Effects of Cooperative, Competitive, and Individualistic Learning Structures on College Student Achievement and Peer Relationships: A Series of Meta-Analyses

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ABSTRACT

This series of meta-analyses investigates the effects of social interdependence (cooperative, competitive, and individualistic learning structures) on achievement and peer relationships among college students. This study quantitatively synthesized the literature on the effects of social interdependence on achievement and peer relationship outcomes based on 1,204 effect sizes from 231 experimental studies involving 37,422 college and graduate-level students. The overall effects of cooperative compared to competitive and individualistic learning structures on achievement resulted in moderate effect sizes (g = .42 and .36 respectively. The estimated effects of cooperative learning on peer relationships was statistically significant and positive for the comparison to competitive structures (g = .88) and individualistic structures (g = .71). These findings are consistent with the conclusions of previous meta-analyses examining this population.

Explanatory models were constructed to examine the variance in effect sizes and the potential influence of several moderating variables including: unit of measure (group vs. individual measures), level of cognitive task (high vs. low complexity), and methodological quality of primary studies (high, moderate, low quality). Only unit of measure was identified as a statistically significant contributor to the overall variance in the effect size for achievement when comparing cooperative and individualistic learning structures. Possible reasons for the remaining unexplained variance in these meta-analyses, along with implications for practice and future directions for research, are also offered.

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INTRODUCTION

Current Challenges in U.S. Higher Education

Today, institutions of higher education operate against a backdrop of increasing college tuition rates, larger class sizes, and growing skepticism of higher education's effectiveness. While this backdrop manifests in complex challenges for academic communities, such challenges may be met by the implementation of instructional methods. Research indicates that cooperative learning, also referred to as collaborative learning in many contexts, may provide effective solutions to developing today's students both academically and socially. In fact, higher education has been slowly transitioning from a teacher-centered model of instruction to one that is more learner-driven and collaborative. This shift in focus makes it critical to develop a deeper understanding of how and when to use small-group learning to alleviate some of the challenges faculty and students may currently face. A thorough synthesis of the research on this instructional method may encourage additional faculty to utilize these techniques for the benefit of students both in and out of the classroom.

The National Survey of Student Engagement (NSSE) has become a measure commonly used to document how higher education institutions are meeting the educational goals of college students. During the last decade, the Indiana University Center for Postsecondary Research has surveyed more than 1,500 four-year colleges and universities to gather data on the experience of college students. Among its Five Benchmarks of Effective Educational Practice, NSSE details active and collaborative learning. The 2011 Annual Report reported that 46% of college students worked collaboratively with peers during class time; 56% of respondents worked with peers outside of class either electively or as part of a course assignment (p. 32). Through the last decade of surveying college students, NSSE has concluded that small-group learning in which students are socially interdependent on one another provides benefits both socially and academically. Students who feel supported academically and socially perform better academically and exhibit higher rates of satisfaction with their overall experience. Collaborative learning may provide one strategy for providing students with such support.

In the United States, rapid demographic changes in higher education have resulted in an increasingly diverse student population (Association of American Colleges and Universities, 2002). College students tend to have unsophisticated, but demanding attitudes regarding their education and financial investment in their learning experience (Levine and Cureton, 1998). Many researchers suggest that rapid changes in higher education institutions effect how learners engage with one another, faculty and the community (Kuh, 2003; Kuh, Kinzie, Schuh, Whitt, 2005). The use of cooperative learning in the classroom may encourage student engagement on many levels.

There has been a tremendous amount of research examining the outcomes of cooperative interactions between students, but less is known about the specific conditions in which these interactions may improve achievement and peer relationships in the college context. In their influential article, Barr and Tagg (1995) suggest that higher education needs to shift from the instruction paradigm to the learning paradigm. Faculty facilitating the learning paradigm would not deliver direct instruction through lengthy lectures but instead would create a condition enabling peer-to-peer sharing and discussion. Such a paradigm shift would also mean transitioning from a competitive win-lose environment to one characterized by cooperative win-win relationships.

Rationale for the Study

This study compares the effects of cooperative learning with individualistic and competitive learning structures on college student achievement and peer relationships. Despite an already extensive collection of research examining the effects of social interdependence on various learning and social outcomes, a significant opportunity exists for an updated meta-analysis of this literature to refine researchers' understanding of effective college instruction.

This work examines 231 studies on interdependence structures in the college classroom. It represents an earnest attempt to review all existing quantitative studies in the literature that compare cooperative, competitive, and individualistic learning methods in the college classroom. The inclusion of recent studies may provide greater relevance for the current environment in which students experience these various learning structures.

Several meta-analyses of small-group learning have been conducted over the last forty years. Overall, the results have shown significant effects in favor of students learning in small groups compared to whole class instruction or individualistic learning. This meta-analysis differs from previous quantitative reviews of the research literature because it focuses on adult learners exclusively, includes many different disciplines, and examines methodological and task characteristics that may influence the relationship between learning structure, achievement, and social outcomes.

Research Questions

The purpose of this study is to synthesize the empirical research examining the effects of cooperative, competitive, and individualistic learning structures on achievement and peer relationships for students in higher education. Specifically, this dissertation will investigate the following research questions:

1. To what extent does cooperative learning promote student achievement when compared to individualistic and competitive learning structures?
2. To what extent does unit of measure, study quality, and cognitive task difficulty influence the relationships between interdependence structure and student achievement outcomes?
3. To what extent does cooperative learning promote positive peer relationships when compared to individualistic and competitive learning structures?
4. To what extent does unit of measure, study quality, and cognitive task difficulty influence the relationship between interdependence structure and student peer relationship outcomes?

Definitions of Relevant Terms

For the purpose of this study, collaborative learning is broadly defined as a method of teaching and learning that emphasizes student interaction in small groups. Studies were included in this meta-analysis if the author classified the experimental condition as a cooperative structure with some element of positive interdependence. Considering the broad definitions used by researchers to classify cooperative learning structures, this dissertation includes any study that meets these minimum requirements.

This approach was deemed more empirical than excluding studies based on descriptions, or lack thereof, provided in primary studies.

The following definitions are presented to provide the reader with a common understanding of the terminology used throughout this study. The inconsistent use of terminology is a significant issue in educational research, particularly in the descriptions and examination of collaborative learning. Whenever possible, specific details of the implemented structures will be described. The terms used throughout this study are defined in Table 1.

Table 1
Terminology and Operational Definitions Used in this Study

Term	Operational Definition
Cooperative learning	A learning structure that emphasizes positive interdependence between students. Small groups of students work together toward a common goal that often includes mastery of specific content or skills. Collaborative learning is often used interchangeably with cooperative learning.
Competitive learning	A learning structure that emphasizes negative interdependence between students. Individual students or small groups of students strive to out-perform others to achieve some goal.
Individualistic learning	A learning structure that lacks any type of interdependence. All students work independently to achieve goals. The outcomes of each student have no influence on the outcomes of other students.
Achievement	Outcomes defined by study researchers that included measures such as the following: test scores on standardized assessments, final grades in an overall course, observational ratings of group process, percent correct on a teacher-developed quiz.
Peer relationships	Social outcomes that are defined by self-report of liking group members, self-perceived level of support, attitude toward classmates, and observational rating of a predetermined set of interaction skills.
Independent variable	The independent variable is synonymous with the experimental conditions manipulated by the investigator. In the case of this meta-analysis, the independent variable was the type of interdependence structures being compared. The three contrasts of experimental and control conditions examined in this study include: • Cooperation (experimental) vs. competitive (control), • Cooperation (experimental) vs. individualistic (control), • Competitive (experimental) vs. individualistic (control).
Dependent variable	The dependent variable refers to the outcomes assessed in a primary study. For this meta-analysis the dependent variables of interest include achievement and peer relationships.
Moderating variable	The term moderating variable is applied to any alternative factors that may have influenced the results and interpretation of this meta-analysis. Such moderating variables in this study include study quality, type of task, and unit of measure.

Table 1 (continued).
Terminology and Operational Definitions Used in this Study

Term	Operational Definition
Effect size	A numerical value that reflects the magnitude of a relationship between two variables. The specific type of effect size used in this study is the standardized mean difference, often referred to as the *d*-index (Glass, McGaw, & Hill, 1981). The standardized mean difference is calculated by subtracting the control group mean from the experimental mean and dividing this number by the pooled standard deviation of the two groups (Lipsey & Wilson, 2001). For this analysis all effect sizes were transformed from Cohen's *d* into Hedges's *g* to control for small sample sizes.
Study-level data/coding	Study-level coding refers to the data collection of primary study characteristics, such as publication information, participant demographics, and research methodology.
Finding-level data/coding	Data necessary for calculating effect sizes is collected from primary study data during the finding-level coding. A single study could provide several different outcome measures comparing the experimental and control structures resulting in several finding-level effect sizes per study. These finding-level effect sizes are averaged at the study-level so that a single study would contribute only one effect size for a given dependent variable and treatment contrast. A single study could yield one or more pooled effect sizes depending on the number of dependent variables and treatment conditions.

Summary

The purpose of this review is to synthesize all of the available experimental research from 1940 through 2010 that compares cooperative, competitive, and individualistic learning structures in college classrooms. Six separate meta-analyses were conducted to examine the effects of each combination of learning structures on student achievement and peer relationships. Cooperative learning is hypothesized to be superior to competitive and individualistic structures. A further purpose of this study is to analyze the various moderator variables that may influence the effectiveness of these structures.

As Finkel (2000) stated, "educational research over the past 25 years has established beyond a doubt a simple fact: what is transmitted to students through lecturing is simply not retained for any significant length of time" (p. 3). Consequently, there has been considerable interest in using cooperative learning as a productive, inclusive teaching method to improve peer relationships, master academic content, and strengthen student self-esteem. Several of the more prominent methods of cooperative learning have been thoroughly examined by educational researchers. Experiments conducted on the effectiveness of grouping structures have been conducted across a wide range of content areas, classroom settings, tasks types and student populations. Several meta-analyses have synthesized the findings of this vast collection of research.

Structure of this Paper

This paper will provide the background, methods, results, and conclusions that apply to this synthesis, each with its own chapter. Chapter 2 provides an overview of the theoretical foundations of small-group learning and the context for its use in higher education. Chapter 3 describes the methods used in this meta-analysis, including those used in searching the literature, screening articles, coding effect sizes, calculating effect sizes, and creating statistical models to examine the relationship between the variables of interest. Chapter 4 provides a description of the included research studies and the results of the quantitative synthesis. Finally, Chapter 5 discusses the contributions this study makes toward informing theory development, the implications of this study's findings on practice, the limitations of this study, and the suggestions indicated by this study for future research on small-group learning and instructional conditions in higher education.

Chapter 2

REVIEW OF THE LITERATURE

Theoretical Foundations

Field Theory

Social psychologist Kurt Lewin is credited with the development of field theory in psychology during the late 1930s and 1940s. Lewin and several of his students, including Morton Deutsch, Leon Festinger, Fritz Heider, Ronald Lippitt, and Stanley Schachter, were responsible for breaking new ground in the examination of human behavior and social motivation (Deutsch & Krauss, 1962). Lewin's field theory guided research to explore the patterns of interaction between the individual and his or her environment. Lewin also encouraged the perspective that psychological research should not only contribute to science but also be valuable for social action (O'Donnell, 2006). Although Lewin himself publishing only minimally in the area of group dynamics, his encouragement of action research and his examination of group influence on individual motivation has had a significant impact on the development of theory and methods related to group behavior.

Theory of Cooperation and Competition

Expanding on Lewin's field theory of human motivation, Morton Deutsch introduced his theory of cooperation and competition (Deutsch, 1949; Deutsch, 1962). In his now-classic papers, Deutsch described the interconnectedness between group goal structures, individuals' motivations, and likely outcomes. In addition to these two social psychological theories, behavioral learning theory also posits that group rewards and extrinsic reinforcers (such as grades) influence individual perceptions of intergroup rewards and motivations to accomplish a goal.

Social Interdependence Theory

Social interdependence exists when the outcomes of individuals' actions affect and are affected by the outcomes of the actions of other individuals (Deutsch, 1949; Deutsch, 1962; Sharan, 1990; Johnson, Johnson, & Holubec, 1998; Johnson and Johnson, F., 2009). Positive interdependence means structuring interactions between individuals in such a way that participants can only succeed if all group members succeed. The common phrase for this cooperative structure, suggested by Johnson, Johnson and Holubec (1998), states that, "all members will sink or swim together" (p. 1: 13). Accordingly, negative interdependence is structured so that a participant will only succeed if others fail: competition between individuals or teams occurs in a win-lose interaction structure (Johnson, Johnson & Holubec, 1998). Individualistic goal orientation exists when a situation lacks interdependence altogether: the outcomes of one individual's actions have no influence on the outcomes of others. Unlike negative interdependence or individualistic goal orientation, social interdependence theory emphasizes the importance of structuring relationships to support cooperative interactions between learners. Learners' goals are linked so that personal success is possible only when the group is successful in its pursuit.

Structures of interdependence determine the relationships between students and affect their actions toward one another. A competitive learning environment, for example, motivates students to work against one another. Grading on a curve or assigning grades based on a ranking of scores illustrates the negative interdependence fostered by competitive class structures and the limited number of “winners” they allow. Individualistic learning exists when there is a lack of interdependence: students' academic success does not help or hinder the progress of other classmates. In a cooperative learning environment, however, students are positively interdependent on one another and are therefore encouraged to assist one another such that one student's success positively influences the results for group members (Deutsch, 1962; Johnson & Johnson, 1989).

Several researchers support the claim that cooperative learning is effective because it increases student motivation: students are more likely to encourage their peers to succeed when their rewards are dependent on group performance. In turn, students work harder (increased achievement motivation) because of their need for social approval by peers (Courtney, Courtney, & Nicholoson, 1994; Slavin, 1983).

Social Constructivist Learning Theory

The social construction of knowledge is facilitated through purposeful discussion, collaborative arguing, and reasoning to resolve cognitive conflict. Jean Piaget considered students active participants in the learning environment and able to construct meaning through both exploration and interactions with peers. Lev Vygotsky (as cited in Johnson, Johnson, & Holubec, 1998) further proposed that knowledge is developed and understood through the active process of perspective-sharing within a social context. Vygotsky's social constructivist approach provides the framework for examining how students work together cooperatively to process new information and solve problems. It is important to note therefore that each learning group is only as valuable as the interactions that foster thoughtful discussion. Cognitive disequilibrium, caused by confronting multiple perspectives, motivates learners to grapple with conflict and develop a new conceptual understanding. Brookfield (1987) argues that facilitating critical thinking depends on individual learners challenging assumptions and exploring alternatives to current understanding, activities best facilitated in small groups.

Currently there is a great deal of scholarly debate over the merits of constructivism (Kirschner, Sweller & Clark, 2006). However, it is understood by many that the social construction of knowledge within a collaborative environment is greatly influenced by the task structure determined by the instructor (Schellens & Valcke, 2005; Springer, Stanne, Donovan, 1999; Webb, 1989). Kirschner, Sweller and Clark (2006) argue that students should not be left unguided to construct their own understanding; course materials, scripting, and instructor feedback facilitate the process of building shared knowledge. Guidance is needed to ensure interaction and integration among group members, as groups will not naturally progress through higher stages of knowledge building alone (Murphy, 2004). With such guidance, interactions with peers can allow students to negotiate shared understanding as they become members of a new knowledge community within the college environment. In essence, collaborative learning allows students a structured opportunity to internalize the knowledge available within a given domain of learning, something arguably important to all college students (Bruffee, 1995).

