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Understanding Two Year College Mathematics Faculty Perceptions and Use of Cooperative Learning

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Understanding Two Year College Mathematics Faculty Perceptions and Use of Cooperative Learning

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Dedication

I dedicate my dissertation work to my family and friends. I am especially thankful to my mother, Frances G. Castillo whose push for persistence and words of encouragement have brought me where I am today. My brothers, Arthur Jr. and Alexander have always been there for me and will always be remembered. I am also grateful for my best friend and girlfriend, Alejandra Fernandez, for continuing to inspire, love, and support me throughout this journey. I would also like to recognize my niece, Alexis, and Ranger, Señor Vincente, and Coby, our beloved family pets.

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Understanding Two Year College Mathematics Faculty Perceptions and Use of Cooperative Learning

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Cooperative learning, or the instructional use of small groups so that students actively work together to increase their own and each other's learning, is a well-documented pedagogical approach to promote student learning. However, despite ample research on cooperative learning in the K-12 setting, there is little research on two-year college mathematics faculty perceptions of cooperative learning and their reported use of this instructional strategy in mathematics courses. A mixed methods study was conducted on two-year college mathematics faculty at Texas two-year colleges to understand their perceptions regarding cooperative learning and its use and what the implementation of cooperative learning looks like in developmental and college-level mathematics courses. Results show that two-year college mathematics faculty who implement cooperative learning are more likely to report having support and opportunities to learn than faculty who report that they do not implement it, implying that college administrators, deans, and department chairs must find ways to provide this support and let two-year college mathematics faculty experience strategies that support student learning. Non-implementing faculty were more likely to report that the barriers to implementing cooperative learning (time constraints, student characteristics) were prohibitive. Further,

there are notable differences in classroom instruction among faculty who report using cooperative learning, ranging from primarily traditional lecture instruction with minimal time devoted to small group work, to collaborative learning, in which students work informally in small groups on self-directed tasks, to formal cooperative learning in which the instructor incorporates all the essential elements identified by Johnson and Johnson (2009). Strikingly, collaborative learning, with less formal structure imposed by the instructor, appeared to be more successful in promoting these essential elements than the more formal cooperative learning prescribed by those authors. This supports assertions in the literature that collaborative learning may be at least as appropriate a choice at the two-year college level (Hennessey & Evans, 2006).

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Chapter 1 - Introduction

Background of the Problem

Classroom environments in which students are provided opportunities to engage in mathematical investigation, communication, and group problem-solving, while also receiving feedback on their work from both faculty and peers, have a positive effect on learning (Freeman et al., 2014). Creating instructional conditions that promote these types of environments is challenging for many college instructors, since most commonly rely on lecture as their main instructional method (Andersen, 2011; Fink 2013). If college faculty are not supported to change their pedagogical approaches, it is more likely that many of the challenges they face will remain too great to overcome (Ramsden, 2003). One strategy to support college faculty is the introduction of student-centered pedagogical approaches that are adaptive to local institutional needs and constraints (Tadesse & Gillies, 2015). Although various pedagogical approaches exist to enable faculty to transform classrooms into more active, engaging, and supportive learning environments, this study will specifically focus on structured small-group learning, referred to as cooperative learning.

Cooperative learning, or the pedagogical use of small groups so that students work together to maximize their own and each other's learning (Johnson, Johnson, & Holubec, 1998; Johnson, Johnson, & Smith, 2014), is a well-documented instructional approach that promotes student success and positive affective outcomes (Johnson & Johnson, 2009; Johnson, Johnson, & Smith, 1998, 2014, Slavin, 1999). In cooperative learning environments, students discuss the material to be learned, help and assist each other to understand it, and encourage each other to work.

The research on cooperative learning has validity and generalizability rarely found in the educational literature given that researchers have now been studying this pedagogical approach for several decades (Johnson, Johnson, & Smith, 2014). Many researchers have conducted studies on cooperative learning with noticeably different orientations working in different settings and countries with research participants that vary by age, cultural background, gender, nationality, and socioeconomic status (Abrami, Poulsen, & Chambers, 2004; Ishler, Johnson, & Johnson, 1998; Johnson & Johnson, 1994). These researchers have employed a wide variety of tasks, subject areas, research designs, ways of structuring cooperative learning, and ways of measuring independent variables. The volume and diversity of the educational research focusing on cooperative learning is almost unmatched (Smith et al., 2005).

However, despite the ample research on the subject of cooperative learning (Barkley, Major, & Cross, 2014), there is little evidence on its use in two-year college math classrooms. Some studies report that faculty struggle with the implementation of cooperative learning (Cafarella, 2013; Michael, 2007), however, there is not much research on how widespread the use of cooperative learning is in two-year college math classrooms. Even though survey results from the Center for Community College Student Engagement report information on classroom pedagogy, such as the frequency and use of active and collaborative learning (Center for Community College Student Engagement, 2015), data reported is generally not disaggregated to show the implementation of cooperative learning from faculty by subject area.

Furthermore, few studies have focused examining two-year college math faculty perceptions and use of cooperative learning together. Since cooperative learning is now being increasingly used in college classrooms (Davidson & Major, 2014), there is a need to examine how it is implemented in order to help faculty use it effectively in their classes to improve student achievement. Although many instructors have heard of cooperative learning, some may not have a clear understanding of how to implement it in the classroom. This study intends to describe the relationship between how two-year college math faculty perceive cooperative learning and how they use it in their courses.

Problem Statement

Three recent dissertation studies began to document college faculty knowledge and use of cooperative learning (Andersen, 2011; Anstrom, 2010; Hunter, 2011). Anstrom's (2010) dissertation study employed a case-study research design at one Christian university using observations and focus groups to investigate college faculty perceptions, knowledge, and experiences concerning group work and how these affect their instruction. Although college faculty in Anstrom's (2010) study reported that students are not interested in cooperative learning and lack the needed social and interpersonal skills, the same faculty indicated they had limited knowledge, experience, and training regarding cooperative learning.

Hunter's (2011) dissertation study examined two-year college faculty perceptions and use of cooperative learning at an urban two-year college that was conveniently selected based on the researcher's teaching status at the college. Hunter (2011) utilized a survey instrument to explore various factors that may affect the use of cooperative learning including the cost of implementation, value of cooperative learning, and expectancy of success. Results from Hunter's study indicate that: instructors perceive cooperative learning as a costly instructional strategy; instructors perceive cooperative learning as a valued instructional strategy; and instructors perceive a high expectancy of success for its use.

Andersen's (2011) dissertation study examined the knowledge and attitudes of Michigan two-year college math faculty regarding three instructional practices, which included cooperative learning, inquiry-based learning, and lecturing. Her study included a survey that asked math faculty to report their level of cooperative learning use, how they acquired their knowledge of cooperative learning, and barriers to cooperative learning use. Results from this study show that both full-time and part-time two-year college math instructors have knowledge of cooperative learning. Knowledge of cooperative learning was also greater for instructors who taught developmental math (compared to instructors who have not taught developmental math).

In terms of cooperative learning use, Andersen (2011) noted that about half of the faculty participants (N=88) reported using cooperative learning frequently. Moreover, full-time instructors were more likely than part-time instructors to frequently use cooperative learning. Part-time instructors were more likely than full-time instructors to never use cooperative learning. Instructors reported time constraints, negative reactions to cooperative learning on part of the students, and cooperative learning not being a good fit for certain students as the main barriers to implementing cooperative learning. In contrast to cooperative learning, Andersen (2011) also noted that the lecture method is used frequently by over ninety percent (N=160) of two-year college math faculty.

Even though these dissertation studies contributed to the knowledge base on college faculty perceptions and use of cooperative learning through focus groups, observations, and survey instruments, current research has not provided a complete picture of the use of cooperative learning in two-year college math classrooms, what two-year college math faculty understand about this pedagogical approach, and how those perceptions influence how they implement it in developmental and college-level math courses. Even though Hunter (2011) appears to be one of the first to study two-year college faculty perceptions and use of cooperative learning, she suggests that further research is needed on the perceptions and use of cooperative learning by faculty from more colleges. Hunter also argues for further research that allows for interviews to help clarify two-year college faculty understanding of cooperative learning.

