is more likely to prevail (Gerard et al., 1968; Rosenberg, 1961). However, the fact that the relationship between group size and scores on the article critique in the present investigation was non-linear (cf. Figure 1), with two-student groups obtaining the second highest mean scores, suggests that the ratio of the functional group size to the actual group size may not have increased as a function of actual group size. In any case, future inquiries should ascertain the relationship among group size, functional size, level of positive interdependence. Qualitative research techniques would be particularly useful in such studies.

In summary, the Matthew effect, the Heterogeneity effect, and the treatment x aptitude interaction appear to prevail when cooperative learning groups are utilized in research methodology classes. This suggests that instructors of these courses should be

cognizant of the potential debilitative and facilitative roles that group composition plays in cooperative or purposively-formed groups. Thus, it appears that in assigning students to groups in graduate-level research methodology classes, instructors should consider forming the cooperative learning groups either randomly or purposively (e.g., modified stratified random assignment procedure), using criteria (e.g., major, profession, and proximity to each other's homes) that are not directly related to aptitude or ability. Even more importantly, the results of the present investigation indicate that merely assigning students to groups is insufficient; instructors must constantly monitor that the five elements of cooperative learning are being adhered to by each group, as well as monitor the impact of group composition in an attempt to minimize the Matthew effect, the Heterogeneity effect, and the Treatment x Aptitude interaction that were observed in the present investigation.

Although there is a myriad of studies documenting the positive effect of cooperative learning with respect to several educational outcomes relative to more competitive and individualistic classroom environments, little is known about the conditions under which cooperative learning is maximized. The present study suggests that relatively large (n = 6) and heterogeneous groups represent optimal conditions. However, because this investigation was conducted in a geographically-restricted area, it is not clear the extent to which the Matthew effect, the Heterogeneity effect, and the treatment x aptitude interaction generalize to other settings. Thus, replications are needed. Indeed, these replications should be undertaken using other types of college classes (i.e., non research-based classes) and utilizing different levels of college students (e.g., doctoral, specialist, Master's, and undergraduates). Additionally, more such investigations are needed at other types of

colleges (e.g., community colleges), as well as at primary and secondary school levels. Further, future research should determine whether the Matthew effect prevails when students are purely randomized to cooperative learning groups. An important feature of all empirical-based replication studies in this area is that the groups themselves rather than the individuals are utilized as the major unit of analysis, as was undertaken in the present investigation. Using groups as the unit of analysis would minimize the possibility of the statistical independence being violated and systematic error being created (McMillan, 1999). It is only by establishing a large database that validly documents the effect of group composition on cooperative learning can we come close to understanding the educational and psychological processes that underlie this promising method of instruction.

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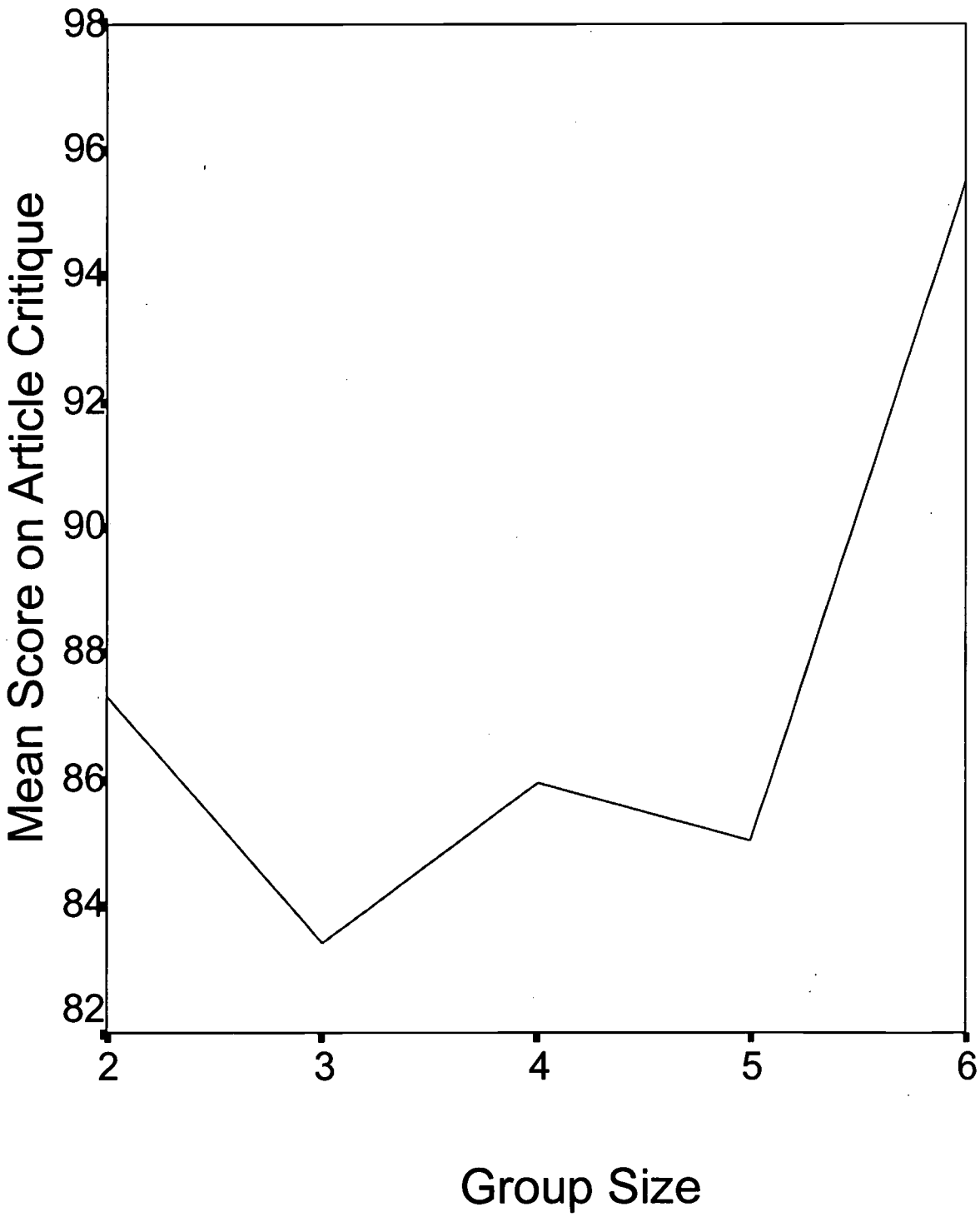
Figure Caption

Figure 1. Mean Scores for the Article Critiques as a Function of Group Size.


Mean Score on Article Critique
98
96
94
92
90
88
86
84
82
2
3
4
5
6
Group Size

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