Theory of Student Involvement

Astin’s theory of student involvement grew out of longitudinal research on college persistence (1999). The theory of student involvement suggests that college students who are engaged in the academic community are more likely to persist in college. Students who are more involved in college life spend more of their time and energy devoted to activities that enrich the overall experience of postsecondary education. The theory of student involvement is supported by data collected by Vincent Tinto (1993) examining the aspects of the college experience that increase likelihood of completion. The principles advocated by both Astin and Tinto suggest that academic environments can nurture both the intellectual and social developmental needs of college students and lead to positive achievement and attitudinal outcomes. Cooperative learning methods may provide the necessary conditions for college students, living both on- and off-campus, to build relationships with one another and to develop a sense of ownership of their educational goals.

All three of these perspectives—social interdependence theory, social constructivist theory, and the theory of student involvement—support the effectiveness of engaging students in meaningful dialogue in an academic setting. Socially, cognitively, and developmentally, college students may benefit from cooperative learning structures.

Basic Elements of Cooperative Learning

The literature is filled with a steady stream of controversy on the use of the terms cooperative and collaborative learning, particularly in higher education. Macaulay and Gonzales (1996) view these methodologies on a continuum, with collaborative learning (unstructured) on one end and cooperative learning (highly structured) on the other. Bruffee (1995) defines collaborative learning as an adult-centered, structured learning experience in which the student has responsibility for the governance and evaluation of a group's output. Smith and MacGregor (1992) regard cooperative learning as the more structured form of collaborative learning. Although it is beyond the scope of this paper to examine the differences between these two terms, several of the more common grouping structures utilized in higher education will be explored in greater depth.

Common Small-Group Structures Used in Higher Education

Diverse faculty experiences and training coupled with distinctive domains and settings result in very different implementations of these known principles (Barr & Tagg, 1995; Weimer, 2002; Fink, 2003; Michaelsen, Knight & Fink, 2002). There are several well-developed methods for structuring group work, each with its own set of theoretical considerations and guidelines for implementation. Faculty may also borrow elements from several different models to create the conditions conducive to their specific context. The following models are among the most frequently used in higher education.

Johnson & Johnson Cooperative Learning

Cooperative learning, as suggested by Johnson & Johnson (1989), includes five basic components, including positive interdependence, individual accountability, promotive interaction, social skills training, and group processing. When implemented appropriately, each of these components helps ensure that cooperative groups will function to the maximum benefit of all students involved (Johnson, Johnson, & Holubec, 1998). The instructor in Johnson and Johnson's concept of cooperative learning maintains a significant directing role in the use of cooperative learning: assigning students to groups, organizing resources, managing time and objectives, and monitoring and assessing student productivity (Johnson, Johnson, Holubec, 1998). These guiding principles, by which a cooperative class structure is created, can be adapted to meet an instructor's needs. Overall, a combination of informal and formal cooperative learning structures, along with the use base groups are advocated for use in classrooms across all grade levels, including college (Johnson, Johnson & Smith, 1991, 1998, 2007).

Learning Communities Model

The learning-communities approach to college instruction originated in the early 1990s as many constructivist educators began to view small groups of students rather than the individual student as the unit of instruction. Influenced by the model of situated cognition presented by Lave and Wenger (1991), educators developed cohesive instructional settings in which students were encouraged to participate in communities of practice. Gabelnick, MacGregor, Matthews, and Smith (1990) suggested a model of a learning community that maximizes the integration of academic content in social dialogue among students, faculty, and staff on a regular basis. Such learning communities have been growing in popularity among U.S colleges and universities in the form of linked courses, first-year interest groups, coordinated seminars and learning clusters.

Peer-Assisted Learning

During the last ten years, Peer-Assisted Learning (PALS) programs have been instituted with increasing frequency at colleges across the country (Fields, Burke, McAllister, & Lloyd, 2007; Fuchs, Fuchs, & Kazdan, 1999). Peer tutoring and supplemental instruction both fall under this type of collaborative learning (Topping, 1996). The peer model provides the same gains in study-skill changes as the professional model; both models' gains are significantly greater than the gains of a waitlist-control condition (Fremouw & Feindler, 1978). While these strategies are generally implemented outside the primary classroom, their use within a wide variety of institutional settings make them practical and advantageous for students in need of more support.

Team-Based Learning

Larry K. Michaelsen began developing a new teaching strategy in his college courses during the late 1970s. This instructional strategy is now formally known as team-based learning (Fink, 2003). Team-based learning is different from other small group learning approaches in two distinct ways. First, team-based learning is a specific sequence of learning activities over the duration of a college course, including a preparation, application, and assessment phase. Second, team-based learning, according to Michaelsen, Knight and Fink (2002), emphasizes the importance of developing high levels of cohesiveness within student teams to maximize learning outcomes.

There are four essential principles of team-based learning: (a) Groups must be appropriately formed and managed; (b) Students must be accountable for both individual and team outcomes; (c) Class assignments and activities must promote learning and team development; (d) Students must receive frequent and timely formative feedback (Michaelsen, et al., 2002). Although less research exists on this specific strategy, team-based learning has been increasingly applied in college and professional courses in the medical and science fields during recent years (Michaelsen & Richards, 2005).

These methods represent a sampling of the wide variety of group-learning structures implemented in higher education today. There is as much variance in the implementation of these different methods as there are alternative varieties of cooperative learning available to educators. Progressive college instructors have made great efforts to utilize student collaboration to influence achievement, social climate, ease of instruction and grading, and to maximize limited resources, and/or increase success of underprepared students in their courses.

Previous Research on Cooperative Learning in Higher Education

To date, there have been several research efforts to synthesize the vast literature on the effects of cooperative learning methods. The majority of these studies examined the use of cooperative learning with elementary-age students. Others have analyzed the influence on learning in a specific domain or using a specific technique. Research consistently demonstrates that cooperative learning produces positive effects for learners of all ages, in all content areas, on a wide variety of tasks (Bossert, 1988; Cohen, 1994, Johnson & Johnson, 1989; Joyce, Showers, Rolheiser-Bennet, 1987; Slavin, 1990; Sharan & Sharan, 1992). Researchers have well-documented evidence of the positive outcomes of cooperative learning, including increased achievement, retention, reasoning, perspective taking, on-task behavior, intrinsic motivation, self-esteem, attitudes, social support, and positive adjustment (Johnson, Johnson, & Holubec, 1998).

Of primary significance in this age of educational accountability are the achievement and productivity outcomes of grouping students under different interdependent structures. Most of the studies examined for this review included achievement among the dependent variables of interest. As indicated above, a great deal of experimental research has been conducted over the past several decades comparing the effects of cooperative versus competitive and individualistic learning environments. Much of this research has shown that collaboration among students leads to increases in learning outcomes, productivity, and problem-solving abilities (Johnson & Johnson, 1989; Johnson, Johnson, & Smith, 2007; Springer, Stanne, & Donovan, 1997; Pascrarella

& Terenzini, 2005). While the results of several syntheses suggest the overarching positive effects of student collaboration, there persists a great deal of disagreement about the specific structures that lead to positive outcomes (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Slavin, 1983; Smith & Waller, 1997).

Studies have demonstrated a variety of cognitive explanations for why effective groups outperform individuals under certain learning conditions. The more prominent of these explanations suggest that groups provide opportunities for members to discuss varying perspectives through constructive argumentation (Johnson & Johnson, 2007; Smith, Johnson, & Johnson, 1984; Damon & Phelps, 1989). Research also indicates another significant aspect of successful cooperative learning: a group's ability to offer students the chance to explain their own reasoning and strategies to at least one other peer (Webb, Trooper, & Fall, 1995). Further, listening to a peer explain his or her approach also increases learning gains (Webb, 1989). Reciprocal questioning, during which students take turns responding to peer- or instructor-generated inquiries, provides a form of collaborative learning developed to maximize these learning opportunities.

Generally, by the time they enter college, students have already proved themselves as successful competitive learners: they are products of the competitive academics model. In fact, students who attend the most prestigious colleges are often those most experienced in individualized academic competition. It is therefore the college's role to provide students with the skills necessary for engaging in collaborative work. Bosworth and Hamilton (1994) present a taxonomy of skills, including interpersonal, management, inquiry, conflict resolution, and synthesis skills, that students must learn in order to be successful in collaborative group work during college.

According to Bosworth and Hamilton, the college classroom may provide the opportunity for students to acquire these abilities and progress from being novice group members to experts in collaboration, able to respond automatically to the demands of the group (Bosworth & Hamilton, 1994). The refinement of collaborative group skills is also beneficial beyond college, when individuals enter the professional workforce.

As many college students and instructors know, simply having students work together in groups does not necessarily lead to increases in learning or productivity. A lack of structure or clear goal often leads to a solidification of unreasoned collective thinking or concurrence-seeking with few learning gains. If the purpose of university education is to nurture higher order thinking skills and analytical problem solving, then some guidance is necessary to encourage students to critically examine course concepts. Scaffolding students' learning is advocated by many learning scientists (Nelson, 1994), and nowhere is such scaffolding more necessary than when young adults come together.

Researchers suggest different ways to provide adequate scaffolding to college students, but among the most essential are structuring the task and providing guidance about the process (Johnson, Johnson, Smith, 2007; Nelson, 1994, Rosenshine & Meister, 1992). Cognitive structuring includes providing students with the necessary framework, often in the form of question scripting, that facilitates greater higher level thinking than what students might automatically do when they experience the material as novices. Role structuring occurs when the instructor both provides adequate guidance about the collaborative process and also reduces any behaviors that may impede the group's functioning so that each student can actively participate (Nelson, 1994, p. 57).

There are numerous published research studies suggesting the causal mechanisms through which various interdependent classroom structures may influence student achievement outcomes, self-esteem, positive peer relationships, and liking for specific subject areas. Despite this vast collection of research on the effects of cooperative learning, there still remains disagreement on which types of cooperative learning techniques or structures lead to the greatest outcome gains (Sharan, 1990; Johnson, Maryuama, et. al, 1981; Slavin, 1983).

Chapter 3

METHODS

This study utilized a meta-analysis methodology to combine the quantitative results of primary studies identified in the existing research literature. The procedures and calculations utilized in this study are based on the recommended practices of Lipsey and Wilson (2001), Cooper and Hedges (1994), and Borenstein, Hedges, Higgins, and Rothstein (2009). This chapter describes the procedures for conducting this meta-analytic review, which consisted of the following five steps: specification of inclusion criteria, literature search and retrieval of studies, coding of study-level characteristics and outcome variables, calculation of effect sizes, and data analysis. This chapter was prepared in an effort to provide all the recommended information suggested by the Meta-Analysis Reporting Standards-MARS (American Psychological Association, 2008) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement (Moher, Liberati, Tetzlaff, Altman, 2009).

Overview of Meta-Analysis

Before Gene Glass introduced a research synthesis technique called meta-analysis in 1976, researchers used narrative literature reviews or a vote-counting method to summarize sets of research findings. Meta-analysis is a set of statistical procedures designed to integrate research findings across a number of independent studies that addressed a related set of research questions (Glass, 1976; Glass, McGaw, & Smith, 1981). Rosenthal and Rubin (1978) were among the first researchers to use what would come to be considered meta-analytic techniques when they synthesized data to examine interpersonal expectancy effects. Meta-analysis has been refined and expanded since these original methods were developed; now the term meta-analysis encompasses all the methods and techniques of quantitative research synthesis used across a wide variety of fields beyond education and psychology (Lipsey & Wilson, 2001). The primary goal of a meta-analysis is both to summarize what has been gathered from the results of other studies examining a specific set of variables and to determine, in a unified manner, what additional relationships would be valuable to explore (Rosenthal, 1998). Meta-analysis is considered a secondary research method, with its greatest potential for use in research areas that are well established and have a large number of primary studies.

Strengths of meta-analysis. There are four primary strengths of meta-analysis compared to traditional narrative research review methods. First, meta-analysis involves a structured technique of identifying relevant research and summarizing results. In the meta-analytic process, the steps are systematic and explicitly defined and thus enable, a meta-analyst's procedure to be documented and replicable (Rosenthal, 1995). Second, compared to narrative research review, which relies primarily on qualitative summaries of previous studies, meta-analysis provides a more sophisticated variety of information. Third, since meta-analysis involves an examination of quantitative data, it allows primary study results to be aggregated to examine general trends and consistencies across the pool of studies. The systematic coding of study characteristics allows a meta-analyst to investigate the relationship between study findings and study characteristics across a number of primary studies and possibly identify overall effects too subtle to identify using traditional, experimental methods. Finally, meta-analytic methods provide an organized procedure for handling information from a large number of study findings and have a potentially unlimited capacity for synthesizing a vast number of research studies (Lipsey & Wilson, 2001).

The feature that most distinguishes meta-analysis from narrative research review, however, is the use of an effect size (Abrami, Cohen, & d'Apollonia, 1988). A mean difference effect size typically represents the average differences between an experimental and control condition divided by a measure of standard deviation. By standardizing the effect sizes of individual studies, it is possible to compare and integrate these results across studies that may have been conducted in different settings or that may have used different measures of outcomes.

According to Abrami, et al. (1988), there are at least five purposes for conducting a meta-analysis: to summarize the relationships between two constructs, to identify the factors that explain variability in the relationship of interest, to suggest directions for future research, to offer new theoretical perspectives or resolve possible conflicts between opposing theories, and/or to suggest expanded applications of the research findings. As the methods of meta-analysis evolve and more sophisticated programs are developed to assist in statistical analysis, the emphasis in meta-analysis has moved beyond providing summary effects to explaining the variability in effect sizes caused by a combination of different factors.

One of the most important tasks of meta-analysis is to distinguish between variations in the estimated effects. Even if every original study produced one "true" effect size, the estimates of that effect would vary from study to study as a result of sampling errors within each study. Therefore, it becomes the task of meta-analysis to distinguish between variations caused by sampling error and those caused by "real" differences between the original studies. Using hierarchical linear modeling (HLM), meta-analysis can explain and distinguish the different sources of variance across studies in one unified model (Raudenbush & Bryk, 2002).

Cautions and possible limitations of meta-analysis. Although meta-analysis has many advantages, researchers have identified several issues that should be addressed in every meta-analysis. First is publication bias. Publication bias occurs as a result of the marked preference among peer-reviewed journals to publish studies with significant results over those studies that failed to find significant results (Cooper, DeNeve, & Charlton, 1997). Such bias in the published literature leads to a sort of “grey literature” that sits unpublished in researchers’ file drawers. Publication bias, also known as the file drawer problem, refers therefore to the tendency for studies reporting a significant result to be overrepresented in the published literature (Rosenthal, 1979, 1993, 1998).

In meta-analysis an overreliance on peer-reviewed journals or easily accessible studies can lead to inflated effect sizes (Lipsey & Wilson, 2001). Therefore, the selected studies may represent a sampling bias and not accurately reflect the actual population of studies that have been conducted. Although there are several suggested remedies to the file drawer problem, the most productive method of combating this issue is to aggressively identify and collect relevant unpublished research (Hunter & Schmidt, 1990). In this study the aggressive searching of unpublished studies (conference proceedings, unpublished research reports) was the primary prevention method. A fail-safe N was also calculated during the analysis phase of this study using the Comprehensive Meta-Analysis Software (CMA). The fail-safe N estimates the number of unpublished studies reporting non-significant results (ES=0) that would be necessary to reverse the results of a hypothesis test (Rosenthal, 1979; Orwin, 1983).