On the other hand, Andersen (2011)'s dissertation study focused on Michigan two-year college math faculty perceptions and use of various instructional strategies, one of which included cooperative learning. Though her findings note that over half of her participants self-reported the use cooperative learning in the classroom, Andersen (2011) found that the most commonly used pedagogical method for two-year college math courses is lecturing. She also noted that two-year college math instructors have a tendency to overestimate their use of student-centered instructional practices. She indicated that math instructors at times perceive that they are familiar with an instructional practice and are using it when, in fact, they do not actually know how to implement it. As a result, it will be important to investigate how faculty perceive cooperative learning, how faculty talk about cooperative learning, and how faculty implement cooperative learning in two-year college math courses.

Significance of the Study

Cooperative learning is a pedagogical method that has attracted considerable attention over the last several decades because of extensive research that indicates students gain both academically and socially when they have opportunities to interact with others to accomplish shared goals (Johnson, Johnson, & Holubec, 1998; Johnson, Johnson, & Smith, 2007; Lou et al., 1996; Slavin, 1996). The results from this study could inform instructors' understanding of how to implement cooperative learning in developmental and college-level math courses. Based on prior research, when faculty have a clear understanding of how to successfully use cooperative learning in the classroom, student achievement in math is expected to improve. According to Mesa, Celis, and Lande (2014), research on pedagogical strategies in content areas and within particular environments, such as cooperative learning in math courses, can help the research community understand the complexity of implementing active learning approaches. Their research suggests that various teaching approaches must be explicitly classified so that these approaches can inform and influence pedagogy in higher education. Moreover, research on faculty perceptions can provide awareness about specific factors that either influence or discourage an instructor's decision to implement and persist at a pedagogical strategy (Abrami, Poulsen, & Chambers, 2004). When faculty understand cooperative learning, and are mindful of its benefits and drawbacks as a pedagogical strategy, their perceptions may change towards its effect on student learning. This study will attempt to provide insight into the perceptions and use of cooperative learning by two-year college math faculty members.

Purpose of the Study

The purpose of this study was to provide an in-depth understanding of how two-year college math faculty perceptions of cooperative learning relate to its implementation in developmental and college-level math courses.

Research Questions

The following research questions guided the study:

(1) What are the perceptions of two-year college mathematics faculty members regarding cooperative learning and its use?

(2) What does the implementation of cooperative learning look like in two-year college math courses?

(3) How do two-year college mathematics faculty perceptions of cooperative learning influence its implementation in mathematics courses?

Data were collected using a mixed methods research design, which involved gathering both quantitative and qualitative data. Quantitative data were gathered using an online survey instrument sent to two-year college math instructors in the state of Texas. The online survey collected basic demographic information, professional views on cooperative learning, and information on their current teaching practices. A survey link was provided via email to colleges that were randomly selected to participate. Faculty participants were also incentivized with gift cards to improve response rates. Qualitative data involved using semi-structured interview and observation protocols to document descriptive and detailed findings to characterize perceptions of two-year college math faculty regarding cooperative learning and its use and what the implementation of cooperative learning looks like in two-year college math courses.

Theoretical Framework

The theoretical framework for this study is based on social constructivist (Vygotsky, 1978, 1986) and social interdependence theory (Johnson & Johnson, 1999, 2009). Vygotsky (1986) suggests that knowledge is a social product, because it arises at the social level before the individual level. The research of Johnson and Johnson (1999, 2009) shows that social interdependence exists when the goals of individual students are affected by their own and others' actions. Social interdependence may be distinguished from social dependence (goal accomplishment of Student A is affected by Student B's actions, but the reverse is not true) and social independence (goal accomplishment of Student A is not affected by Student B's actions and vice versa) (Johnson & Johnson, 2009). From the research on social interdependence theory, Johnson and Johnson (2009) note that cooperative learning typically results in greater efforts to achieve, more positive relationships among students, and greater psychological health. The effects of social interdependence on these outcomes separate cooperative learning from other pedagogical approaches.

This is a suitable framework to guide this research in that it operationalizes the essential elements of successful group work based on years of research. This framework allows for the development of an observation tool to document successful cooperative learning as prescribed by Johnson and Johnson (1999, 2009).

Definition of Terms

Cooperative learning is the "instructional use of small groups so that students work together to maximize their own and each other's learning" (Johnson, Johnson, & Smith, 2014, p. 87). Cooperative learning involves groups of students actively working together to accomplish a common goal. Johnson, Johnson, and Smith (2014) indicate five elements essential for successful cooperative learning: positive interdependence, face-to-face promotive interaction, individual accountability, social skills, and group processing.

Collaborative learning refers to "students working in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product" (Smith & MacGregor, 1992, p. 11). Collaborative learning typically refers to informal group learning that focuses on open-ended, complex tasks (Cooper & Robinson, 1998).

Developmental mathematics refers to courses that an individual college considers to be below college-level mathematics. The structure of developmental math may vary between colleges (Cafarella, 2013). Some colleges have stand-alone departments of developmental education while other colleges have developmental and college-level math courses paired in a department of mathematics.

Two-year colleges, also called community colleges or junior colleges, are higher educational institutions, found throughout the United States, that serve local communities. Typically, they are commuter schools with open enrollment.

Chapter 2 – Literature Review

This chapter describes literature relevant to the research purposes of this study. It is organized in the following sections: (1) cooperative learning, (2) historical roots of cooperative learning, (3) research on the effectiveness of cooperative learning, (4) perceptions and use of cooperative learning, and (5) conceptual model of cooperative learning. Taken all together, this body of literature makes the case that understanding how two-year college math faculty perceptions of cooperative learning influence its implementation in the classroom will help to inform efforts to promote its use in two-year college mathematics and provide appropriate professional development for instructors in this area.

Cooperative Learning

Cooperative learning is the "instructional use of small groups so that students work together to maximize their own and each other's learning" (Johnson, Johnson, & Holubec, 1998). Cooperative learning involves groups of students actively working together to accomplish a common goal. The group fails or succeeds together, thus illustrating that cooperative learning does not focus simply on individual students succeeding.

Cooperative learning can be differentiated from collaborative, competitive, and individualistic learning. Collaborative learning, often used as an inclusive expression for small-group learning, involves "joint intellectual effort by students, or students and teachers together" (Smith & MacGregor, 1992, p. 10). In collaborative learning environments, students actively work in groups of two or more to understand content, develop solutions, or create a product. Collaborative learning stands distinct from cooperative learning, because cooperative learning is more narrowly defined since it is explicitly designed to ensure shared goals and individual accountability. Competitive learning involves students working against each other to accomplish a learning goal without consideration (and possibly at the expense) of other students' learning goals. In competitive learning environments, the common goal concept is missing, resulting in students competing with others to achieve a learning goal that not all students can achieve (Anstrom, 2010; Johnson & Johnson, 2009). Individualistic learning involves students working independently so the responsibility of accomplishing a learning goal lies with each student. In individualistic learning environments, students work by themselves to accomplish learning goals unrelated to those of other students (Johnson & Johnson, 2009). Though there are limitations on when and where competitive and individualistic learning may be used appropriately, any learning task may be structured cooperatively (Johnson, Johnson, & Smith, 2014).

The potential for cooperative learning exists any time students interact. However, cooperative learning will only develop successfully if essential elements are put in place by the instructor. According to Johnson, Johnson, and Smith (2006), cooperative learning has five interrelated key elements: positive interdependence, face-to-face promotive interaction, individual and group accountability, use of small-group skills, and group processing. Researchers suggest that for a pedagogical method to be truly cooperative, it must be structured to facilitate these elements (Johnson & Johnson, 1999).

The core component of cooperative efforts is positive interdependence, in which the success of individuals is linked to the success of the group (Johnson & Johnson, 2009). Individual students succeed to the degree that the group succeeds. Group members work together to learn from each other, promote everyone's success, and share in the group's success. Positive interdependence produces a positive relationship among group members that motivates them towards mutual success. It also gives students a vested interest to work together to overcome challenges and accomplish goals that would be difficult to reach individually. There are four ways to ensure positive interdependence: goal interdependence, resource interdependence, role interdependence, and reward interdependence (Johnson & Johnson, 1999). Goal interdependence is achieved by setting up clear and mutual goals. Group members understand that individual goals are met only when all group members meet their goals too. Resource interdependence is achieved when group members must rely on each other for appropriate resources. In this case, each group member is provided with limited information and/or resources so they must share in order to complete the task. Role interdependence gives each group member a different role that provides specific responsibilities for members and requires them to complete a portion of the task. Reward interdependence provides the group with joint rewards for their overall performance and effort (Johnson & Johnson, 1994).