Another issue applicable to meta-analysis has been termed the problem of apples and oranges (Lipsey & Wilson, 2001). Some researchers argue that meta-analysis enables analysts to examine a combination of variables too diverse to be aggregated. The most effective remedy to avoid making fruit salad is to code precise descriptive characteristics from primary studies and to be attentive to the decisions made about summarizing effect sizes. Another possible degradation of the data occurs in the combination of low and high quality studies. Not all primary studies are conducted with the same rigor or methodological astuteness. If primary studies were conducted with poor methodologies or sloppy procedures, a meta-analysis can be confronted with a possible charge of "garbage in, garbage out." Ultimately, a meta-analysis is only as good as the data that goes into it.

Another important issue that must be addressed in a meta-analysis is the independence of primary study results. There are several probable causes of the independence problem in meta-analysis. Often in primary studies, researchers will report the outcomes of several dependent variables that are measured from the same group of participants. Another possible cause is calculating effect sizes by comparing different interventions with a single control group. Third, researchers may use the same sample to conduct a series of different studies or prepare manuscripts covering the same data resulting in non-independent results. To combat this possible bias, the meta-analyst must make deliberate decisions about how to maintain the independence of multiple effect sizes coming from one study or set of data (Rosenthal, 1993). The simplest remedy for this problem is to calculate only one effect size for each study or to keep effect sizes sharing a similar sample completely separated in the meta-analysis.

Meta-Analysis Procedure

Specification of inclusion criteria. A crucial step of a meta-analysis is establishing the selection criteria to determine which research studies will be included or excluded from further analysis. Criteria must be well defined and transparent in order to make inclusion judgments as objective as possible. Detailed inclusion criteria will increase the generalizability of meta-analysis results and strengthen the implications for theory development and future research. Prior selection of key search terms and search restrictions ensure literature searches maximize the inclusiveness of relevant literature while also maintaining efficiency.

In order to be included in this meta-analysis, eligible studies had to meet each of the criteria described below.

1. Eligible studies must be primary studies conducted with students at a community college, 4-year university, or participants in a graduate or professional program (high school students taking postsecondary-options and adults learners in a employee-sponsored professional development program were excluded). Experiments conducted outside an academic environment were included if the participants were drawn from a student population at a higher education institution.
2. Eligible studies must involve the use of at least two different interdependence structures. Therefore, all studies considered for inclusion had at least one of three comparisons: cooperative learning versus individualistic learning, cooperative

learning versus competitive learning, or competitive learning versus individualistic learning, as defined by the study's authors. Studies comparing two different cooperative learning structures were excluded from this analysis.

3. Eligible studies must report at least one achievement or peer relationship outcome. Student learning is defined as a student's development that the institution either does influence or attempts to influence through its educational programs and practices (Astin, 1999). Outcomes related to peer relationships measured such aspects as students' self-assessment of social skills, liking for group members, self-rating of support received from peers, and willingness to work again with a partner. At the initial stages of study screening, all measures of achievement and perceived peer relationships were included.
4. Eligible studies must use an experimental/control group design to measure the effects of interdependence on outcomes. Pre-post experiments lacking an independent control condition were excluded from further analysis because of the threat they pose to artificially inflating the effect sizes due to smaller variance than two group comparisons (Lipsey & Wilson, 2001).
5. Eligible studies must report sufficient information to either directly calculate effect size or indirectly estimate effect size. The necessary data are sample sizes, means, and standard deviations for both experimental and control group, or *t*-value, *F*-ratio, Chi-square, or significance level. Studies reporting only qualitative or narrative data were excluded in this study.
6. Eligible studies must be written or presented in English, though qualifying studies conducted in other languages and translated into English were considered eligible.

Each primary study identified in the existing literature was advanced to the next level of scanning and coding and then through to analysis unless it was found to be ineligible, at which point it was excluded from further analysis. Each study excluded from further analysis was labeled with its first-identified exclusion reason code from the following list:

- No quantitative data available
- Cooperative learning not variable of interest
- Insufficient data to calculate ES
- Population not of interest
- Compares two cooperative learning structures
- No control condition
- Non-experimental methods
- Can not locate copy
- Duplicate record
- Unable to isolate cooperative learning variable
- Meta-analysis
- Not available in English

Identification of and Search for Relevant Studies

Pre-existing database of research. As a basis for this review, the database initiated and maintained by David and Roger Johnson (1989, 2005, 2007) was searched for relevant studies and expanded upon using similar comprehensive search protocol and data collection. This cooperative learning archival database of studies and effect sizes was established in 1977 and now includes more than 1,000 studies spanning all age groups and subject areas. Existing records that met the aforementioned inclusion criteria were included in this study.

Literature search. Using/exploiting the convenience of electronic databases and sophisticated search engines, the current study included a comprehensive search of all existing research literature to identify any published or unpublished studies that may have been unavailable during previous searches and to identify studies conducted since the most recent additions to the archival database. Every reasonable effort was made to identify and code all research findings that met the current inclusion criteria for this meta-analysis database through March 2010. The initial search of research literature was performed with the intent of being over-inclusive to increase the likelihood of identifying all relevant studies. Duplicate studies and previously coded studies were later identified and removed. Comprehensive search strategies, suggested by White (1994), were employed to identify studies for inclusion in this meta-analysis: electronic database search, manual scanning of relevant resources and reference lists, and consultation with researchers in the field.

Electronic database searches. The first and arguably most effective search method was a comprehensive search of the literature using PsycINFO (1887-2009), ERIC, EBSCOhost (Academic Search), and ProQuest Dissertation and Theses databases. These electronic database searches were performed using a combination of keywords: cooperative learning, collaborative learning, peer tutoring, peer teaching, small group teaching, team learning, and team-based learning. The results of these preliminary searches were refined by adding additional selection criteria, including English language, human population, and education-level characteristics covering high school, postsecondary education, graduate and professional education, and adult learning. The citation and abstract for each study identified through these search conditions were exported from the electronic databases into RefWorks, a bibliographical software program.

Manual searches of existing literature. The second search method was performed continuously throughout the coding process by examining the reference lists of relevant articles and the additional bibliographies uncovered during the coding. This "ancestry approach" identified additional primary studies that were then evaluated for inclusion in the meta-analysis (White, 1994). Prior meta-analytic reviews conducted on a subset of the participant population or with a specific outcome (science achievement, online instruction) were also reviewed to identify any additions to this analysis (Lou, Abrami, & d'Apollonia, 2001; Romero, 2009; Springer, Stanne, & Donovan, 1997).

The third method used for identifying relevant studies consisted in browsing the table of contents of relevant journals, including *Educational Researcher*, *Psychological Bulletin*, *Journal of Computer-Supported Collaborative Learning*, and *Journal of Educational Psychology* from January 1990 through May 2010. An Internet search, using Google Scholar, was performed on each of the aforementioned keywords to identify potentially unpublished research or reports available from university and research organization websites. Currently available conference programs for the Association for Psychological Science (APS), the American Educational Research Association (AERA), and the Computer-Supported Collaborative Learning (CSCL) International Conference were also scanned for relevant studies.

Consultation with researchers. As recommended by White (1994), the fourth search method employed for this meta-analysis was consultation. Although somewhat informally instigated, this method involved conversations with researchers in the field, email exchanges with authors and students, postings to special interest group listservs, and requests for papers presented at conferences or referenced elsewhere. Despite the diminishing returns of these various methods, the goal of approximating a near census of the relevant literature motivated the process. The primary researcher of this meta-analysis did not maintain a dynamic count of studies located through the manual search methods, but estimates that approximately 35-40 additional studies were identified for study-level screening.

Abstract screening and data set reduction. All records identified through the electronic literature searches were aggregated using the RefWorks aggregator, available through the University of Minnesota library, and a complete list of citations and abstracts for the identified studies was compiled in Excel for ease of record management. Duplicate studies and those previously coded for the cooperative learning meta-analysis database were identified, and records containing the most extensive information were maintained. When the same study was reported in different formats, such as conference presentation and dissertation, the manuscript providing the most quantitative data was retained for further screening. The abstract screening process was completed by reviewing each abstract, applying the inclusion criteria, and determining if a study should be excluded or included for further examination. At this beginning stage of the process, the intent was to be over-inclusive by retaining any study that was not clearly outside the inclusion criteria on the basis of the abstract. Next, filtering was performed to determine which studies would be retrieved for complete study and effect size coding. A full-text screening was performed once the manuscripts were identified and retrieved.

Study retrieval and full-text screening. The next step in the data collection process was to retrieve the full text of studies that remained after the abstract coding process. Many of the studies that were appropriate for full-text coding were available through online research journal archives. Articles and reports were saved in electronic form for coding and archiving purposes. Those publications (reports and books) that were not available electronically were requested from the University libraries or inter-library loan from partnering institutions. Doctoral dissertations that were not available through Digital Dissertations were requested from the degree-granting institution where the thesis was completed.

Coding study characteristics. In order to systematically collect the desired information from each retrieved study, a coding rubric and form was used to extract study-level characteristics and outcome data. A separate form was used to calculate effect sizes for each comparison in a study. Trained raters utilized the coding guidelines originally developed by David and Roger Johnson and recently refined by Roseth, Johnson, Johnson, and Fang (2008). Minor modifications were made to distinguish unique characteristics of studies conducted with college- and graduate-level participants. (A complete study coding manual is included in Appendix A.) A study-level coding form was used to record all of the necessary information from the primary studies (See Appendix B for a copy of the study-level coding form.) Coded study characteristics included the following: report characteristics, research design, participant descriptions, and learning structures. Following is a brief summary of each of these coding categories:

***Report characteristics*.**

- Complete reference
- Year of publication
- Type of publication

Research design.

- Sample size
- Duration of study
- Types of interaction data examined
- Comparison structures (e.g. cooperative vs. competitive)
- Random assignment versus non-random assignment of participants
- Pure versus mixed treatment conditions
- Integrity check of condition implementation
- Consistency of curriculum across conditions
- Teacher consistent versus different teachers in each condition

Participant demographics.

- Gender composition
- Age of participants
- Ethnic composition
- Ethnic classification
- Group composition of cognitive abilities
- Cognitive ability levels
- Economic status
- Country where study took place

Learning conditions.

- Group size
- Division of labor
- Type of task
- Output quality or quantity
- Response type
- Type of setting
- Subject of study
- Reward type
- Intragroup structure
- Intergroup structure
- Type of cooperative structure

Defining outcome variables. Achievement outcomes were measured in a variety of forms, including standardized tests, teacher-created quizzes, and products. Primary studies that provided sufficient quantitative data on some measure of achievement were included in the meta-analysis. The meta-analyst in this study did not make a judgment on the appropriateness of specific measurement instruments or outcome indicators provided by primary study authors. This decision not to add a validity filter on outcomes measures may influence the findings of this analysis, but it was done in an effort to reduce the possible bias presented by study coders.

Unit of measure. The unit of measure variable indicates whether the outcome was measured at the group or individual level. In some studies, students would work together to complete an exam or other assessment after working together to learn the material cooperatively—this condition was classified as measuring at the group level. Studies for which the unit of measure was the individual required students to complete the outcome measure independently after the cooperative learning activity was completed. This is a crucial distinction because individual student scores could not be disaggregated from the group performance when a group-level unit of measure was reported in a primary study. Only when the individual was used as the unit of measure could the meta-analysis compare individual student effects between the cooperative and competitive or individualistic learning structures.

Study quality classification. An assessment of methodological quality was determined for each study included in the meta-analysis. Cook and Campbell (1979) outlined the importance of differentiating a study's internal validity, external validity, generalizability of the study results, and reproducibility of the methods. They suggest assigning a score to each study for its methodological adequacy. To maintain historical consistency, the calculation of the quality variable was the same as that used by Johnson and Johnson (1989), Stanne (1996), Roseth, Johnson and Johnson (2007). This trichotomous index of study quality is a composite of the condition check, control condition, teacher effect, curriculum, and random assignment variables.

Effect size extraction. In addition to these study characteristics, quantitative data necessary for calculating effect sizes were also collected for each dependent variable in each study. To ensure that the assumption of independence of observations among the included cases was not violated, several decision rules were used during the coding process. First, independent samples contained within the same article were treated as independent cases (e.g., females and males). Second, different dependent variables (achievement and peer relationships) collected from the same sample were not considered independent and were therefore coded separately and not pooled in the analysis. Third, when multiple outcome measures were collected for one independent variable using the same subjects, an effect size was computed for each measure, and a single mean effect size was included for further analysis. When a representative composite score was provided in addition to sub-section data, only the summary score effect size was included in the aggregation across studies. Finally, when multiple comparisons between two or more levels of the independent variable were provided in a single study, then all possible pairs of comparisons were computed separately and analyzed separately to maintain independence.

Several additional variables related to the effect size data were coded for later consideration and analysis. Appendix C provides the protocol for coding effect size data, and Appendix D presents the effect size data collection form.

Reliability of coding and calculations. Extensive training was provided to the research assistants who coded study-level variables and collected effect size data. All research assistants were graduate students pursuing a master's degree or doctorate in educational psychology. During the initial training stage, research assistants met at least once a week to review coding issues, answer questions, and refine coding protocols. Differences in coding decisions were resolved by consensus. To ensure reliability in the coding protocol, studies were independently coded by a minimum of two research assistants until the percentage of intercoder reliability exceeded 95%. To ensure the consistency of the primary coder and estimate the potential influence of coder drift, every seventh study coded at the study level was identified for recoding again one to three weeks later. Any inconsistencies identified among the categorical variables were re-examined using the original study source; consultation with a second reviewer was utilized when needed. The data extracted from primary studies and the calculation of individual effect sizes were recorded by hand on the effect size coding form for ease of later verification. Any discrepancies in the re-calculation of the data were resolved by examining the original data provided in the study and retracing the calculation steps. All reliability checks were completed before entering a study's effect size calculations into the database.

Statistical Analysis

This study performed its meta-analyses with the effect size metric (Rosenthal, 1991) and a random effects model (Raudenbush, 1994). The first criterion to consider when selecting a random or fixed effects analysis is the number of primary studies included in each analysis (Schmidt, 2008). A random effects analysis is not appropriate when the number of primary studies is small because the smaller number provides insufficient information to model random, between-study variability. The second criterion a researcher must consider is the expected variability within the hypothetical population from which the sample of studies is drawn. Since the studies included in this analysis vary in many ways (e.g., research design, length of intervention, quality of measures), it was not meaningful to treat them as if they all came from the exact same population. Therefore, in the present study, a random effects model was utilized for each meta-analysis with greater than six independent studies.

Because they were formulated using a random effects model instead of a fixed effects model, the results of this meta-analysis are more accurate (Hedges & Vevea, 1998; Hunter & Schmidt, 2000). A fixed effects model results in an inappropriately narrow confidence interval around the estimated average effect size, and all significance tests are vulnerable to Type I error biases. A fixed effects model assumes that the same population effect size underlies all study effects. The variance between effect sizes in the population is assumed to equal zero. Unlike a fixed effects model, the random effects model assumes that there is real variability across the effect sizes and that the variance of the population effect sizes is equal to or greater than zero (Borenstein, et. al., 2009). Using the random effects model, this variability can be estimated and incorporated into the model.

Calculation of effect sizes. After all study-level data was collected and individual study data was extracted, basic calculations of effect sizes were computed using the appropriate formulas suggested by Lipsey & Wilson (2001), Rosenthal (1991), and Borenstein, et. al. (2009). Effect sizes were calculated such that a positive sign indicates that the experimental group outperformed the control group, while a negative sign means the control group outperformed the experimental group. For primary studies that provided means, standard deviations, and sample sizes for each group, g_j was calculated using the equation (3-4). When this data was not provided in the primary study, effect sizes were calculated from *t*-values, *F*-ratios, and *p*-values using an effect size calculation spreadsheet called ES-CALCULATOR developed by Wilson (2008), following the recommended formulas provided by Lipsey and Wilson (2001).

In this meta-analysis, a standardized mean difference was calculated as the index of effect size. This effect can be described as the difference in outcomes between the experimental and control groups. For each outcome and comparison of interest, a standardized mean difference was computed by subtracting the mean of the control group from the mean of the experimental group divided by the pooled standard deviation, such that:

$$d_j = (\bar{Y}_{E_j} - \bar{Y}_{C_j})/S_j \qquad (3\text{-}1)$$

where:

$\bar{Y}_{E_j}$ = experimental group mean,

$\bar{Y}_{C_j}$ = control group mean,

S_j = pooled, within group standard deviation.

To calculate the pooled, within group standard deviation the following formula was used:

$$S_j = \sqrt{\frac{(n_{E_j}-1)s_{E_j}^2+(n_{C_j}-1)s_{C_j}^2}{n_{E_j}+n_{C_j}-2}} \qquad (3\text{-}2)$$

where:

n_{E_j} = number of subjects in experimental group,

n_{C_j} = number of subjects in control group,

$s_{E_j}^2$ = variance of experimental group,

$s_{C_j}^2$ = variance of control group.

The standardized mean difference has been shown in the literature to contain an upward bias, particularly when sample sizes are small ($n < 20$), so Hedges's conversion factor is applied (Hedges, 1981). In order to convert d_j to Hedges's unbiased estimator g_j, a correction factor called J is used, such that:

$$J = 1 - \frac{3}{4df-1} \qquad (3\text{-}3)$$

where:

df = degrees of freedom used to estimate S_j, or $n_{E_j} + n_{C_j}$-2.

Then,

$$g_j = J \times d_j \tag{3-4}$$

where:

g_j= unbiased effect size estimate of d_j.

Maintaining independence of effect sizes. Many of the studies included in this meta-analysis included multiple effect sizes. Non-independence of effect sizes occurs when the same subjects are repeatedly measured for the same outcome or when the comparison conditions used to calculate effect sizes overlap within a study (Matt & Cook, 1994). For example, a study that compared cooperative, competitive, and individualistic learning structures would provide three different comparison effect sizes, (cl vs. comp, cl vs. ind, and comp vs. ind). Because of the overlap in the subjects used to calculate these three effect sizes, it would be inappropriate to combine them. Meta-analysts (Lipsey & Wilson, 2001; Rosenthal, 1991) have provided several strategies for dealing with this issue of independence. In this meta-analysis, the following steps were taken to maintain independence of effect sizes. First, findings for each outcome were separately analyzed; in other words, summary effects for achievement were examined separately from summary effects for peer relationships. A single aggregated average effect size was calculated when multiple effect sizes in a primary study were provided by the same subjects for the same outcome and the same comparison of conditions (Shadish & Haddock, 1994). Each comparison of two interdependence structures (ex. cooperative versus individualistic) was analyzed separately, leading to three meta-analyses for each outcome.

Aggregating effect sizes across studies. When calculating the weighted mean effect size, g_j, and its corresponding variance, V, each independent effect size was assigned a weight based on its sample size. Studies with larger samples sizes produce results with less sampling error and provide more precise estimates of the true effect. The SE of each Hedges's g_{u_j} was calculated using the formula:

$$SE = \sqrt{\frac{n_{E_j}+n_{c_j}}{n_{E_j}*n_{c_j}} + \frac{g_j^2}{2(n_{E_j}+n_{c_j})}} \quad (3\text{-}5)$$

where:

n_{E_j} = experimental group sample size of the j^{th} study,

n_{c_j} = control group sample size of the j^{th} study.

Then, each study effect size was weighted by the inverse of its variance because the standard error (SE) is a direct estimate of the precision of the effect size:

$$\omega_j = \frac{1}{SE_j^2} \quad (3\text{-}6)$$

where:

ω_j = calculated weight of study j,

SE_j = standard error of the ES for study j.

The estimated population effect size mean, g, is the summation of each individual effect size weighted by the inverse of its variance, such that:

$$g = \frac{\Sigma(\omega_j * g_j)}{\Sigma\omega_j}. \quad (3\text{-}7)$$

The precision of each average mean effect estimate was determined by using the estimated SE of the mean to calculate the 95% confidence interval (CI) using the following formulas:

$$SE = \sqrt{\frac{1}{\Sigma\omega}} \tag{3-8}$$

and,

$$\text{Lower limit of } 95\%\ CI = g - 1.96 * SE \tag{3-9}$$

$$\text{Upper limit of } 95\%\ CI = g + 1.96 * SE.$$

Next, the data was exported from SPSS and imported into hierarchal linear modeling (HLM6) software developed by Raudenbush, Bryk, & Congdon, 2005. The HLM6 program generates two different variance-known models: a within-study model and a between-studies model (Raudenbush and Bryk, 2002). An unconditional mixed-effects model using restricted maximum likelihood estimation was fitted to estimate the overall mean effect sizes and the variability in effect sizes. The unconditional (within-studies) model is as follows

$$g_{u_j} = \delta_j + e_j \tag{3-10}$$

where:

g_{u_j} is the standard mean difference for the *jth* study,

δ_j is the true effect size of g_{u_i} across all studies, and

e_j is the sampling error associated with g_{u_i} as an estimate of δ_j.

The conditional (between-studies) model is represented by

$$\delta_j = \gamma_0 + \textstyle\sum_s \gamma_s W_{sj} + u_j, \tag{3-11}$$

where W_{sj} are study characteristics predicting δ_j; γ_0 is the overall effect size across studies; and u_j is a level-2 random error for which it is assumed that u_j is normally distributed with a mean of zero and a variance of τ.

Combining these level-1 and level-2 models, it follows:

$$g_{u_j} = \gamma_0 + \sum_s \gamma_s W_{sj} + u_j + e_j. \quad (3\text{-}12)$$

Test of heterogeneity. The variability of studies in any meta-analysis is the result of two types of study variability. Within-study variability refers to the variability that results from sampling error and from differences between subjects that may not have been accounted for or measured in the primary study, and for which the meta-analyst does not have a good indication. Between-study variability refers to evidence of the influence of various characteristics that differ from study to study, such as study quality, type of learning task, and unit of measure. The chi-square statistic (x^2) is a measure of this between-study variability; a significant x^2 indicates a significant amount of variance between studies that cannot be accounted for by chance alone.

Following the implementation of a mixed-effects model, the heterogeneity of the population effect size distribution was estimated to determine the extent to which observed variation was not explainable by sampling error alone. HLM6 software was used to calculate the chi-square statistic and related variability statistics. Calculating the variance from the conditional analysis indicates the residual variance after sampling error and level-2 variables are controlled for in the model. The difference between τ from the unconditional and conditional models represents the amount of variance explained by the included variable.

Moderator and subgroup analyses. Once the mean and variance were calculated, the next step in the mixed-effects analysis was to perform the conditional analysis that would include study variables presumed to be significant sources of variation (unit of measure, task type, and quality of study methods). A series of moderator analyses were conducted in HLM6 to fit a conditional model for each comparison with each outcome. A mixed-effects model was utilized for these moderator analyses to model within-group variation. A between-group heterogeneity statistic was computed to test for statistical differences in the weighted mean effect sizes for various subsets of the effects. Due to the extremely small sample size ($n = 2$) of the competitive vs. individualistic comparison for peer relationships, the between-study variance was not estimated for this conditional model.

Chapter 4

RESULTS

The purpose of this study was to determine the effects of interdependence structure on achievement and peer relationships in the postsecondary learning environment. To answer the proposed research questions and keep the scope of this research manageable, not all of the variables from the coding schema were used in meta-analyses. These additional variables do provide value to this research in their ability to characterize the research literature in this area. Meta-analysis was used to calculate the overall effects and examine possible moderators of the relationships between interdependence structure and achievement and peer relationship outcomes. This chapter begins with a descriptive overview of the literature search process and descriptive information for the studies included in this meta-analysis. It then continues with a presentation of the results of the unconditional and conditional models for achievement and for peer relationships. It ends with an examination of moderators as part of the model to determine if differential effects were apparent based on particular study characteristics.

Outcomes of Literature Search for Relevant Studies

A detailed search of the online ERIC and PsycINFO databases identified 4,671 manuscripts; an additional 51 studies were located through scanning journal indexes, attending conference presentations, and contacting relevant listservs and researchers in the field. These citations were cross-referenced with the existing database to reduce the amount of duplicate coding. The steps of the coding process and number of studies examined at each stage are detailed in Figure 1.

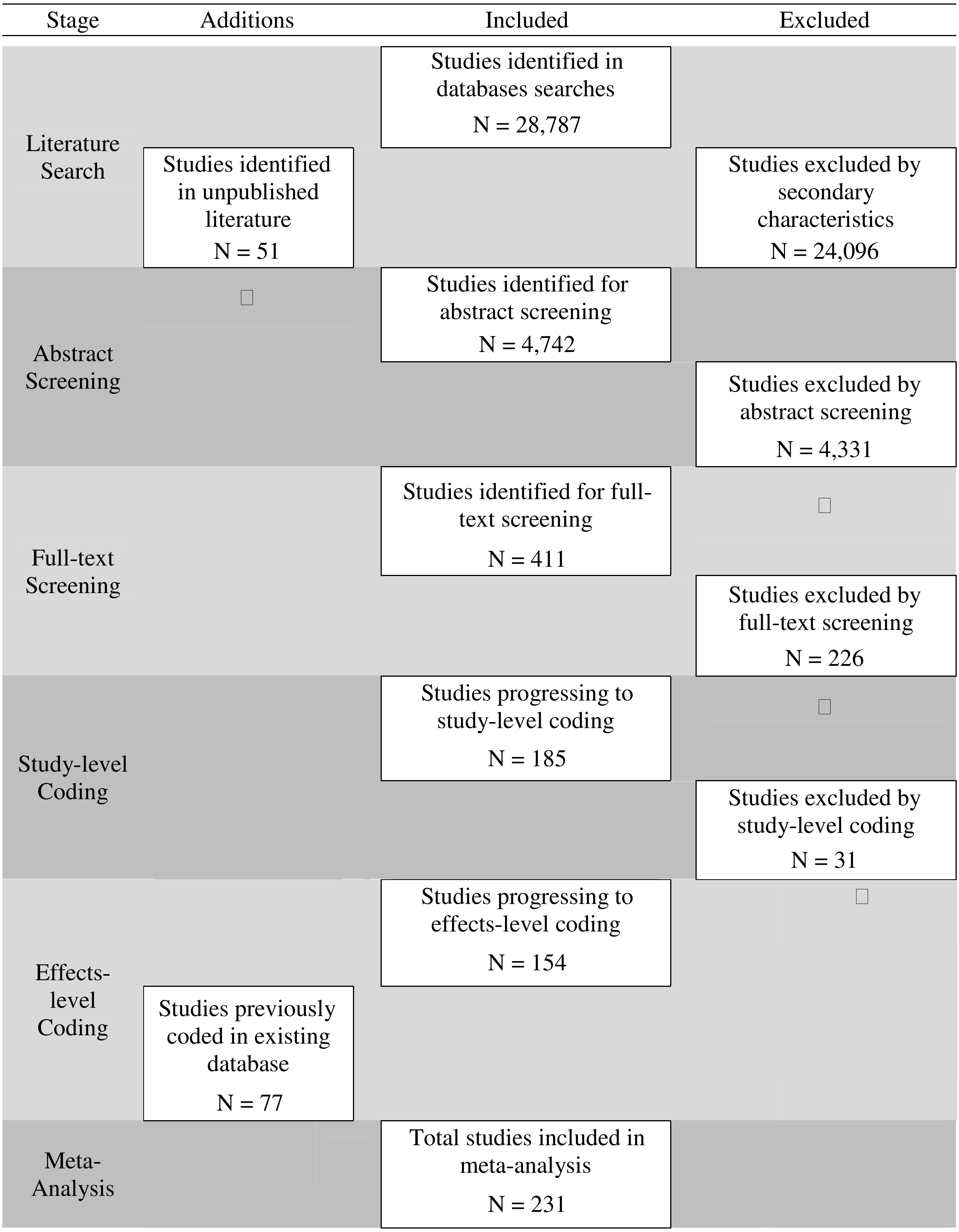

Figure 1. Number of studies included and excluded at each stage of coding

A total of 4,742 manuscripts were screened at the abstract-level, with 411 studies filtering through to the full-text screening. Of these studies, 185 had at least one comparison between cooperative, competitive, and individualistic learning and presented outcomes for achievement and/or peer relationships. This updated search of the research literature, combined with 77 qualified studies from the Johnsons' database resulted in the inclusion of 231 unique studies in this quantitative analysis (approximately 5% of the original number of manuscripts identified in the search of existing research).

Following the recommended practices for meta-analyses, all studies excluded during the screening and coding process were coded with an exclusion reason (Wortman, 1994; Higgins & Green, 2008). A summary of the exclusion codes and their prevalence in this meta-analysis list can be found in Table 2. The primary reason most studies were excluded from further coding was a complete absence of quantitative data (40%), an additional 14% were excluded because they lacked the necessary data/statistics to calculate effect sizes. Twenty-one percent of the excluded studies involved group learning but did not examine the learning structure as the independent variable of interest. There were approximately 96 studies that could not be located despite all reasonable efforts (reasons for these exclusions include original copies lost by the library, missing pages from microfiche, and invalid IP addresses for online publications). This concern will be addressed in further detail in the Limitations section of the Discussion chapter.

Table 2
Number of Studies Excluded from Meta-Analysis with Reasons for Exclusion (N = 4,588)

Exclusion Reason	Number of Studies	Percent of Total
No quantitative data available	1,831	39.9%
CL not variable of interest	949	20.7%
Insufficient data to calculate ES	647	14.1%
Population not of interest	359	7.8%
Compares two cooperative structures	288	6.3%
No control condition	191	4.2%
Non-experimental methods	167	3.6%
Can not locate copy	96	2.1%
Duplicate record	27	0.6%
Unable to isolate CL variable	19	0.4%
Meta-analysis	11	0.2%
Not available in English	3	0.1%
Total studies excluded	*4,588*	*100%*

Descriptive Analysis of Studies Included in the Meta-Analysis

Study characteristics. After final effect-level coding was completed, a total of 231 studies, yielding 939 effect sizes, were included in this meta-analysis. Table 3 presents descriptive results of study characteristics. More than half of the included studies were conducted after 1990, with one study stretching back to the 1940s. Whereas 77% of the included studies came from peer-reviewed journal articles, approximately 19% were presented in an unpublished format, including 40 dissertations and theses. As a likely result of the English-language requirement for inclusion, 84% of studies were conducted in North America, followed by 10% from Europe. Sixty-seven percent of studies took place in an academic setting, while 31% were conducted in a lab environment.

Learner demographics. This collected literature represents 37,422 study participants who were students enrolled in undergraduate, graduate, or professional programs. Table 4 reports demographic data of study participants represented in this meta-analysis. While graduate and professional students were represented in this analysis, 93% of the studies involved undergraduate students. Only 54 studies provided ethnicity data on participants: 77% of studies did not report this information. The majority of studies did not report ethnic, socioeconomic, or ability characteristics of their study participants, so those factors were not used in further analysis. Of the studies reporting data on the composition of learning groups, the majority organized participants heterogeneously by ethnicity, gender, and ability.