The second essential element of cooperative learning is promotive interaction. Students promote each other's success by actively helping, supporting, encouraging, and praising each other's efforts to learn. Examples include orally explaining how to solve problems, teaching a concept to another student, or connecting current with prior knowledge (Johnson, Johnson, & Holubec, 1994). As face-to-face promotive interactions increase among group members, accountability to peers, social support, and ability to influence each other's conclusions all increase. However, to obtain meaningful promotive interactions, the size of the group should not exceed four students (Johnson & Johnson, 1999).

The third element of cooperative learning is individual accountability, which exists when the performance of each individual student is assessed, and results are reported back to the group. Each group member is accountable for contributing his or her share of the work and the group is also held accountable for reaching its goals. Common ways to provide for individual accountability include individual exams, student explanations of what they learned to the class, randomly selecting a group member's work to represent the entire group, and teacher observation (Johnson & Johnson, 1999).

The fourth essential element of cooperative learning is appropriate use of small-group skills. Interpersonal and social skills are required to contribute to the success of a cooperative learning effort. Placing students who lack social skills in a group and asking them to cooperate with group members does not ensure that they will be able to do so. Small-group skills, such as trust building, communication, and conflict-management skills, should be taught just as purposefully and precisely as academic skills (Johnson & Johnson, 1999).

The last essential element of cooperative learning is group processing. Students should frequently evaluate their group productivity, where they reflect on and discuss how the group functions and provide feedback to each group member (Johnson, Johnson, & Holubec, 1994). Groups need to process in order to talk about what actions are helpful and unhelpful and decide what to continue or discontinue in the future. When challenges occur, students must identify, define, and solve the problems working cooperatively (Johnson & Johnson, 1999).

Understanding how to implement these five elements allows instructors to structure any lesson cooperatively and adapt cooperative learning to their specific needs and students. More importantly, understanding the use of cooperative learning enables instructors to intervene to improve the efficacy of groups (Johnson, Johnson, & Smith, 2014).

Historical Roots of Cooperative Learning

The use of cooperative learning in postsecondary classes has its roots in social constructivist and social interdependence theory. Lev Vygotsky (1986) suggests that knowledge is a social product, because it arises at the social level before the individual level. He claims that working with a more knowledgeable and capable person is pertinent to cognitive development. By focusing on the individual embedded in a cooperative learning context, Vygotsky noted that learning is first mediated on a social level between an individual and other people in his or her environment, and then is internalized by that person on an individual level. Moreover, Vygotsky (1978) saw that learning on the social level often involves mentoring provided by more experienced and knowledgeable individuals, who engage in activity with less experienced individuals in a process of guidance or cooperation. In order for learning to process from the social to the individual level, language serves as a psychological tool to regulate objects, others, and themselves in organizing functions that are critical to cognitive growth. From this perspective, the development of an individual must consider both the individual and the social environment in which the individual has developed. As a result, learning is "embedded within social events and occurring as a child interacts within people, objects and events in the environment" (Vygotsky, 1986, p. 287).

The use of cooperative learning in college classes also has its roots in social interdependence theory. According to Johnson and Johnson (1994), social interdependence theory provides the basis for understanding the necessary conditions for cooperation to develop. Johnson, Johnson, and Smith, (2007) propose that social interdependence "exists when the accomplishment of each individual's goals is affected by the actions of others" (p. 15). The type of interdependence that is built into course activities determines how individuals interact with one another, and as a result, broadly determines outcomes (Deutsch, 1962; Johnson, 1970).

The historical roots of social interdependency theory can be traced to the Gestalt school of psychology and Kurt Koffka, who proposed that groups were dynamic wholes in which the interdependence among members could differ (Deutsch, 1949). Building on these roots, Kurt Lewin (1948) proposed that the essence of a group is the interdependence among members that results in the group being a dynamic whole so that a change in the state of any member or subgroup changes the state of any other member or subgroup. Group members are made interdependent through common goals. As members perceive their common goals, a state of tension arises that motivates movement toward the accomplishment of the goals.

Morton Deutsch (1949, 1962), one of Lewin's graduate students, extended Lewin's notions about social interdependence and formulated a theory of cooperation and competition. He conceptualized two types of social interdependence: positive interdependence, which is viewed as cooperation; and negative interdependence, which is viewed as competition. Positive interdependence exists when there is a positive correlation among individuals' goal achievements. Students perceive they can reach their goals if and only if other group members also reach their goals. Negative interdependence exists when there is a negative relationship among individuals' goal achievement. Students perceive that they can achieve their goals if and only if the other students with whom they are competitively linked fail to reach their goals.

David Johnson, one of Deutschs' graduate students collaborating with Roger Johnson, extended social interdependence theory and developed procedures for instructors. The basic premise of social interdependence theory is that the way social interdependence is structured by the instructor determines how students interact, which in turn, determines outcomes (Johnson & Johnson, 2009). According to their framework, positive interdependence is found in cooperative learning environments that are described by face-to-face interactions, individual responsibility in working toward a group goal, the use of interpersonal skills, and group processing through the exchange of feedback and explanations (Johnson & Johnson, 2009). Negative interdependence, which is characterized by competitive learning, results in oppositional interaction as students discourage and hinder each other's efforts to learn. No interdependence exists when there is no interaction involved among individuals. No interdependence results when students try to achieve the goal independently (Johnson & Johnson, 1990; Johnson, Johnson, & Holubec, 1998). Moreover, in classrooms with negative or no interdependence, where students work on their own, students do not benefit from an improvement in cognitive growth and social skills that is thought to result from the exchange of information amongst peers. From the research on social interdependence theory, Johnson and Johnson (2009) note that cooperative learning typically results in greater efforts to achieve, more positive relationships among students, and greater psychological health. The effects of social interdependence on these outcomes separate cooperative learning from other pedagogical approaches.

Research on the Effectiveness of Cooperative Learning

Meta-analyses and systematic research reviews on cooperative learning are useful in providing evidence on the effectiveness of this approach in higher education classrooms. The following research studies examined the effects of cooperative learning on student achievement and outcomes related to student engagement.

Springer, Stanne, and Donovan (1999) conducted a meta-analysis to examine the effects of cooperative learning on student achievement in postsecondary STEM courses. The search produced 383 reports related to two forms of small-group learning, cooperative and collaborative learning, in postsecondary STEM courses from 1980 or later. After several inclusion criteria were considered to determine whether a report met the requirements for providing adequate research data, thirty-nine studies were eligible for inclusion in the meta-analysis. Springer, Stanne, and Donovan (1999) concluded that STEM students who learned in small groups demonstrated greater academic achievement on instructor-designed assessments than students in traditional instruction, or students who were not exposed to cooperative or collaborative learning (effect size = 0.51). The authors also found that students who worked in small groups exhibited a higher level of persistence through STEM courses than their counterparts (effect size = 0.46). The final result from this study notes that students expressed more favorable attitudes towards learning compared to students who were not exposed to small groups (effect size = 0.55).

Johnson, Johnson, and Smith (1998) also conducted a meta-analysis including 168 studies, conducted between 1924 and 1997, comparing the effectiveness of cooperative learning, compared to competitive and individualistic learning, on academic achievement on verbal (e.g., reading, oral presentations), mathematical (e.g., solving a problem), and procedural (e.g., laboratory exercises) tasks in postsecondary classes. Individual students in these studies were eighteen years or older. This meta-analysis indicated that cooperative learning promotes higher individual academic achievement than both competitive (effect size = 0.49) and individualistic (effect size = 0.53) learning, which are both significant and substantial increases in achievement (Johnson, Johnson, & Smith, 1998). The authors found that cooperative learning improves a range of achievement measures including accuracy, creativity in problem solving, higher-level reasoning, knowledge acquisition, and retention. The authors also identified studies that found significant advantages for cooperative learning in promoting metacognitive thought, willingness to take on difficult tasks, persistence in working towards goal achievement, intrinsic motivation, transfer of learning from one situation to another, and greater time spent on task. These results are consistent with results from Springer, Stanne, and Donovan's (1999) meta-analysis that examined the effects of cooperative and collaborative learning collectively on student achievement in postsecondary STEM courses.

The most recent meta-analysis of 305 studies conducted by Johnson, Johnson, and Smith (2014) found that cooperative learning is the pedagogical method of choice when faculty want to "maximize students learning, ensure that highly complex or difficult material is understood, and maximize long-term retention" (p. 114). Extending on their initial meta-analysis (Johnson, Johnson, & Smith, 1998), the authors found three factors that contribute to cooperative learning improving the aforementioned achievement measures: quality of relationships among students and between faculty and students; psychological health; and attitudes towards the university experience.