Table 3
Characteristics of Primary Studies Included in Meta-Analysis (N = 231)

	Descriptors	Overall N	Overall %
Year of Publication			
	1940 - 1949	1	0%
	1950 - 1959	4	2%
	1960 - 1969	12	5%
	1970 - 1979	22	10%
	1980 - 1989	58	25%
	1990 - 1999	69	30%
	2000 - 2009	58	25%
	2010	7	3%
Study Source			
	Book	8	3%
	Journal article	178	77%
	Thesis/Dissertation	40	17%
	Technical report	3	1%
	Unpublished	2	1%
Global Region			
	Africa	2	1%
	Asia	6	3%
	Middle East	1	>1%
	North America	194	84%
	Oceania	4	2%
	South America	1	>1%
	European Union	23	10%
Study Setting			
	Lab	72	31%
	Unspecified academic setting	34	15%
	Intact classroom	120	52%

Table 4
Summary Descriptives: Participant Demographics

	Descriptors	Overall	
		N	%
Age group			
	College	213	92%
	College and Graduate	3	1%
	Graduate and Professional	15	6%
Ethnicity			
	American Indian	2	1%
	Asian	5	2%
	Middle Eastern	6	3%
	Hispanic	3	1%
	White	16	7%
	More than one ethnicity represented	22	10%
	Unknown	177	77%
Ethnic composition			
	Heterogeneous	28	12%
	Homogeneous	33	14%
	Unknown	170	74%
Gender composition			
	Female majority	28	12%
	Male majority	18	8%
	Homogeneous groups	25	11%
	Heterogeneous group	123	53%
	Unknown	37	16%
Ability composition			
	Homogeneous	20	9%
	Heterogeneous	32	14%
	Groups varied	13	6%
	Unknown	166	72%

Learning conditions. Learning conditions utilized in the primary studies are described in Table 5. Thirty-three percent of studies examined an intervention that only lasted for one session, while 19% of studies used grouping structures that lasted for more than 20 learning sessions. The size of learning groups varied from two to six members, with an average of three members. The primary type of incentive offered to study participants was symbolic, predominantly in the form of a grade, test score, or point total. Of the specific grouping methods provided in the studies, Johnson and Johnson's methodology was the most frequently named, appearing in 12% of studies. More than half of studies included in this meta-analysis examined learning outcomes related to concept attainment, while only 19% focused on problem solving tasks. Studies of the interdependence structures have been performed in many academic subject areas: approximately 28% of studies are from the math and science domain, and 36% of studies were conducted using content in psychology or education.

Research design and quality. One result of using rigorous inclusion criteria for this meta-analysis was the overall robust quality of research represented in the sample. Forty-five percent of studies randomly assigned participants to conditions at the individual level. Nearly 90% of studies ensured curriculum consistency across comparison conditions, and 57% of studies included a condition check to ensure treatment fidelity. Using the quality rating assessment described in the methods section, 28% and 38% of studies scored in the low- and high-quality groups respectively. Descriptive information on study research design is included in Table 6.

Table 5
Descriptive Characteristics of Studies Included in Meta-Analysis

Descriptors	Overall	
	N	%
Length of intervention (number of sessions)		
1 session	76	33%
2 – 10	83	36%
11 – 20	30	13%
21 – 30	13	6%
31 – 40	13	6%
Greater than 41	16	7%
Size of group		
2	87	38%
3	34	15%
4	50	22%
5	29	13%
Greater than 6	14	6%
Unknown	17	7%
Division of labor		
Divisible	61	26%
Unitary	114	49%
Unknown	56	24%
Group response type		
Additive	137	59%
Conjunctive	1	0.4%
Discretionary	43	19%
Disjunctive	6	3%
Unknown	44	19%
Type of Incentive		
Symbolic	105	45%
Tangible	36	16%
Verbal feedback	17	7%
Unknown	73	32%

Table 5 (continued)

Descriptive Characteristics of Studies Included in Meta-Analysis

Descriptors	Overall N	Overall %
Cooperative method used		
Jigsaw	10	4%
Johnson & Johnson	28	12%
Mixed methods	5	2%
PALS/Supplemental instruction	6	3%
Peer tutoring	4	2%
Reciprocal teaching	12	5%
STAD	7	3%
Other methods	64	28%
Unspecified collaborative learning	94	41%
Type of task		
Analytical problem solving (H)	29	13%
Categorization (H)	2	1%
Composition (H)	10	4%
Concept attainment (L)	119	52%
Guessing/judging/predicting (H)	7	3%
Motor activity (L)	7	3%
Other (H/L)	12	5%
Retention/memory (L)	16	7%
Spatial problem solving (H)	3	1%
Verbal problem solving (H)	11	5%
Unknown (H/L)	13	6%
Subject		
Computer Science	12	5%
Education	21	9%
History	3	1%
Math	15	6%
Other	38	16%
Physical Education	4	2%
Psychology	62	27%
Reading	26	11%
Science	39	17%
Writing/Composition	5	2%
Unknown	6	3%

Note. Task type was identified as high (H) or low (L).

Table 6
Research Design Descriptives for Included Studies

Descriptors		Overall N	Overall %
Unit of Measurement			
	As a group	28	12%
	Individually	203	88%
Type of Outcome Measure			
	Actual measure	19	8%
	Self-Report	44	19%
	Standardized assessment	31	13%
	Teacher-assessed performance assessment	38	16%
	Teacher-made assessment	94	41%
	Textbook assessment	5	2%
Condition Check			
	No (L)	99	43%
	Yes (H)	132	57%
Curriculum Consistency			
	Not the same (L)	26	11%
	Same (H)	205	89%
Purity of Conditions			
	Mixed (L)	108	47%
	Pure (H)	123	53%
Teacher Consistency			
	Differed (L)	76	33%
	Rotated (H)	10	4%
	Experimenter/Teacher (H)	145	63%
Assignment to Conditions			
	Not random	69	30%
	Random by individual	103	45%
	Random by group, unit was individual	46	20%
	Random by group, unit was group	13	6%
Overall Research Quality Rating			
	Low (L)	64	28%
	Moderate (M)	80	35%
	High (H)	87	38%

Effect Size Contrasts

From the group of included studies, a total of 939 effect sizes were calculated with an aggregated total of 265 independent effect sizes. The comparison between cooperative structures and individualistic learning structures was by far the most frequently examined comparison in this pool of research which included 187 independent effect sizes for achievement and 21 examining peer relationships. The quantities of gathered and aggregated effect sizes for each dependent variable and comparison condition are provided in Table 7.

Table 7
Included Effect Size Counts by Structure Comparison and Dependent Variable

	Number of Non-Independent Effect Sizes	Number of Independent Effect Sizes
Achievement		
Cooperative vs. Individualistic	622	187
Cooperative vs. Competitive	87	27
Competitive vs. Individualistic	20	7
Total	**729**	**221**
Peer Relationships		
Cooperative vs. Individualistic	56	21
Cooperative vs. Competitive	146	21
Competitive vs. Individualistic	8	2
Total	**210**	**44**
Total number of effect sizes	**939**	**265**

Examination of Outliers and Publication Bias

The first step of the effect size analysis was the identification of potential outliers. The set of effect sizes comparing cooperative and individualistic effects on achievement warranted a closer examination of suspected outliers. Among 178 independent effect sizes in this set, three potential outliers were found, two larger than +2 *SD* and one effect size less than -2.0 *SD*. Table 8 includes the identified potential outliers and the decisions for removal. Figure 2 visually displays the overall spread of these effect sizes before and after the adjustment of extreme outliers.

Table 8
Potential Outliers and Rationale for Handling Decisions

Effect Size Identifier	Approach for Handling Outlier	Rationale for Selected Approach
110	Winsorized	This high quality study that lasted for 90 days was considered valuable, but possibly biased due to very small sample size (n = 8).
432	Excluded	This very low quality study that utilized group consensus as the cooperative learning method was not deemed reliable enough to include in further analysis.
378	Excluded	This study was removed from further analysis. Upon closer examination of the original study it was determined that the achievement outcomes were measured as pre-post, within individuals (no control group).

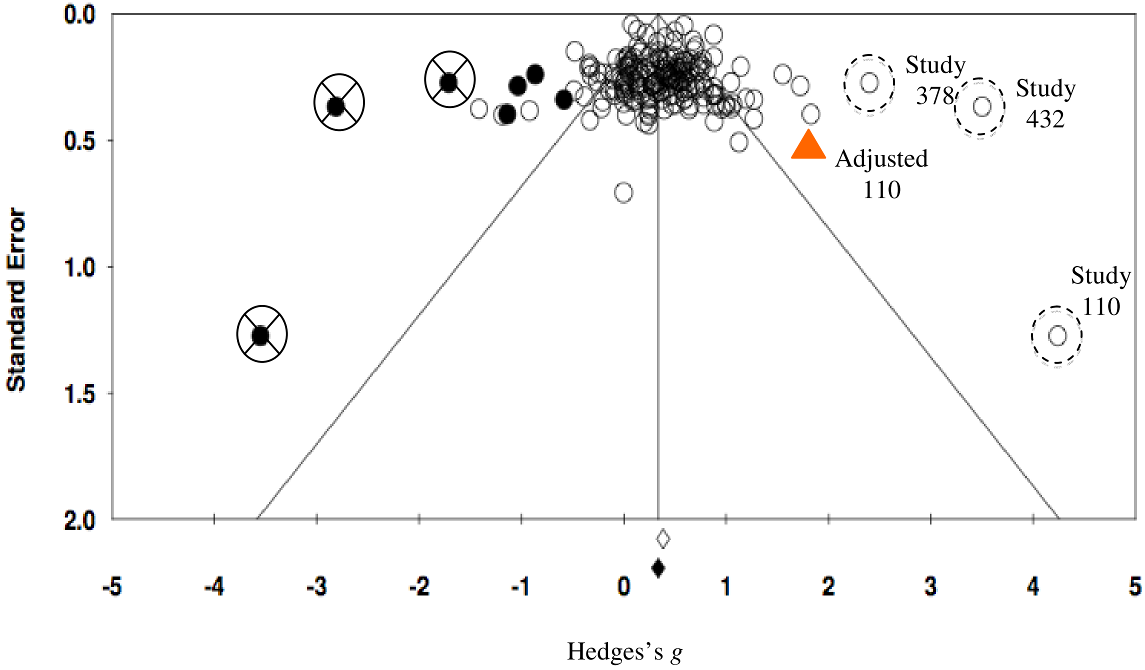

Figure 2. Funnel plot of all effect sizes for cooperative vs. individualistic effects on achievement.

Open circles represent effect sizes in this analysis; filled circles represent hypothetical studies that would have appeared in the literature if there was no publication bias; dashed circles indicate outliers removed or adjusted; circles with an X represent those hypothetical studies that would no longer be necessary with the adjustment of outliers; the triangle represents the winsorized effect size included in the analysis.

The distribution of effect sizes was then examined for four of the six meta-analyses with sufficient sample size ($j > 20$). Visual representation of these effect size distributions is provided in Figures 3, 4, 5, and 6. In three of these four data sets, the distributions of weighted effect sizes revealed no skewness. The exception was the positively skewed distribution for the comparison of cooperative versus competitive structures for peer relationships (Figure 6).

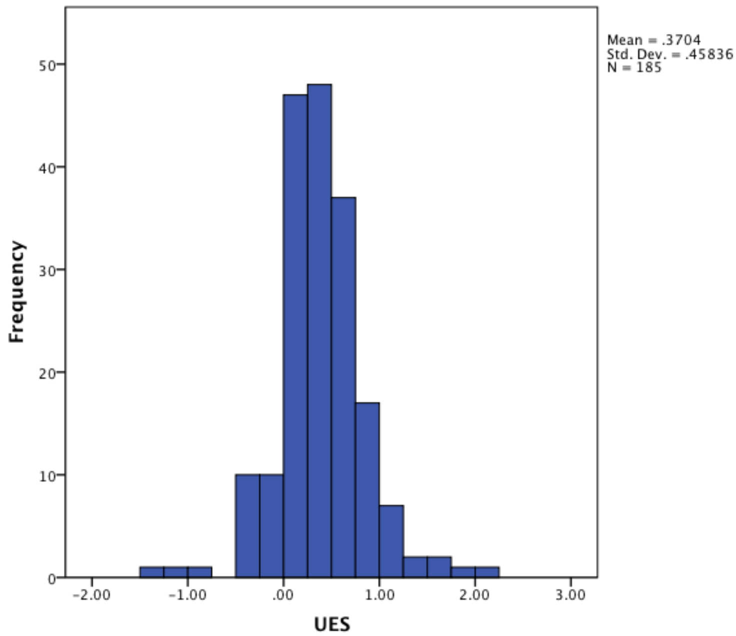

Figure 3. Distribution of independent weighted effect sizes for achievement: cooperative versus individualistic learning structures (*j* = 185).

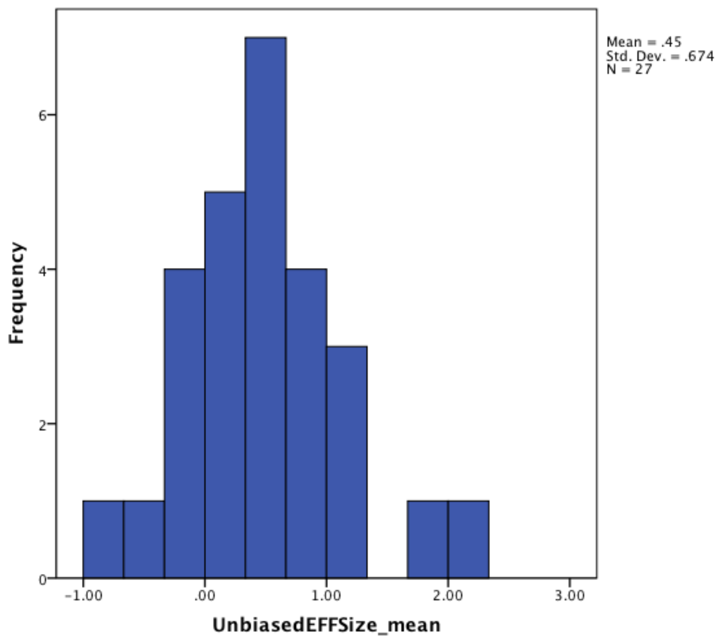

Figure 4. Distribution of independent weighted effect sizes for achievement: cooperative versus competitive learning structures (*j* = 27).

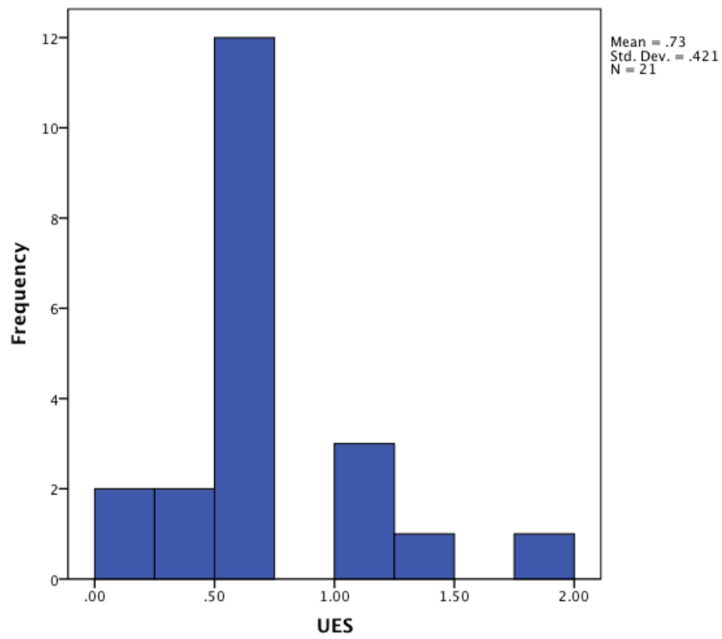

Figure 5. Distribution of independent weighted effect sizes for peer relationships: cooperative versus individualistic learning structures (*j* = 21).

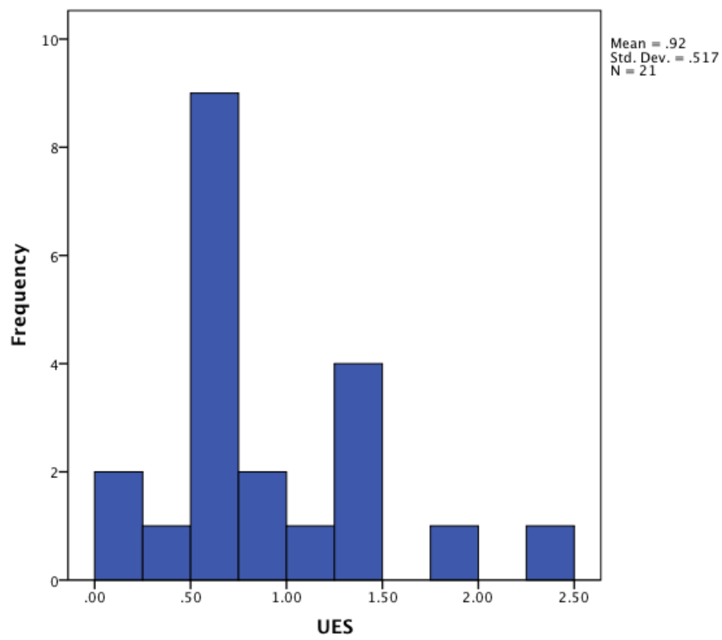

Figure 6. Distribution of independent weighted effect sizes for peer relationships: cooperative versus competitive learning structures (*j* = 21).

Sensitivity Analysis

Fail-Safe N Analysis

Fail-safe N identifies the number of missing studies that would be required to reduce the weighted effect size to a non-significant number using Orwin's (1983) formula. For the comparison of cooperative and individualistic structures, this number means that more than 3174 additional studies with an effect size of zero would be needed to reduce the weighted average effect size to make it no longer statistically significant.

A fail-safe N analysis was performed for each meta-analysis in this study; the results are presented in Table 9.

Table 9
Fail-Safe N for Each Meta-Analysis

Dependent Variable	Comparison	Classic Fail-Safe N	Orwin's Fail-Safe N
Achievement	Cooperative vs. Individual	3174	145
	Cooperative vs. Competitive	329	20
	Competitive vs. Individualistic	3	3
Peer Relationships	Cooperative vs. Individual	702	55
	Cooperative vs. Competitive	1084	63
	Competitive vs. Individualistic	NA	NA

Note: Orwin's Fail-Safe N set at .20.

Inferential Analyses

Achievement Outcomes

Unconditional analyses. An unconditional model was fitted to estimate the overall mean ESs and variability for each of the three achievement meta-analyses. The results are presented in Tables 10 and 11. The model intercept is a fixed effect that estimates the overall mean effect size across the respective studies. As predicted, the estimated effect sizes for cooperative versus individualistic structures and cooperative versus competitive goal structures were significantly different from zero.

For the comparison of cooperative and individualistic learning structures, the estimated intercept was .362 ($t(180) = 12.004$, $p < .001$), meaning that the average student in the cooperative condition will score .36 standard deviation units above the average student in the individualistic condition. This is considered a moderate effect size. The estimated variance component, which provides information about variability among the effect sizes, was .096 ($\chi_{180}^2 = 506.65$, $p < .001$). There is statistically significant variance attributable to the between-study characteristics; thus an additional model with predictors that may account for some of the variability is needed (Rosenthal, Hoyt, Ferrin, Miller, & Cohen, 2006).

For the meta-analysis of cooperative versus competitive structures, the results of the fixed effects model show that the average effect size across studies is significantly different from zero ($t(26) = 3.472$, $p = .002$) The grand mean effect size of .416 indicates that on average, students in the cooperative condition will score about .42 standard deviation units above the students in the competitive condition. Based on Cohen (1992), an effect size of .416 is considered moderate. The estimated variance of the standardized mean difference ($t = .294$) is statistically significantly different from zero ($\chi_{26}^2 = 103.55$, $p < .001$). This difference corresponds to a standard deviation of .542, indicating that considerable variance exists among these effect sizes.

For the comparison of competitive and individualistic learning structures, the estimated intercept was -.004 ($t(6) = -.014$, $p = .990$). There is no significant difference between the achievement outcomes of individualistic and competitive learning structures.

The estimated variance component was .557. The chi-square test in the random effects model tests the null hypothesis of $\tau = 0$. Since the results of the chi-square test (χ_6^2 = 35.654, p <.001) showed that variance is significantly different from zero, the studies vary significantly in their effects. The variance estimates and effect sizes for the comparison of competitive versus individualistic learning structures should be interpreted with caution: the number of effect sizes is too small to accurately estimate the actual effects in the population.

Table 10
HLM Weighted Mean Effect Sizes for Achievement Outcomes

Comparison Group	*N*	*g*	*SE(g)*	*95% CI*	*t-ratio*	*p-value*
Cooperative vs. Individualistic	185	.36	.03	(.30 - .42)	12.004	<.001
Cooperative vs. Competitive	27	.42	.12	(.18 - .66)	3.472	.002
Competitive vs. Individualistic	7	-.004	.31	(-.60 - .60)	-.014	.990

Table 11
HLM Unconditional Variance Component Estimates for Achievement Outcomes

Comparison Group	*SD*	*Variance*	*df*	x^2	*p-value*
Cooperative vs. Individualistic	.310	.096	180	506.65	<.001
Cooperative vs. Competitive	.542	.294	26	103.548	<.001
Competitive vs. Individualistic	.747	.557	6	35.654	<.001

Conditional analyses. Next, a conditional model was fitted to two of the three achievement models to examine the effect of moderator variables on between-study variance. A conditional model was not fitted for the competitive versus individualistic comparison because the sample size was considered too small (j = 7). The three predictors (unit of measure, task type, and study quality) were selected because of their potential influence on study outcomes and because there was sufficient data on these variables to warrant further analysis. The cross tabs are presented in Table 12. For ease of interpretation all the predictors were dummy-coded with 0 for the reference condition and 1 for the comparison condition. The results of the conditional analyses are presented in Table 13. With the other predictors held constant, the significant coefficients indicates that the respective variable explains significant between-study variance. Regarding study quality, two dummy variables were created to represent the three quality levels (i.e., high, medium, low); the high-quality studies were treated as the reference group.

Table 12
Crosstabs of Unit, Task, and Study Quality for Achievement Outcomes

Cooperative vs. Individualistic					
Unit	Task	Quality			Total Studies
		High	Moderate	Low	
Individual	High	20	20	12	52
	Low	33	39	45	117
Group	High	3	0	1	4
	Low	6	0	6	12
Total		62	59	64	185
Cooperative vs. Competitive					
Unit	Task	Quality			Total Studies
		High	Moderate	Low	
Individual	High	5	2	0	7
	Low	1	7	2	10
Group	High	0	1	0	1
	Low	4	5	0	9
Total		10	15	2	27

Table 13
Results of HLM Analysis of Conditional Models for Achievement Outcomes

Cooperative vs. Individualistic

	Coefficient	Standard Error	*df*	*t*-ratio	*p*-value
Conditional	.595	.109	176	5.480	<.001
Unit of Measure	-.199	.107	176	-1.856	.065
Task	.044	.063	176	.696	.487
Quality-Mid	-.089	.075	176	-1.190	.236
Quality-Low	-.105	.073	176	-1.434	.153

Estimation of variance component

	SD	Variance	*df*	x^2	*p*-value
g_j	.304	.092	176	470.933	<.001

Cooperative vs. Competitive

	Coefficient	Standard Error	*df*	*t*-ratio	*p*-value
Conditional	.863	.304	22	2.835	.010
Unit of Measure	-.162	.263	22	-.615	.544
Task	-.221	.301	22	-.735	.470
Quality-Mid	-.598	.534	22	-1.121	.275
Quality-Low	-.405	.289	22	-1.402	.175

Estimation of variance component

	SD	Variance	*df*	x^2	*p*-value
g_j	.564	.318	22	93.374	<.001

Cooperative vs. individualistic. The analysis of high-quality studies assessing outcomes at the group level (for cooperative structures) for students learning low level cognitive tasks resulted in an effect size of .595 ($t(176) = 5.480$, $p < .001$). The unit of measure variable was the only moderator to approach significance ($t(176) = -1.856$, $p = .065$). The influence of unit of measure on the achievement outcomes indicated that students who completed the achievement measure as a group scored higher than group members who completed the assessment individually after learning in a group setting. In other words, measuring outcomes at the group level rather than measuring cooperative students individually may contribute to larger mean differences between cooperative and individual structures. For each of the other three moderator variables, no significant effects were found (See Table 13 for complete results). The conditional model, including all four moderator variables, reduced the unexplained variance in the model by only 0.4 percent, which is to be expected since none of the moderators explained significant variance.

Cooperative vs. competitive. For the cooperative versus competitive achievement model, high-quality studies had the largest effect size followed by mid-quality and low-quality studies, though none of the moderators was found to be statistically significant in the model. The conditional model for this meta-analysis increased the amount of variance left unexplained in the model from v =.294 (unconditional) to v =.318 (conditional). Possible explanations for this increased variability will be presented in the discussion session.

Peer Relationships Outcomes

Unconditional analyses. An unconditional mixed-effects model was fitted to estimate the overall mean effect sizes and variability in effect sizes for each of the three peer relationship meta-analyses. The results are presented in Table 14.

For the comparison of cooperative and individualistic learning structures, the estimated intercept was .709 ($t(20) = 8.201$, $p < .001$). The mean score of students in the experimental group was .7 SD above the mean score of students in the control group. For interpretative purposes, the experimental mean score exceeds the mean score of approximately 76% of the students in the control group. The estimated variance component was .071 ($\chi_{20}^2 = 38.64$, $p = .008$; see Table 15). Thus, a statistically significant amount of the total variance in effect sizes is attributable to the between-study characteristics.

For the comparison of cooperative and competitive learning structures, the estimated intercept in the unconditional model was .882 ($t(20) = 7.661$, $p < .001$), meaning that on average the effect of cooperation versus competitive learning is moderate with a mean effect of .88. An average student in the cooperative learning structure would outscore 82% of the students in the competitive structure. The estimated variance component was .189 ($\chi_{20}^2 = 73.059$, $p < .001$). Thus, a statistically significant amount of the total variance in effect sizes is attributable to the between-study characteristics. An additional model with predictors that may account for some of the variability is needed (Rosenthal, Hoyt, Ferrin, Miller, & Cohen, 2006).

The comparison of competitive and individualistic learning structures yielded an estimated effect size of -.271 ($t(1) = -.679$). The estimated variance component was .215

(χ_1^2 = 3.076, p =.076). A conditional model was deemed inappropriate due to an insufficient number of studies (j = 2).

Conditional analyses. A conditional model was then fitted to two of the peer relationship models to examine the effect of moderator variables on between-study variance. The predictors (task type and study quality) were selected because of their potential significance and because there was sufficient data on these variables to warrant further analysis. The cross tabs are presented in Table 16. Although the achievement outcomes could be measured at the group level, students' perceptions of social support and positive peer relationships were always measured at the individual level, so the unit of measure variable became irrelevant for the analysis of peer relationship outcomes. The results of the conditional analyses are presented in Table 17.

Table 14
HLM Weighted Mean Effect Sizes for Positive Peer Relationship

Comparison Group	*n*	*g*	*SE*	*95% CI*	*t-ratio*	*p-value*
Cooperative vs. Individualistic	21	.709	.087	(.54 - .88)	8.201	<.001
Cooperative vs. Competitive	21	.882	.115	(.64 - 1.12)	7.661	<.001
Competitive vs. Individualistic	2	-.271	.400	(-1.05 - -.51)	-.679	NA

Table 15
HLM Unconditional Variance Component Estimates for Positive Peer Relationships

Comparison Group	*SD*	*Variance*	*df*	x^2	*p-value*
Cooperative vs. Individualistic	.266	.071	20	38.64	.008
Cooperative vs. Competitive	.435	.189	20	73.059	<.001
Competitive vs. Individualistic	.464	.215	1	3.076	.076

Table 16
Crosstabs of Task, and Study Quality for Positive Peer Relationships

Cooperative vs. Individualistic					
Unit	Task	Quality			Total Studies
		High	Moderate	Low	
Individual	High	2	1	1	4
	Low	5	9	3	17
Total		7	10	4	21
Cooperative vs. Competitive					
Unit	Task	Quality			Total Studies
		High	Moderate	Low	
Individual	High	6	1	1	8
	Low	6	5	2	13
Total		12	6	3	21

Table 17
Results of HLM Analysis of Conditional and Unconditional Models for Peer Relationships

Cooperative vs. Individualistic

	Coefficient	*SE*	*t*-ratio	*p*-value
Conditional	.509	.168	3.038	.008
Task	.050	.191	.262	.796
Quality-Mid	.278	.250	1.11	.283
Quality-Low	.250	.210	1.193	.250

Estimation of variance components

	Standard Deviation	Variance Component	*df*	x^2	*p*-value
g_j	.278	.077	17	33.68	.009

Cooperative vs. Competitive

	Coefficient	*SE*	*t*-ratio	*p*-value
Conditional	.744	.198	3.757	.002
Task	.327	.225	1.458	.163
Quality-Mid	.364	.316	1.149	.267
Quality-Low	-.209	.248	-.843	.411

Estimation of variance components

	Standard Deviation	Variance Component	*df*	x^2	*p*-value
g_j	.390	.152	17	51.405	<.001

Note. No conditional model was fit for the competitive vs. individualistic comparison due to the small sample size (n = 2).

For the comparison of cooperative to individualistic structures, high-quality studies with low-level cognitive tasks produced an effect size of .509 ($t(17) = 3.038$, p = .008). The variance component was higher for the conditional model, increasing from .071 to .077. This meta-analysis produced higher effect sizes as the methodological quality of the studies decreased. Possible explanations for the increased variability and the shift in the direction of influence of methodological quality (compared to the positive influence of methodological quality on achievement outcomes) will be presented in the Discussion chapter.

The conditional model for cooperative versus competitive structures produced an effect size of .744 ($t(17) = 3.757$, $p = .002$). As expected, including only the highest level cognitive tasks increased the size of the effect size (though not statistically significant) for cooperative versus competitive structures. The variance component decreased from .189 in the unconditional model to .152 in the conditional model. While the conditional model contributed to reducing the variance in the model, the p-value of <.001 suggests there is still unexplained between-study variance that has not been accounted for by these examined moderator variables.

Chapter 5

DISCUSSION

The purpose of this meta-analytical research was to examine the effects of the three interdependence structures used in higher education. The analyses examined the extent to which cooperative, individualistic, and competitive learning conditions influence achievement and social outcomes. This study therefore contributes a meta-analysis to the thriving research literature examining the effectiveness of small-group learning structures in higher education. In addition, the research findings provide support for social learning theories.

The Discussion chapter provides a summary and discussion of the major findings from the data analysis presented in the previous chapter. Comparisons with previous meta-analyses, possible limitations of this study, and suggested priorities for future research will also be examined.

Research Question 1

To what extent does cooperative learning promote student achievement outcomes when compared to individualistic and competitive learning conditions?