Several researchers have investigated the quality of the relationships among students and between faculty and students (Astin, 1993; Pascarella, 2001; Tinto, 1993). Johnson, Johnson, and Smith's (2014) recent meta-analysis found that cooperative learning promotes more positive relationships among students than does competitive (effect size = 0.68) or individualistic learning (effect size = 0.55), even among college students from different ethnic, cultural, language, social class, ability, and gender groups. These studies included measures of interpersonal attraction, cohesiveness, and trust. Moreover, college students exposed to cooperative learning perceive greater social support from peers and instructors than students working competitively (effect size =

0.60) or individualistically (effect size = 0.51). These results corroborate findings from a previous study that the quality of college life depends on the quality of relationships (Tinto, 1993). Positive interpersonal relationships promoted by cooperative learning can increase the quality of students' social adjustment to college life, the importance of social goals for students' persistent attendance, students' integration into college life, and students' sense of belonging in college (Smith et al., 2005).

Attending college also requires substantial personal adjustments for many students. Meta-analysis results show that working cooperatively in groups, and valuing cooperative learning, results in greater psychological health, higher self-esteem, and greater social competence than does competing with one another or working independently (Johnson & Johnson, 1999; Johnson, Johnson, & Smith, 2014). When students actively work together, they improve social skills and competence by interacting, gain confidence by promoting each other's success, and create the foundation for strong social development by forming personal and professional relationships. These results also corroborate findings from Tinto's (1993) study that the psychological health promoted by cooperative learning has various positive effects on the college experience. Tinto notes that psychological health promoted by cooperative learning increases students' academic self-efficacy, quality of psychological health in regard to college life, ability to formulate and accomplish meaningful goals, ability to deal with uncertainty, and ability to develop and maintain interpersonal relationships (Tinto, 1993).

Johnson, Johnson, and Smith's (2014) meta-analysis also focused on student attitudes promoted by cooperative learning. Results show that cooperative learning promotes more positive attitudes toward learning, the subject area, and the college than do competitive (effect size = 0.37) or individualistic (effect size = 0.42) learning. Johnson and Johnson (2009) note that social psychological theories (e.g., social constructivism, social interdependence theory) predict that students' attitudes, behaviors, and values are most effectively developed and changed in cooperative learning environments.

The research on the effectiveness of cooperative learning is extensive, captivating, and "even more impressive than it looks" (Johnson, Johnson, & Smith, 2014, p. 103) for several reasons. For one, the research studies presented in this literature review include a combination of practical and theoretical studies conducted in laboratories, classrooms, and colleges. Although lab (or scientific) studies on cooperative learning typically last for a single session, demonstration studies on cooperative learning usually last for an entire academic semester or year. These demonstration studies usually included summative evaluations showing that cooperative learning produces positive results or comparative summative evaluations showing that one group learning strategy works better than others. The combination of both practical and theoretical research on cooperative learning strengthens the confidence college faculty can have when implementing cooperative learning. Furthermore, the research on cooperative learning has validity and generalizability rarely found in the educational literature given that researchers have now been studying this pedagogical approach for over eleven decades (Johnson, Johnson, & Smith, 2014). Many researchers have conducted research studies on cooperative learning with noticeably different orientations working in different colleges and countries with research participants that vary by age, cultural background, gender, nationality, and socioeconomic status (Abrami, Poulsen, & Chambers, 2004; Ishler, Johnson, & Johnson, 1998; Johnson & Johnson, 1994). These researchers have employed a wide variety of tasks, subject areas, research designs, ways of structuring cooperative learning, and ways of measuring independent variables. The volume and diversity of the educational research focusing on cooperative learning is almost unmatched (Smith et al., 2005).

Perceptions and Use of Cooperative Learning

Quantitative and qualitative research on K-12 teacher and postsecondary faculty perceptions and use of cooperative learning provided the motivation for conducting this study. The following studies highlight various perceptions related to cooperative learning and its use.

In an effort to identify teacher perceptions that best predicted the use and non-use of cooperative learning, Abrami, Poulsen, and Chambers (2004) used a survey instrument, called the Cooperative Learning Implementation Questionnaire (CLIQ), that was designed to determine factors that contribute to the implementation and non-implementation of cooperative learning (Abrami, Poulsen, & Chambers, 2004). The authors applied expectancy-value theory to explore teacher implementation of cooperative learning. According to expectancy-value theory, cooperative learning is more likely to be used if its perceived value and the likelihood of success are high, and if these benefits outweigh the perceived costs of implementation (Abrami, Poulsen, & Chambers, 2004; Shah & Higgins, 1997; Shepperd, 1993). Results from their study showed that the components of expectancy-value theory, namely cost, expectancy, and value, could be used as predictive components to the implementation of cooperative learning. This theory led to the development of the CLIQ, which contains forty-eight items grouped based on the three components of expectancy-value theory: perceived cost, perceived value, and perceived expectancy of success. These factors were identified as affecting K-12 teacher perceptions of cooperative learning, which were derived from previous research identifying factors that generally affect the use of innovation by educators (Briscoe, 1991; Ross, 1994). Cost items assessed the perceived demand of cooperative learning on instructors, such as time needed for preparation and time needed for implementation. Value items assessed the perceptions of teachers regarding the usefulness of cooperative learning. These included benefits to both the teacher and the students. Expectancy items examined the perceptions of instructors regarding their expected outcomes when using cooperative learning. These included both internal attributes (e.g., teacher self-efficacy) and external attributes (e.g., student characteristics, classroom environment). All together, these items accounted for over forty percent of the total variance in self-reported use of cooperative learning among over 900 K-12 teachers, which is considerably higher compared to previous studies that focused on factors that impact long-term sustainability of cooperative learning use (Ishler, Johnson, & Johnson, 1998).

Fausnaugh (2016) recently completed his dissertation study that focused on identifying differences in perceptions towards cooperative learning implementation and current teaching practices among elementary, middle school, and high school teachers using the CLIQ instrument developed by Abrami, Poulsen, and Chambers (1998, 2004). Of the 149 survey participants, over seventy-eight percent of participants reported that they either somewhat, largely, or entirely implemented cooperative learning, which is higher than the percentage of cooperative learning users reported by Abrami, Poulsen, and Chambers (2004). The study then employed a multivariate analysis of variance (MANOVA) to determine if there was a statistically significant difference in the mean CLIQ subscale scores between elementary, middle school, and high school teachers. The results of this study show that K-12 teachers have similar perceptions of cooperative learning and similar current teaching practices, meaning no significant difference in mean CLIQ subscale scores was found among the three groups. Participants reported overall lower ratings for perceived expectancy of success and perceived cost, which are not consistent with Abrami, Poulsen, and Chambers' (2004) findings that attribute cooperative learning use to teachers' expectancy of success and perceived cost.

Hunter (2011) examined faculty perceptions and use of cooperative learning at an urban two-year college in the southern United States. The two-year college was selected using convenience sampling since the researcher was a faculty member who had access to the college directory and could contact faculty participants directly (Creswell, 2009). Using a descriptive research approach, Hunter (2011) incorporated a survey, based on the work of Abrami, Poulsen, and Chambers (2004), to gather data about the perceptions of two-year college faculty using a modified version of the Cooperative Learning Implementation Questionnaire (CLIQ) to explore various factors that may affect the use of cooperative learning. The factors identified as affecting the perceptions of teachers about cooperative learning are time-cost, physical-cost, perception of value regarding students, perception of value regarding educators, value, expectancy of success regarding students, expectancy of success regarding knowledge of educators, and expectancy of success regarding training and support (Hunter, 2011). Similar to Abrami, Poulsen, and Chambers (2004), faculty perceptions were grouped based on cost of implementation, value of cooperative learning, and expectancy of success with the use of cooperative learning. Results from Hunter's study indicate that: instructors perceive cooperative learning as a costly instructional strategy; instructors perceive cooperative learning as a valued instructional strategy; and instructors perceive a high expectancy of success for its use.

Anstrom's (2010) dissertation using a case-study research design focused on understanding college faculty perceptions of cooperative learning and how knowledge and experiences guided their instruction. By investigating college faculty perceptions of cooperative learning through the use of focus groups, Anstrom (2010) was able to take an in-depth look at whether current faculty knowledge and experiences with group work aligned with current instructional practice in college classrooms. Faculty participants indicated that students were not interested in cooperative learning and that they did not have the necessary social and interpersonal skills to be successful in cooperative learning. Faculty participants also reported that they could not devote class time to teaching these skills. Moreover, faculty reported having limited knowledge, experience, and training regarding cooperative learning. These perceptions highlight possible barriers and difficulties implementing cooperative learning.

Andersen (2011) conducted a quantitative study that measured the knowledge and attitudes regarding cooperative learning and lecturing of Michigan two-year college math faculty. The study includes a survey that asks math faculty to report their level of cooperative learning use, how they acquired their knowledge of cooperative learning, barriers to cooperative learning use, participation in professional development that address cooperative learning, and attitudes towards cooperative learning. Results from this study show that both full- and part-time two-year college math instructors have knowledge of cooperative learning, although part-time instructors' knowledge of cooperative learning is slightly less. Knowledge of cooperative learning was also greater for females (compared to males) and those instructors who taught developmental math (compared to instructors who have not taught developmental math). The top three reported professional learning opportunities that addressed cooperative learning are professional training, followed by learning from a colleague, and experimentation.

In regards to attitudes towards cooperative learning, Andersen (2011) noted that an increased positive attitude towards cooperative learning correlates with an increased use of cooperative learning in the classroom. An unfavorable attitude towards cooperative learning can be used to predict non-use. The author notes that about seventy-five percent of instructors with knowledge of cooperative learning and a favorable attitude towards it choose to use cooperative learning frequently. However, it is not possible to know what cooperative learning looked like in their classrooms from the survey alone.

In terms of cooperative learning use, Andersen (2011) noted that about half of the faculty participants reported using cooperative learning frequently. Moreover, full-time instructors were more likely than part-time instructors to frequently use cooperative learning. Part-time instructors were more likely than full-time instructors to never use cooperative learning. In addition, female instructions were more likely than male instructors to frequently use cooperative learning. Male instructors were also more likely than female instructors to never use cooperative learning. Instructors reported time constraints, negative reactions to cooperative learning, and cooperative learning not being a good fit for certain students as the main barriers to implementing cooperative learning. In contrast to cooperative learning, Andersen (2011) also noted that the lecture method is used frequently by over ninety percent of two-year college math faculty. Her results corroborate early research that the most commonly used pedagogical method in college math courses is lecturing (Lutzer et al., 2007).

Conceptual Model of Cooperative Learning

A conceptual model (see Figure 2-1) was developed to show how two-year college math faculty perceptions of cooperative learning relate to its implementation in the classroom. Based on this literature review and how Johnson and Johnson (1999) characterize cooperative learning, instructors can be grouped into three categories based on their use: those who use it minimally, those who implement it informally (as what has been characterized as collaborative learning), and those who implement it formally, as prescribed by Johnson and Johnson.

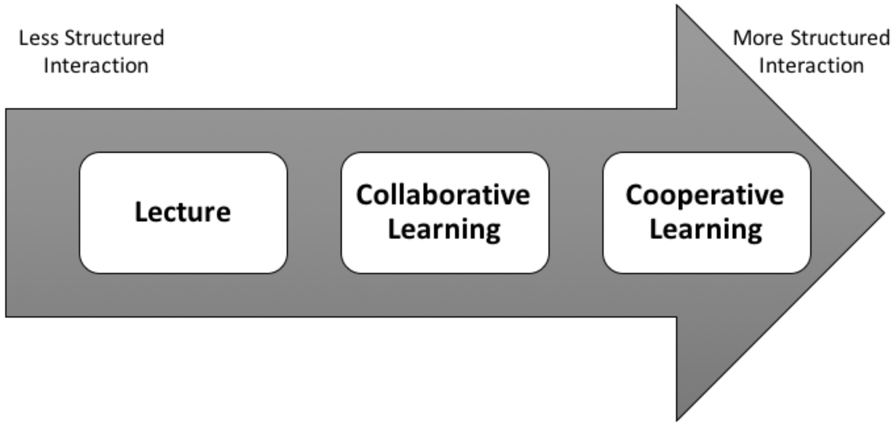

Figure 2-1. Continuum of cooperative learning use

Faculty who use cooperative learning minimally often lecture throughout class. Faculty who tend to tend to lecture are characterized by having teacher-centered classrooms where students are expected to write notes and absorb information. The teacher is primarily in control of all instructional activities. Similar to competitive and individual learning (Johnson & Johnson, 1999), students' goals are not related to one another, which often causes students to work independently. Although some students might choose to work together without direction from the instructor (and possibly even surreptitiously), cooperative learning elements are typically not present in classrooms of faculty who use cooperative learning minimally, if at all.

Faculty who use cooperative learning informally (collaborative learning) often have students work together to achieve shared goals in temporary, ad hoc groups that can last from several minutes to an entire class period (Johnson, Johnson, & Smith, 2006). According to Smith et al. (2005), informal cooperative learning is frequently used in lecture classes. The authors argue that breaking up lectures with short processing times for students to informally work together in groups on an activity ensures that students are actively involved in understanding the content. Moreover, instructors can reorganize the lesson, monitor groups, and listen to student discussions. Informal cooperative learning is often labeled as collaborative learning, because both are recognized as less structured forms of group learning. Control is exerted differently by an instructor who uses collaborative, or any form of active learning (Michael, 2007). Faculty show little to no attention to group formation, student social skills are ignored, and assignments are discussed with little commitment to other students' learning (Smith et al., 2005). While implementing collaborative learning results in less time for lecture and less control for the instructor (compared to lecture), it will increase both the amount of material retained by students and their comfort level working with other students (Johnson, Johnson, & Smith, 2006).

Faculty who use cooperative learning formally often have students working together, for one or multiple class periods, to achieve a shared learning goal and complete a specific task (Johnson & Johnson, 1999). Johnson and Johnson (1989, 2005) argue that only structured cooperative learning will yield the essential elements they have identified: positive interdependence, promotive interaction, individual accountability, social skills, and group processing. An instructor's role in structuring formal cooperative learning includes specifying the lesson objectives, making pre-instructional decisions (e.g., group size, group composition), explaining the task and type of interdependence, monitoring groups, and evaluating students' learning (Smith et al., 2005). There is clear structure to these groups, set in advance by the instructor, which includes task and behavior expectations. If implemented effectively, cooperative learning promotes higher academic achievement, positive relationships among students, higher self-esteem, and more positive attitudes toward learning than competitive and individualistic learning, where the teacher controls much of the classroom interactions through the instructional design (Smith et al., 2005) and through assessing both student learning and the ability for students to interact (Hennessy & Evans, 2006).

Summary of Literature Review

This review of the literature makes the case that understanding perceptions and use of any innovative pedagogical approach has benefits and implications for instructors. Several of the studies referred to in this chapter focus on cooperative learning implemented in K-12 settings. While Andersen (2011) does provide a glimpse into two-year college math faculty perceptions of various instructional practices (e.g., cooperative learning, inquiry-based learning, lecture), this study will attempt to focus primarily on cooperative learning based on Johnson and Johnson's (1999, 2009) work, how two-year college math faculty perceive it, and how they use it in their courses. Given the overwhelming research on cooperative learning in K-12 education, this study is designed to extend on the work of Anstrom (2010), Hunter (2011), and Andersen (2011) by contributing to the knowledge base on two-year college math faculty perceptions and use of cooperative learning. Given the recent math reform efforts in two-year colleges, such as math pathways (Dana Center, 2017) and compressing courses (Fong & Visher, 2013; Jaggars, Edgecombe, & Stacey, 2014), it will be important to study innovative pedagogical methods in the two-year college setting, especially since reform efforts that focus primarily on structural reform divert attention away from instruction (Edgecombe, 2011). Although Hunter (2011) shed some light on two-year college faculty perceptions and use of cooperative learning, she suggested that further research is needed on the perceptions and use of cooperative learning by faculty from more colleges. Andersen (2011) then followed with her dissertation research that focused on Michigan two-year college math perceptions and use of cooperative learning. Unfortunately, she found that the most commonly used pedagogical method for two-year college math courses is lecturing, and was not able to observe cooperative learning specifically in classrooms. Her study also clarified a considerable difference between full- and part-time two-year college math faculty in cooperative learning use. As a result, it will be essential to focus on two-year college math faculty perceptions and use of cooperative learning based on similar demographics (i.e., faculty-status, gender) and other variables of interest (e.g., years of experience, former K-12 experience), so results can be compared. More importantly, gathering both quantitative and qualitative data on two-year college math faculty will help to understand how their perceptions of cooperative learning influence its implementation in the classroom.