It was hypothesized that cooperative learning would result in the higher achievement outcomes than either individualistic or competitive structures. The modest effect size for cooperative versus individualistic learning conditions indicate that cooperative learning promotes achievement outcomes that would not only be easily visible to an expert but also be noticeable to a casual observer. The meta-analysis of cooperative versus competitive learning conditions produced even larger effects--but also greater variance--

between effect sizes. Overall these results are consistent with previous meta-analyses of small-group learning with high school and college-age students (Bowen, 2000; Haas, 2005; Leary, 2012; Springer, et. al, 1999; Johnson, Johnson, and Stanne, 1999). Although these effects are considered moderate for educational research, they provide evidence of the beneficial effects of cooperative learning when compared to individualistic and competitive learning structures.

Research Question 2

To what extent does unit of measure, study quality, and cognitive task difficulty influence the relationships between interdependence condition and student achievement outcomes?

It was hypothesized that effect size contrasts (cooperative versus individualistic and cooperative versus competitive) would be highest in those studies that measured achievement outcomes at the group level, that assessed low-level cognitive tasks, and that implemented the highest quality research designs. For this particular classification of studies, the effect sizes were $g = .595$ for cooperative versus individualistic conditions and $g = .863$ for cooperative compared to competitive.

Since this research was also concerned with the magnitude and significance of the predictor variables, each moderator was examined as a significant contributor to between-study variance. The contributions of moderator variables (unit of measure, level of cognitive task, study quality) reduced the between-study variance component from .096 to .092. The only moderator that approached significance was unit of measure ($p = .065$). The variance did not decrease dramatically since none of the individual moderators produced significant results for explaining contributing variance. From the unconditional model to the conditional model, the estimation of between study variance increased from .294 to .318. Although this was not an expected result from this analysis, the increase in unexplained variance may be a result of the high number of moderators relative to the sample size of studies. It is also possible that the rating system for difficulty of cognitive task and study quality may have been a composite of too many factors to provide additional clarity in the overall variance. The analysis of this series of moderator variables left a significant amount of between-study variance unexplained.

Research Question 3

To what extent does cooperative learning promote positive peer relationships when compared to individualistic and competitive learning conditions?

Cooperative learning was found to be superior to individualistic learning and to competitive learning structures. The effect sizes for each of these comparisons suggest that cooperative learning has a strong positive influence on college students' peer relationships. The effect size for cooperative compared to individualistic learning provides evidence for the positive effects of using cooperative learning, which supports students working together, rather than individualistic learning which encourages students to work independently and not hinder or help one another. Clearly, a class structure in which students are actively encouraged to work together to support one another is more likely to increase the positive attitudes that students develop for their classmates.

The meta-analysis of cooperative versus competitive learning conditions produced even larger effects than those found for the comparison of cooperative and individualistic conditions. It follows the theory of social interdependence that researchers and educators alike would observe more evidence of positive peer relationships in cooperative conditions than in competitive or individualistic conditions. Individualistic conditions, with an absence of interdependence result in neutral opinions of fellow classmates: other students neither hinder nor support the learners in individualistic conditions. Positive interdependence, facilitated by cooperative learning, is expected to produce favorable student ratings of peer liking and positive attitudes toward peers. The results of these meta-analyses support this conclusion. Competitive learning perpetuates a structure in which students work against one another therefore hindering the development of positive peer relationships. Students are less likely to regard their peers positively when they consider these classmates as an obstacle to their successful learning outcomes.

Research Question 4

To what extent does study quality and cognitive task difficulty influence the relationship between interdependence condition and student peer relationship outcomes?

None of the predicted moderator variables significantly reduced the amount of between-study variance in the analysis of cooperative versus individualistic or cooperative versus competitive learning structures. The hypothesis that guided this analysis predicted that higher quality studies would result in a smaller effect sizes across each meta-analysis indicating less extreme values in the comparison of conditions. It was also predicted that studies examining greater cognitive task difficulty would produce results that favor cooperative learning over competitive and individualistic learning conditions for developing positive peer relationship outcomes.

Similar to previous research, this meta-analysis reports that high-quality designs result in positive effects favoring cooperative learning, but it fails to report significant differences for high-quality studies compared to low- or mid-quality studies. In general, quality of the study design did not moderate the relationship between interdependence condition and peer relationship outcomes. It is possible, however, that this quality measure variable did not appropriately represent the overall quality of the represented studies. The components of study quality (purity of control condition, assignment to conditions, treatment fidelity, teacher consistency, and curriculum similarity) may be too irregular to be consolidated into one variable. Understanding how these multiple components factor into the understanding of study quality and its influence on outcome measures is difficult and does not present any easily interpretable answers. Therefore, caution should be used in the interpretation of these results.

The lack of clarity regarding study quality indicates the necessity to report more information in empirical studies. A lack of information presented in original studies ensures lower quality scores in subsequent meta-analyses, while a surfeit of information promotes a more accurate meta-analytical picture of original-study elements. Future meta-analysts may increase the validity of the composite quality variable by excluding primary studies that provided insufficient information to classify it accordingly. Several methodologically sound studies may have been coded as low-quality due to insufficient information in the study write-up.

These meta-analyses did not provide significant evidence that cognitive task difficulty moderated the effects of interdependence on peer relationships when other moderator variables are held constant. Possible explanations for this lack of significant relationship will be examined in the limitations section of this chapter.

How this review differs from previous reviews

A total of 231 experimental studies examining the effectiveness of interdependence structures in the higher education learning environment were included in this meta-analysis. It examined a broader scope of subject areas and task types than those analyses completed in the last decade and therefore provides an update to the comprehensive analysis conducted by Johnson & Johnson in 2005, adding approximately 154 new studies published since the time of that analysis. This analysis did not include studies examining two different cooperative learning methods. In addition, while this analysis included a considerably large scope of subjects, grouping structures, group size, duration and setting, it depended on a restricted set of inclusion criteria related to minimum availability of data and restricted age group and academic outcomes. Strict pooling techniques were utilized in this review: effect sizes that may have been collected from overlapping samples or that included a common control group were never combined in this study. The utilization of such techniques may have led to different results than those found in previous meta-analyses.

Theoretical Significance

Researchers can glean valuable information from this analysis in order to examine cooperative learning at a deeper level. Accordingly, this data contributes to the credibility of social interdependence theory and the effectiveness of cooperative learning structures within higher education. Despite the inability of this study to identify significant contributors to the between-study variability, the overarching conclusions inform understanding of the theoretical foundation. The large to moderate achievement effect sizes comparing cooperative learning with individualistic and competitive conditions indicate the superiority of structuring student learning experiences using positive interdependence. The data presented in this study provides evidence of students working together to improve the academic outcomes of cooperating group members. These meta-analyses provide evidence supporting shared achievement outcomes when students work together, but the elements that may contribute to the social construction of knowledge remain unclear. A further analysis of the cooperative learning process may provide additional clarity to the learning process of individual students involved in structured group learning tasks.

The effects of cooperative learning on the development of positive peer relationships is demonstrated in this study. Astin's theory of student involvement suggests that students who engage in academic discussions with peers may benefit academically, socially and motivationally. Although persistence was not examined explicitly in this series of meta-analyses there is evidence that cooperative learning experiences positively effect college students' achievement outcomes and the development of positive peer relationships. Both of which have been shown to contribute to persistence of college students.

Practical Significance

This analysis provides higher education practitioners with evidence of the effectiveness of using cooperative learning structures to improve student achievement outcomes and to encourage the development of students' positive peer relationships. Somewhat counter to researcher assumptions, higher quality studies do not necessarily affect the size of effects resulting from the use of positive interdependence. Time and money may be invested in developing and implementing cooperative learning structures with a high probability of a positive return in terms of student learning outcomes and social factors. College instructors can be confident that students will benefit both academically and socially when engaging in cooperative learning activities regardless of the cognitive difficulty of the task.

Limitations

As with all educational research, meta-analysis has its limitations; this particular study is no exception. This review was intentionally limited to experimental-control studies. The strict inclusion criterion only captures a small slice of the available quantitative literature. Although the inclusion of studies with within-subject designs utilizing pre-post comparisons may contribute significantly to our understanding, the effect size statistics for these types of studies may add to the inflation of effect sizes when pooled with studies utilizing a separate control group. Studies providing insufficient statistical information to calculate effect sizes were also excluded: this resulted in a tremendous narrowing of the considered literature. Studies providing qualitative comparisons and those providing limited quantitative data certainly add to educators overall understanding of effective instruction but were not included here in an effort to keep this review from becoming unwieldy.

A richer understanding of all results would be accomplished through an expansion of the inclusion criteria. While the research design has strict criteria for inclusion, the definition of interdependence did not. Studies were not coded for the primary experimenters' working definitions of cooperative learning or the criteria used for defining the experimental and control conditions. The studies examined in this analysis included a broad range of grouping structures and implementation of study conditions.

Although diligent attempts were made to collect and code all studies examining the key variables for this meta-analysis, a small number of fugitive studies were never located (3%). These studies may have contributed data to this meta-analysis and generalizability of the results to the population of interest.

The primary studies from which this meta-analysis data was collected came from the written literature provided by the author(s) of each original study; therefore the conclusions of this meta-analysis are only as reliable and trustworthy as the original methods, definitions, and measures utilized by the primary researchers. Defining cooperative conditions and what constituted an effective measure of outcome variables was determined by the original studies' authors with no judgment made by the meta-analyst in terms of the proximity to defined methods or integrity of design characteristics. Primary study authors were taken at their written word as to the implementation of their methods and the checks on their own possible biases.

As with any meta-analytic review, there were many decisions made by the researcher in terms of inclusion criteria, types of ES adjustments, removal of outliers, and levels and predictors in the HLM, all of which may be criticized for subjectivity. Although considerable effort was invested to reduce the potential of bias in this review and provide transparency on the entire process, other researchers may question the high-stakes nature of this analysis in consideration that its final review will be completed by two of the eminent researchers in the area of cooperative learning. In fact, this doctoral dissertation, which is built upon the methods and previous work established by David and Roger Johnson, will also be evaluated by these researchers.

Primary studies employed a variety of achievement measures, including outcomes on standardized exams or results of teacher-designed quizzes. Studies that used more elementary assessment instruments tended to lack the data that would make it possible to estimate reliability statistics. When a dependent measure is not reliable or data to estimate its reliability is not available to make adjustments, the strength of the observed relationships between independent and dependent variables are likely affected. Hunter and Schmidt (2004) advise that effect sizes be adjusted for attenuation caused by unreliability of the dependent measure. Such corrections were not made due to a lack of meaningful data provided in the primary studies included in this meta-analysis. This imprecision may have contributed to lower than expected effect sizes.

This study adds a timely addition to the knowledge base on social interdependence. Specifically, the results of these meta-analyses provide up-to-date (through 2010) evidence on the overall effects of cooperative, individualistic, and competitive learning on student achievement and peer relationships within the context of higher education.

Future Research

This study indicates several directions for future research. First, an examination of the specific instructional aspects of cooperative learning may contribute to the understanding of effective cooperative learning implementation. Second, a refinement of the meta-analysis coding schema would add validity to an analysis based on specific cooperative learning techniques. Finally, a careful examination of the outcome measures used by primary study researchers may reduce the noise associated with ineffective measures of the intended outcomes.

An exploration of the specific types of interdependence (goal, role, resource) that contribute to achievement and social outcomes may contribute to our understanding of effective cooperative learning. Expectations and process variables used in the structured learning environment may arguably influence the effectiveness of small-group learning with motivated adult students. A refinement of this meta-analysis research would establish required criteria for coding each interdependence condition in the primary studies. For instance, coders would need to identify the specific elements of the condition (goal, role, reward, identity) that were evident in the conditions to justify a code of positive or negative interdependence.

An in-depth examination of the different cooperative learning components (individual accountability, social skills, group processing) is also warranted to identify the optimal conditions for significant academic and social outcomes. If individual accountability is not a requirement of the cooperative condition, there may be a lack of evidence indicating whether students actually learned or if the group was able to produce a better product as a result of one or two strong members. Further examination of the variables that contribute to effective group work with college students is a likely area for future research. Of particular importance is the nature of the group task. Evidence of observed behaviors, in the form of numerical data, or specific condition protocols would provide more credibility rather than relying on the author's descriptions of intended activities. This change would restrict the number of studies analyzed in the meta-analysis, but it would also improve the validity of the primary studies' data.

Refinement of the Coding Process

Future research may refine the coding process according to the differences in the multitude of cooperative relationships that constitute the positive interdependence condition in this analysis. There is a considerable difference between a tutoring relationship in which a give and take relationship is expected and a cooperative group experience in which each member must make decisions about what to contribute and what to extract from the group. In many higher education group conditions, students are started on equal footing in terms of inputs and expectations. This study grouped together all of the positive interdependence conditions such that tutoring outcomes were aggregated with collaborative structures with minimal accountability or expectations for individual contributions.

Many studies conducted during the 1970s and 1980s were performed by academics in the field of education who were refining models and developing theories. Specific cooperative learning methods were taught in teacher education programs and professional development retreats. Professors in higher education settings are much less likely than K-12 teachers to have formal, structured exposure to proper methods of conducting cooperative learning activities in their classrooms. This lack of proper training may result in less thoroughly implemented methods and in lessened effectiveness for student outcomes, which may result to lower overall effect sizes.

Assessment of Outcomes

Future research should also take into consideration the characteristics of the assessment measure used by primary researchers. A new coding protocol should be developed to assess the reliability of the assessment instruments including evidence of validity checks and reliability measures. A rating system to designate the use of standardized exams, teacher-scored assessments, and self-reports may be a beneficial factor to explore as a moderator in the effects modeling.

Moving Beyond the Basics

The field of educational psychology has amassed a considerable collection of evidence indicating that cooperative learning improves achievement and social outcomes for college students. Research should now focus efforts on identifying which elements in the process make it successful. In the past, analyses may have been over-reliant on existing classifications and data collection methods to move into new areas of exploration. Higher education would benefit from a prescriptive framework for implementing successful group learning structures that are highly likely to improve learning and retention of new material.

Future research could include studies that examined one cooperative learning condition compared to another. This particular study examined the comparison of positive interdependence to negative or to a lack of interdependence; therefore studies exploring subtle comparisons between two cooperative structures were not included. An examination of multiple positive interdependence methods may reveal more specific elements necessary for effect group learning. For example, it may be determined that social skills training, seldom implemented in higher education settings, is not an essential expectation for minimum group functioning but may influence the effectiveness of long-term group functioning.

Differentiation in Expectations of Learning Environment

Future research may want to differentiate between group work that strives to complete some task--to "get the project done"--because the common goal of such work is seldom to ensure each individual's complete comprehension or future exam success. Such research may therefore consider individual motivation as an influential factor in collaborative learning. For example, in higher education there is currently an assumption that adult learners need to take responsibility for their own education. Although the collaborative learning model may be more appropriately defined as a group of learners coming together to share resources, discuss ideas, examine conflicts in understanding, adults who work in learning groups may be ultimately more motivated to get what they need individually from the shared experience. Is the priority of the group to function together to get a task done or is it to ensure that each member learns some content or process? This is a subtle difference that could be clarified through closer examination of primary studies and teacher expectations for the learning task.

Realistic Next Steps

Other moderators of interest that were not examined in this analysis include type of outcome measure. All studies were coded for the type of measure. A wide variety of assessment measures were used for measuring peer relationship outcomes although a majority were attitudinal scales or self-reports. A majority of achievement measures were either teacher-created tests, standardized tests, or assessments of a product created by students. Specific types of cooperative learning structures were not examined in this meta-analysis, but many primary studies did provide some details as to the guiding methodology for the cooperative conditions. This data could be used to compare the various cooperative methods for effectiveness with this population of mature students. The application of cooperative structures in specific disciplines could also be examined quite easily. Nearly all of the articles included in this meta-analysis included information on the subject matter being taught during the intervention. It may be beneficial to isolate specific disciplines and examine which types of tasks are most effectively taught using cooperative group structures.

The vast amount of data collected during the coding phase of this analysis would also allow for a detailed investigation of specific task types to determine which cognitive tasks are most effectively implemented using a cooperative framework. The specific examination of a fairly large set of effect sizes for analytical problem solving, concept attainment, verbal problem solving and retention tasks could provide researchers specific information about which phases of learning are most effectively taught in peer groups. For this study, task types were combined and rated according to their cognitive sophistication.

Professional Development for Faculty

Cooperative learning advocates should only expect modest results from faculty who are structuring cooperative activities if the research continues to provide them with general answers regarding effective frameworks. Recommendations provided to developing faculty need to be up-to-date based on the latest technologies, student demographics, and social nature of the learning environment. Young learners are different from adult learners in their motivation, ability to function supportively in a social setting, and willingness to contribute to others' learning experiences. Educational researchers should focus efforts on clarifying the appropriate methods for a given context. Educators need to be encouraged to have structured conversations about specific applications of proven practices. Certain group learning programs were developed for specific content areas and grade levels. It may not be effective to utilize these methods across disciplines (Grossman & Stodolsky, 1995). Providing professional development to collegiate faculty presents a different challenge from providing professional development to K-12 educators, who are required to have some coursework or training in instructional methods. Educational researchers should continue to explore the types of professional development opportunities that will increase the likelihood that cooperative learning will be implemented effectively. Many educators view cooperative learning as another strategy to increase social cohesion, to ensure a sense of community, and to operate as a mechanism for mastery and review (Brody & Davidson, 1998).

Conclusion

This series of meta-analyses indicate that positive social interdependence produces significantly higher effects on achievement and peer relationship outcomes than either negative interdependence or individualistic structures of learning in a higher education context. Results were significantly heterogeneous and only unit of measure was found to approach significance. None of the examined moderating variables accounted for significant variance in achievement outcomes comparing cooperative and individualistic learning structures.

The strength of meta-analysis is that it allows researchers to synthesize a large volume of research that may otherwise be overwhelming to summarize qualitatively (Lipsey & Wilson, 2001). This review demonstrates that overall, positive interdependence has a positive effect on achievement and peer relationships for college students compared to conditions featuring negative interdependence or a lack of interdependence. It also demonstrates moderate effects for achievement and strong effects for peer relationships.

Meta-analysis is also capable of identifying relationships across studies that are often obscured using other approaches. In this review, several factors that affect the impact of small-group learning were identified. This study contributes to the overall understanding of cooperative learning uses in the college classroom and adds to the validity of social interdependence theory and collaborative argumentation theory.

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APPENDICES

Appendix A
Meta-Analysis Study Level Coding Protocol

I.D.: The study's identification number

Reference: The exact APA reference. For example: Johnson, D. W., & Johnson, R. T. (1980). "Constructive peer relationships and cooperative learning experiences: Implications for the prevention of drug abuse." *Journal of Drug Education*, 10, 7-24.

NumFind: The number of findings in the study. Leave blank. The number of findings will be totaled after calculating effect sizes.

Rater: The name of the person coding the article

YrPub: The year the study is published

Sample Size: The # of subjects involved in the study

SizeGroup: The # of people in each group in the study. For example: 100 students are involved in a study and 5 students in each group.
Sample Size = 100. Size of Group = 5.

DurationDays: How long the study lasted. For example: 0 ≤ 1 = 1 day. If this number is based on more general information, explain how you calculated the number of days – e.g., "Classes met twice a week during two, 9-week semesters."

ModePub: Where the document was published
Book
Peer-Reviewed Journal
Conference presentation/proceeding
Dissertation/Thesis
Other (specify in comments)

Sex: The sex composition of the sample
Female
Homogeneous by group
Majority female
Majority male
Male
Mixed
Not given, unclear

Age of Subject: The academic grade-level representing the average age of the sample:
Adult (age 22+)
College (age 18-22)
Graduate/Professional School (age 22+)

EthComp: Ethnic composition
Heterogeneous in study, homogeneous in groups
Heterogeneous
Majority homogeneous
Minority homogeneous
Non-U.S. homogenous
Not given, unclear
White homogeneous

EthClass: Ethnic classification
African American
Asian
Hispanic
Middle Eastern
Native American
Not given, unclear
Other (specify in comments)
White

HCompAbil: Group composition of cognitive abilities
Average, gifted homogeneous
Handicapped homogeneous
Heterogeneous in study, homogeneous in groups
Heterogeneous
Mixed (i.e., composition varies btw. groups)
Not given, unclear
Other (specify in comments)

HClassAbil: Classification of cognitive disabilities within the sample
Groups mixed ability
High ability
Low ability
Not given, unclear
Other (specify in comments)

EconStat: Subjects' economic status
Not given, unclear
Lower
Working
Middle
Upper
Mixed

Country: The country where the study was conducted

DivisTask:
Divisible - a division of labor with subtasks
Unitary - tasks are not divisible; no division of labor
Unknown, unclear

TypTask: The type of task subjects are working on within the subject area
Analytical problem solving
Categorization
Composition
Computer
Concept attainment
Guessing, judging, predicting
Motor
Not given, unclear
Other (specify in comments)
Retention and memory
Rote decoding, correcting
Spatial problem solving
Verbal problem solving

MaxOptimiz:
Both – i.e., rate of quality output
Maximizing – speed or quantity
Optimizing – quality
Unknown, unclear

RespType: The type of response required of subjects in the cooperative condition
Additive – summative combination of group outputs
Conjunctive – group score based on least effective
Discretionary – members combine individual contributions in the way they want
Disjunctive - response from only 1 member
Unknown, not given

TypGrpSet: Setting (context) in which the study is conducted
Not given, unclear
Lab/experiment
Academic Setting - a generalized academic setting
Intact Classroom - specific classrooms

SubjArea: Subject area people are learning, or the area in which they are working
Allied Health
Anatomy
Art
Biology
Business writing
Computer
Conflict Resolution
Economics
Education – methods
Engineering
English
Foreign language
Geography
History
Language Arts
Literature
Math
Not given, unclear
Other (specify in comments)
Peer Mediation
Physical Education
Psychology
Reading
Science
Social Studies
Spelling

TypeReward: The type of reward for successful task completion
Not given, unclear
Feedback only - e.g., "Well done."
Symbolic - grades, categorical praise – e.g., "Your group is the best/first/superior quality
Tangible – e.g., candy, money, toys

InterData: The type of interaction (comparison) data
Ability
Age
Anxiety level
Complexity of task
Computer assisted instruction
Ethnicity
Mastery vs. Non-Mastery
None
Other (specify in comments)
Sex
Socioeconomic status (SES)
Success or failure
Summary vs. No summary
Subject area readiness
Teacher
Time (repeated measures)
Trained vs. Untrained
Type of supplemental material

ComparStat: The type of comparison used in statistical analysis
Experimental-Control and Correlational
Experimental-Control
Other (specify in comments)
Pre-Post and Experimental-Control

IntraStruc: Intragroup structures (i.e., within groups)
Not given, unclear
Cooperation
Competition
Individualistic

InterStruc: Intergroup structures (i.e., between groups)
Not given, unclear
Cooperation
Competition
Individualistic

TypCoopCnd: The type of cooperative experimental condition (mixed/pure)
Collaborative learning
Controversy
Group Investigation
Individualistic w/ competitive elements
Integrative negotiation
Jigsaw
Jigsaw II
Johnson & Johnson
Mixed
Not specified
Other (specify in comments)
Peer Assisted Learning
Problem Based Learning (PBL)
Reciprocal Teaching
STAD
Supplemental instruction (SI)
TGT

SmpRndAsgn: The extent to which subjects were randomly assigned to groups
Not random
Random by group, unit of analysis was individual
Random by group, unit of analysis was group
Random by individual

CondCheck: The experimental condition was successfully implemented
No
Yes

Curriculum: The curriculum/task was the same across conditions
Not same
Same

CntrlCond: The extent to which the control condition differed from the experimental
Average of mixed and pure
Mixed
Pure

TchrEffect: The teacher/experimenter was the same across conditions
Teacher/experimenter differed
Teacher/experimenter rotated
Teacher/experimenter same in all conditions

Quality: Leave blank. This rating is calculated automatically by the computer

Comments: Explanations of vague and/or unusual aspects of the study

Appendix B
Meta-Analysis Study Level Coding Sheet

Study ID ___ ___ ___ - ___ ___ - ___ Rater's Initials: ___________

Reference:____
____
____
____
____
____
____
____

NumFind *(after es)*: __________
YrPub: ________________ ModePub: ______________________________
Country: __________________ Metro: _______________________________
Sample Size Total: _______________
Experimental Condition: ___________________________
Control Condition: _________________________________
Other: ___________

DurationDays: _________ DurationText: _______________________________

PARTICIPANT CHARACTERISTICS

Gender: ________________ #Females: ___________ #Males: ___________
Age of Subjects: ____
EthnicComp: ____
EthnicClass:____
_
EconStat: ____

GROUP CHARACTERISTICS

SizeGroup: ___________________
CompPhy:____________________ ClassPhy: ___________________________
CompAbil:____________________ ClassAbil: __________________________
DivisTask: ____
TypeTask:____
MaxOptimiz: ____
RespType: ____
TypGrpSet:____
IntraStruc:_____________________ InterStruc: ________________________
TypCoopCond: ____
InterdepStructure: ____

Last Updated: 7/29/08

SubjArea: ____

TypeReward: ____

STUDY DESIGN/METHODS

SmpRndAsgn: ____

Control: _________________

CondCheck: ______________ CntrlCond: ____________________

ComparStat: ____

InterData: ____

Curriculum: ____

TchrEffect: ____

Quality *(computed)*: ___________

Comments:____

____

____

____

____

____

____

Appendix C
Effect Size (ES) Coding Manual

Taken verbatim from: Lipsey, M.W., & Wilson, D.B. (2001). *Practical Meta-Analysis.* Sage Publications: Thousand Oaks, CA.

For each effect size, code all of the following items. Note that studies will have different numbers of outcome constructs, and different numbers of effect sizes within the same construct. Hence, different studies will have different numbers of effect size level data coding forms.

1. Study ID number. Identification number of the study from which the offset size is coded.

2. Effect size number. Assign each effect size within a study a unique number. Number multiple effect sizes within a study sequentially, e.g., 1, 2, 3, 4, etc.

Dependent Measure Descriptors

3. Effect size type. Code an effect size as a pre-test comparison if the measures being compared across groups were taken prior to the intervention. Post-test effect sizes are the first reported comparison between the groups following the intervention. Code any effect sizes measured at future points in time as follow-up comparison.
   1) pre-test comparison
   2) post-test comparison
   3) follow-up comparison
   4) other (specify)

4. Independent variable(s) (IV). The factor(s) being manipulated (or selected) by the researcher.

5. Experimental condition. Label the condition representing the experimental (treatment) group.

6. Control condition. Label the condition functioning as the control group.

7. Dependent variable (DV). The measure used to assess the effect of the IV on the construct of interest.
   1) Social competencies (trust, perspective-taking, sense of purpose, interdependence, personaly identity).
   2) Achievement and productivity
   3) Intrinsic motivation
   4) Psychological health (coping with failure, controlling anxiety, personal control, constructive management of conflict).
   5) Social skills.
   6) Positive relationships.
   7) Attitudes toward learning experience.
   8) Other (specify)

8. Statistical nature of the variable
   1) dichotomous (nominal)
   2) discrete ordinal
   3) continuous
   4) other (specify)

9. Measurement Operationalization:
   1) Page number(s) were the measures is described.
   2) The number of different measures used for same construct.
   3) Description of the measures using the same labels as those reported in the study's result tables.

Reliability of Dependent Measures

10. Social desirability response bias. Rate the extent to which this measure seems susceptible to social desirability response bias. At one end of the continuum would be measures based on objective procedures administered by impartial other, e.g., random surprise tests. At the other end would be the student's own reports made to someone with authority over him/her.
    Very low potential ----------------------------→ 7) Very high potential. ------→ 8) Not applicable

Effect Size Data

11. Type of data effect size based on:

1) means and sd's
2) means & t-test
3) mean gain scores
4) t-test (independent)
5) t-test (p-value only)
6) t-test (dependent)
7) proportions (dichotomous)
8) proportions (polychotomous)
9) frequencies (polychotomous)
10) oneway ANOVA (k = 2)
11) oneway ANOVA (k>2)
12) oneway ANCOVA
13) chi-square (df = 1)
14) chi-square p-value only (df = 1)
15) other (specify in comments

12. Page number where the data for this effect size was found:

13. When means and standard deviations are reported or can be estimated:

1) Treatment group sample size
2) Treatment group mean
3) Treatment group standard deviation
4) Control group mean
5) Control group sample size
6) Control group standard deviation

14. When proportions or frequencies are reported or can be estimated:

1) *n* of treatment group with a successful outcome
2) *n* of control group with a successful outcome
3) Proportion of treatment group with a successful outcome
4) Proportion of control group with a successful outcome

15. When effect sizes are based on a sub-sample:

1) Non-overlapping sub-samples (e.g., boys vs. girls)
2) Overlapping (i.e., dependent) sub-samples

16. When significance test information is reported. Complete separately for each measurement in construct.

1) Test statistic value and df's (e.g., *t*-value, *F*-value, Chi-square)
2) Statistically significant? (Yes, No)
3) Alpha level (.05, .01, .001, etc.)

Calculating ES Summary Info

17. Construct effect size: (report to two decimals with an algebraic sign in front: + favors treatment, - favors control)

18. Construct unbiased effect size (report to two decimal points)

19. Construct standard error (report to two decimal points)

20. Construct inverse variance weight (report to two decimal points)

21. Confidence rating in effect size computation:

1) no estimation (have descriptive data such as means, standard deviations, frequencies, proportions, etc. and can calculate the effect size directly)
2) slight estimation (must use significance testing statistics rather than descriptive statistics, but have complete statistics of conventional sort)
3) some estimation (have unconventional statistics and must convert to equivalent *t*-values or have conventional statistics but incomplete, such as exact *p*-level)
4) moderate estimation (have complex but relatively complete statistics, such as multifactor ANOVA, as basis for estimation)
5) highly estimated (have *N* and crude *p*-value only)

Appendix D
Effect Size Coding Sheet

1. Study ID number

2. Effect size number

3. Effect size type

4. Independent variable

5. Experimental condition

6. Control condition

7. Dependent variable (construct)

8. Statistical nature of the variable

9. Measurement operationalization
   Page #(s) where described

   Number of different measures

10. Social response bias

11. Type of data effect size based on

12. Page # where ES data found

13. Means and standard deviations
    a. Treatment sample size
    b. Treatment mean
    c. Treatment sd
    d. Control sample size
    e. Control mean
    f. Control sd

14. Proportions or frequencies
    a. *n* treatment w/ success
    b. *n* control w/ success
    c. Proportion treatment w/ success
    d. Proportion control w/ success

15. When ESs are based on a sub-sample
    a. Non-overlapping?
    b. Overlapping sub-sample

Measure Description

Include reliability statistics when available

Data Report

1. When significance test information is reported
   Test statistic value, df's. 2) Statistically significant? 3) Alpha level?

Summary Information

2. Construct effect size

3. Construct unbiased effect size

4. Construct standard error

5. Construct inverse variance weight

6. Confidence rating in effect size computation