Chapter 3 – Pilot Study

During the spring 2016 semester, I conducted a pilot study, or small-scale implementation of my research design, to "test drive" my data collection procedures, detect possible problems with research instruments, and set the stage for my actual study (Creswell, 2015; Teddlie & Tashakkori, 2009). The first purpose of this study was to pilot test a survey instrument to determine needed modifications to the instrument and locate two-year college mathematics faculty with a range of perceptions about cooperative learning for further study in follow-up interviews and classroom observations. The second purpose of this study was to pilot and refine interview and observation protocols for use with a larger sample.

Research Questions

The following research questions were addressed by this pilot study:

1. What are two-year college mathematics faculty perceptions regarding cooperative learning?
2. What does the implementation of cooperative learning look like in two-year college mathematics courses?

Study Participants and Context

The sampling strategy used for the pilot incorporated both purposive and convenience sampling (Teddlie & Yu, 2007). The population for this pilot study was full-time and part-time faculty members who taught at least one face-to-face class during the spring 2016 semester at four Texas two-year colleges, purposefully selected for their involvement in major mathematics reform initiatives, specifically the New Mathways

Project and Achieving the Dream programs: Austin Community College, Brazosport College, College of the Mainland, and McLennan Community College. Collectively, the New Mathways Project and Achieving the Dream work with over 200 community and technical colleges across thirty-seven states (Achieving the Dream, 2016; Dana Center, 2015). This selection was intended to increase the probability of identifying faculty familiar with, and with nominal administrative support for, reform strategies such as cooperative learning. This purposeful sample selection increased the chances of respondents familiar with cooperative learning, but not necessarily employing it with fidelity, enabling me to characterize perceptions of two-year college mathematics faculty regarding cooperative learning and what the implementation of cooperative learning might look like in two-year college math classrooms.

The four two-year colleges chosen were also selected according to proximity and ease of access given my relationship with the Charles A. Dana Center, which developed the New Mathways Project. Faculty participants included in the pilot study were all at least eighteen years old. The study received Institutional Review Board (IRB) approval and instructors who participated gave consent.

Methodology

A mixed methods research design was used in an effort to examine the perceptions and use of cooperative learning by two-year college math faculty. This design helped to address descriptive questions about faculty perceptions in addition to exploratory questions that examine what the implementation of cooperative learning looks like in two-year college math classrooms.

Faculty participants were recruited with the support of the Charles A. Dana Center. Administrators and/or math department chairs at the four selected two-year colleges were contacted to set up correspondence with potential math faculty participants. To recruit participants from the four selected two-year colleges, I sent an email to administrators and/or math department chairs at the college that asked them to send out an invitation email for faculty to participate in the study. The instructions for completing the survey contained informed consent material. The instructions indicated that the participation of faculty members was voluntary, and that by completing and submitting an online survey, faculty participants consented to participate. Participants were not required to identify themselves for confidentiality purposes. The link provided to the online survey also ensured confidentiality. Those faculty participants that did not want to participate simply did not have to access the provided link or complete the survey.

Data for the pilot study came from multiple sources including an online survey, semi-structured interviews, and classroom observations. To help identify faculty perceptions and use of cooperative learning, two-year college math faculty participants were asked to complete an online survey composed of sixty-four total questions. The last eight questions of the survey focused on perceptions of participants' use of cooperative learning. As a result, faculty participants that reported not using or planning to use cooperative learning in the immediate future only needed to answer fifty-six of the sixty-four total questions (see Appendix B).

A majority of the survey questions (56 of 64) are based on items from the Cooperative Learning Implementation Questionnaire (CLIQ) (Abrami, Poulsen, &

Chambers, 2004). The other eight questions were developed to pilot test for future use with math faculty at other two-year colleges. Similar to the CLIQ, my online survey had three sections: professional views on cooperative learning, which was composed of forty-eight Likert-scale items related to faculty perceptions of cooperative learning and two questions focused on classifying cooperative learning activities and identifying possible barriers to implementation; five demographic questions; and nine questions related to current teaching practices. The first and last sections, composed of fifty-nine total questions, focused on faculty perceptions and use of cooperative learning (see Appendix B).

Qualtrics software (Qualtrics, 2017) was used to design and collect data for the online survey. The program has the ability to securely de-identify data for confidentiality purposes. The survey required about seventeen minutes to complete, as documented by Qualtrics. Permission to utilize the CLIQ was received from Dr. Philip Abrami, Director and Research Chair for the Centre for The Study of Learning and Performance at Concordia University in Montreal, Quebec, Canada. Documentation of permission for use is provided in Appendix C.

Although the online survey helped to report faculty perceptions and use of cooperative learning, it alone could not offer an in-depth understanding of the use of cooperative learning in math classrooms. As a result, the online survey was also used to recruit key cases or faculty that would provide a more in-depth understanding about the reasons why faculty choose to or not to use cooperative learning and more importantly, what the implementation of cooperative learning looks like in their math classrooms. At the end of the online survey at the completion screen, faculty were asked if they were interested in being interviewed and/or having observations taken of their use of cooperative learning in the classroom. If participants were interested in having me interview them or come and visit their classroom, I asked for contact information to follow-up via email and schedule an interview and/or observation at a later date.

Semi-structured interviews, which were audio-recorded and transcribed, were then used to elicit a deeper understanding of faculty perceptions regarding cooperative learning. There was a total of two interviews conducted during the spring 2016 semester. Interviews lasted between fifteen to twenty minutes and included notes. A protocol was used for each interview that contained four main questions, although others were asked as follow-up questions. The protocol also included these cues in the event that participants needed to elaborate or provide more detail (see Appendix D).

Semi-structured observations, along with accompanying field notes, also served as a primary method in data collection for the qualitative component of the pilot study. Observations, which are critical to qualitative research (Marshall & Rossman, 2011), were conducted to provide a further picture of what the implementation of cooperative learning looks like in two-year college mathematics courses. The classroom observation instrument (see Appendix E), adapted from the Cooperative Learning Observation Protocol created by Kern, Moore, and Akillioglu (2007), involved gathering both qualitative and quantitative data. Observations included extensive field notes regarding instructor and student behavior throughout the class at time intervals established by the researcher. The goal of incorporating field notes into the observation instrument was to document detailed, unbiased, concrete descriptions of instructor and student behavior using a recurring time scale (e.g., every five minutes). The observation instrument also included columns associated with the five essential elements of cooperative learning (Johnson & Johnson, 1999) and asked the observer to mark the frequency of the elements present. The intent was to record the number of instances that cooperative learning elements were present during the observation (Marshall & Rossman, 2011; Teddlie & Tashakkori, 2009). Definitions and prompts related to the elements of cooperative learning (Johnson & Johnson, 1999; Johnson, Johnson, & Smith, 2006) and what to notice guided the observations in terms of what to document. These definitions and prompts also helped to organize field notes while gathering them in a sequential manner (Teddlie & Tashakkori, 2009) (see Appendix F).

In the pilot study, I used descriptive statistics to analyze the quantitative data collected in the online survey. Questions related to faculty perceptions regarding cooperative learning were grouped based on theme: perceptions regarding cost; perceptions regarding value, perceptions regarding expectancy; perceptions regarding types of cooperative learning activities; perceptions regarding barriers or difficulties to implementation; perceptions regarding support for use; and perceptions regarding use and frequency of use. I then used descriptive statistics in the form of percentages to characterize the data, detect patterns and help communicate the results (Teddlie & Tashakkori, 2009).

I analyzed the qualitative data collected using the constant comparative method (Thomas, 2011). Interview transcripts and observation notes (i.e., protocol notes, field notes) were reviewed several times to find emerging themes that capture the essence of two-year college math faculty perceptions and use of cooperative learning in math classrooms, and determine needed revisions to the observation and interview protocols. This type of qualitative data analysis helped to break down the narrative data to produce themes that simplify comparisons. More importantly, the data will give insight into how two-year college math faculty perceptions of cooperative learning influence its use in the classroom, which was a guiding question for the subsequent study.

Results

From the eligible math faculty members at the four two-year colleges chosen for this pilot study, forty-one completed the survey and formed the sample for the survey (N=41). The completers of the survey included twenty-one full-time (51%) and twenty (49%) part-time two-year college math faculty members. The group of completers included twelve males (29%) and twenty-nine females (71%). Figure 3-1 displays the faculty characteristics identified in the pilot survey broken down by gender and faculty status.

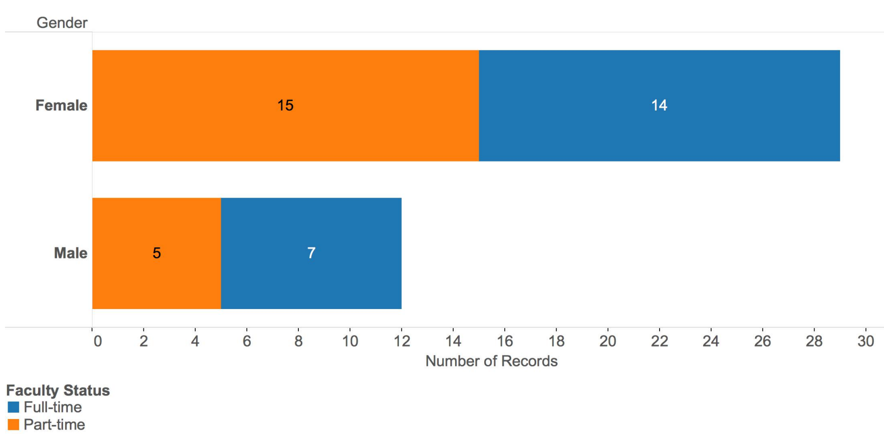

Figure 3-1. Characteristics of pilot participants
(Gender, Faculty Status)

More than two-thirds (N=28) of two-year college math faculty members that completed a survey were currently teaching a developmental math course. Of the twenty-eight participants who taught a developmental course, over half (N=16) were part-time. Figure 3-2 displays these faculty characteristics identified in the pilot survey broken down by whether or not faculty were currently teaching a developmental math course and faculty status.

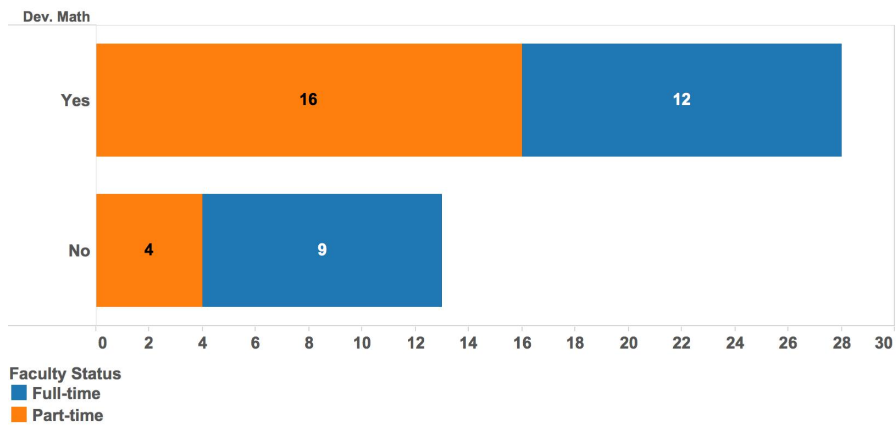

Figure 3-2. Characteristics of pilot participants
(Teach Developmental Math, Faculty Status)

Faculty members were not required to answer all of the items in the final section of the survey that focused on current teaching practices. The first question in the section asked faculty whether they were using or had plans to use cooperative learning in the immediate future. The instructions asked those faculty members who did not use or have plans to use cooperative learning in the immediate future to stop after that question, because the remaining questions dealt with the use of cooperative learning. Of the forty-one faculty members who completed the survey, thirty-four faculty members (83%) reported using or having plans to use cooperative learning in the immediate future.

Research question 1. *What are two-year college mathematics faculty perceptions regarding cooperative learning?* As mentioned earlier, there were a total of fifty-nine questions related to faculty perceptions and use of cooperative learning. The following faculty perceptions regarding cooperative learning were examined using this survey: perceptions regarding cost; perceptions regarding value, perceptions regarding expectancy; perceptions regarding types of cooperative learning activities; perceptions regarding barriers or difficulties to implementation; perceptions regarding support for use; and perceptions regarding use and frequency of use.

Perceptions regarding cost. Seven survey questions in the first section (Professional Views on Cooperative Learning) related to perceptions of faculty regarding the cost of implementing cooperative learning. Questions related to perceptions of faculty regarding the cost of cooperative learning dealt with both physical and time costs. The cost perception items consisted of the following: 3, 20, 27, 32, 36, 38, and 45 (see Appendix A).

The results of this pilot study suggest that the faculty participants perceive cooperative learning as a costly instructional strategy. The grand mean value of the means of the seven questions regarding the costs of cooperative learning was 3.02, out of a five-point Likert scale. Over half of the survey respondents (N=21) agreed or strongly agreed that there is not enough class time available to prepare students to work effectively in groups. Forty-one percent (N=17) of respondents agreed or strongly agreed that implementing cooperative learning takes too much class time. Concerning physical costs, sixty-three percent (N=26) of the respondents reported that they agreed or strongly agreed that implementing cooperative learning requires a great deal of effort.

Perceptions regarding value. Twenty-one survey questions in the first section (Professional Views on Cooperative Learning) related to perceptions of faculty concerning the value or usefulness of cooperative learning. Questions in this category dealt with both faculty-related and student-related values. The value perception items consisted of the following: 4, 6, 7, 8, 12, 14, 15, 16, 21, 22, 25, 26, 29, 31, 34, 35, 37, 39, 42, 46, and 47 (see Appendix A).

The results of the pilot study suggested that faculty participants perceive cooperative learning as a valuable instructional strategy. The grand mean value of the means of the twenty-one questions regarding the value of cooperative learning was 2.97, out of a five-point Likert-scale Approximately two-thirds (N=27) of faculty respondents agreed or strongly agreed that cooperative learning is consistent their teaching philosophy. Seventy-three percent (N=30) of faculty reported to agree or strongly agree that cooperative learning is a valuable instructional approach. Forty-six percent (N=19) of faculty agreed or strongly agreed that they feel a personal commitment to using cooperative learning. Concerning student-related values, eighty-three percent (N=34) of faculty respondents agreed or strongly agreed that peer interaction helps students obtain a deeper understanding of content. Close to three-fourths (N=30) of faculty agreed or strongly agreed that using cooperative learning enhances students' social skills, while sixty-six percent (N=27) of faculty agreed or strongly agreed that using cooperative learning fosters positive student attitudes towards learning.

Perceptions regarding expectancy. Twenty survey questions in the first section (Professional Views on Cooperative Learning) related to perceptions of desired outcomes of cooperative learning. Questions in this category dealt with expectancy regarding students, knowledge of faculty, and training/support. The expectancy perception items consisted of the following: 1, 2, 5, 9, 10, 11, 13, 17, 18, 19, 23, 24, 28, 30, 33, 40, 41, 43, 44, and 48 (see Appendix A).

The results of this pilot study suggest that faculty participants perceive a high expectancy of success when implementing cooperative learning. The grand mean value of the means of the twenty questions regarding the expectancy of cooperative learning was 2.78, out of a five-point Likert scale. Concerning expectancy regarding students, sixty-six percent (N=27) of faculty reported to disagree or strongly disagree that there are too many students in their class to implementing cooperative learning effectively. Only seventy-one percent (N=29) of faculty disagreed or strongly disagreed with the statement that cooperative learning would not work with their students. The majority of faculty think cooperative learning will work with their students. Concerning expectancy regarding knowledge of faculty, the majority (over 90%) of faculty respondents indicated that they are very effective instructors. Almost two-thirds (N=27) of faculty respondents agreed or strongly agreed that they understand cooperative learning well enough to implement it successfully and also have confidence to implement cooperative learning successfully. Eighty percent (N=33) of faculty reported to disagree or strongly disagree that they have too little teaching experience to implement cooperative learning successfully. Concerning perceptions of expectancy regarding training and support, forty-six percent (N=19) of faculty disagreed or strongly disagreed that the amount of cooperative learning training they had received had prepared them to implement it successfully. Additionally, fifty-six percent (N=23) of faculty disagreed or strongly disagreed that their training in cooperative learning had not been practical enough for them to implement it successfully.

Perceptions regarding types of cooperative learning activities. One question included in the survey asked faculty participants to select from a list of classroom activities those they would classify as cooperative learning activities. Descriptive statistics were used to report the number of participants that classified a particular activity as one that involved cooperative learning. Over half of faculty respondents reported the following classroom activities would classify as cooperative learning activities: think-pair-share (N=38, 94%), jigsaw groups (N=33, 80%), team jeopardy (N=30, 73%), students sitting together talking with each other as they work on an assignment (N=26, 63%), whole-class discussion (N=24, 59%), and test-taking teams (N=23, 56%).

Perceptions regarding possible barriers or difficulties to implementing cooperative learning. One open-ended question included in the survey asked faculty participants to list possible barriers or difficulties to implementing cooperative learning in their courses. Results were then exported to an Excel file and coded for emerging themes. A total of ten themes were identified from this question. Forty-nine percent (N=20) of math faculty respondents reported *time constraints.* Twenty percent (N=8) of faculty members mentioned *resisting students*. Seventeen percent (N=7) of math faculty members mentioned *amount of course material to cover*. Fifteen percent (N=6) of faculty respondents reported the *physical setup of the classroom* as a barrier. Ten percent (N=4) of faculty members mentioned *teaching philosophy and/or methods* as a possible barrier to implementing cooperative learning. Other barriers reported included underprepared/struggling students, student dependency on others, computer-delivered courses, students working at different paces, and language/social barriers. See Table 3-1 below for specific quotes grouped by barriers mentioned by participants.

What Participants Mentioned	N (%)	Quotes That Highlight Barriers/Difficulties
Time constraints	20 (49%)	“Time is probably my biggest constraint”; “…lessons take longer than the allotted time”; “Cooperative learning takes time…”; “There simply isn’t enough time in class to use cooperative learning effectively”; “…rarely do I feel that I have enough class time”; “class time management’; “Cooperative learning takes time”
Resisting students	8 (20%)	“Larger classes seem to resist. Also, youngers students resist.”; “Students not wanting to work with others”; “Some students indicate they work more effectively on their own”; “…students are not willing to work with others”; “Students don’t want to put in the added effort to participate in class”
Amount of course material to cover	7 (17%)	“Some courses are too crammed with material”; “We have a lot of material to cover”; “…constraints to cover all the material in the curriculum”; “…using group learning on a regular basis is made difficult…by the requirement to cover several topics”; “Cooperative learning takes a lot of planning upfront”
Physical setup of classroom	6 (15%)	“Overcrowded classrooms, stadium seating, limited whiteboard space”; “I am physically unable to walk around the class to keep tabs on what’s going on”; “Physical set up of the room”; “The tables and chairs in the room are not easily rearranged to facilitate cooperative learning”; “classroom layout”; “classroom space and structure”
Teaching philosophy/methods	4 (10%)	“Un-pedagogical teaching”; “Inevitably, there comes a point where I need to take over and drag them through the rest of the lesson”; “My understanding of methods and my preparation”
Underprepared/struggling students	3 (7%)	“Many students do not do the pre-homework assignments, which slows the classroom down”; “…so few College Algebra students are prepared to take the course. Most do not really have the prerequisite”; “I have students who struggle with the objectives so they don’t even know where to begin”

Table 3-1. Possible barriers to implementing cooperative learning identified by pilot participants

Perceptions regarding support or incentives colleges provide for implementing cooperative learning. One question included in the survey asked faculty participants to select from a list of possible supports or incentives a college provides for implementing cooperative learning. Descriptive statistics were used to report the number of participants that reported a listed support or incentive. Twenty-seven percent (N=11) of faculty members reported *professional learning communities*. Twenty-two percent (N=9) of faculty members reported *no support or incentives provided.* Seventeen percent (N=7) of faculty members reported that the use of cooperative learning was *included in a formal review process.* Fifteen percent (N=6) of faculty members reported the college *provided money/technology resources*. Ten percent (N=4) of faculty members reported the college allowed the *ability to include questions (regarding the use of cooperative learning) on course instructor survey.* Ten percent (N=4) of faculty members reported the college *provided supplemental course materials*. Seven percent (N=3) of faculty members reported the college *provided opportunities to attend professional development or training*. Only one faculty participant (2%) reported an *increase in review or planning time*.

Perceptions regarding professional learning or training participated in within the last year that addressed/focused on cooperative learning. Another question included in the survey asked faculty participants to select from a list of possible professional learning or training opportunities they have participated in within the last year that addressed cooperative learning. Similar to other questions, descriptive statistics were used to report the number of participants that reported a listed professional learning or training opportunity. Forty-six (N=19) reported *personal experiences and/or course preparation.* Forty-one percent (N=17) reported *local professional development*. Thirty-four percent (N=14) reported *use of mentors and/or colleagues*. Twenty-nine percent (N=12) reported *attending or presenting at a conference*. Twenty-two percent (N=9) reported *no professional development or training*. Twelve percent (N=5) reported *locally negotiated curriculum planning/training*. Twelve percent (N=5) reported *administrative/school* *endorsement*. Other types of professional learning or training mentioned include online professional development modules and training offered by the Charles A. Dana Center.

Perceptions regarding use and frequency of use of cooperative learning. One of the most important questions in the survey asked faculty participants whether or not they use or have plans to use cooperative learning in the immediate future. A follow-up question based on whether faculty reported ‘yes’ to the previous question (saying they use or have plans to use cooperative learning), asked how often they use or plan to use cooperative learning in their course(s). Those participants that reported ‘no’ did not have to answer the remaining eight questions on the survey. Based on descriptive statistics, of the forty-one faculty members who completed the survey, thirty-four (83%) reported using or having plans to use cooperative learning in the immediate future (see Figure 3-3). From this subset of faculty members who used or planned to use cooperative learning in the immediate future, more than half (N=18) of CC math faculty members indicated that they use or planned to use cooperative learning in their courses at least one a week or at least once a class period. Thirty-eight percent (N=13) reported using cooperative learning at least once a month. Thirty-five percent (N=12) reported using cooperative learning at least once a week. Eighteen percent (N=6) reported using cooperative learning at least once a class period. Nine percent (N=3) reported using cooperative learning at least once a semester (see Figure 3-4).

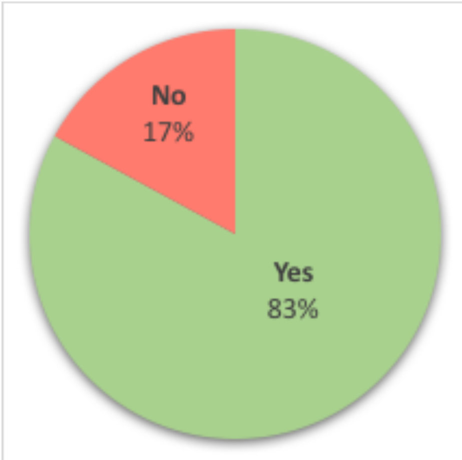

Figure 3-3. Current/planned use of cooperative learning by pilot study participants

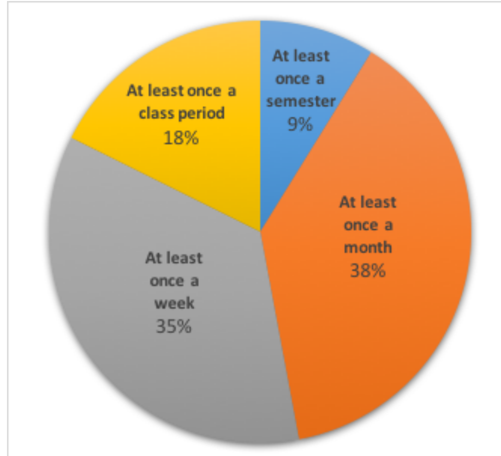

Figure 3-4. Frequency of current/planned cooperative learning use by pilot study participants

Survey Reliability and Validity. Creswell (2009) expressed the significance of establishing the reliability and validity of surveys when used in research. Validity requires that questions measure what they are intended to measure and that respondents interpret the question as intended (Czaja & Blair, 2005). To ensure survey participants had a common understanding of the survey questions, a definition of cooperative learning, based on a definition formed by Johnson, Johnson, and Smith (2014) was provided to the participants prior to answering the questions. Although this definition is different than the one provided on the original CLIQ, it is connected to the theoretical framework underlying this study.

Reliability tells the extent to whether the survey will yield consistent results when repeated over time (Czaja & Blair, 2005). Previous research using the CLIQ, which was administered to 933 K-16 teachers, revealed that the questions in the first section of the survey, which focused on factors identified as affecting faculty perceptions about cooperative learning, fell into three categories: cost, value, and expectancy (Abrami, Poulsen, & Chambers, 2004). A test of internal reliability using Cronbach's alpha for the items within each of the three categories on the original CLIQ was noted to be high (α_{cost} = 0.87, α_{value} = 0.74, $\alpha_{expectancy}$ = 0.86). Factor analysis and testing for internal reliability revealed that the original CLIQ met the required criteria of reliability and validity. A test of internal reliability using Cronbach's alpha for the items within each of the three categories on the modified CLIQ used in this pilot study found it to be average to low (α_{cost} = 0.57, α_{value} = 0.30, $\alpha_{expectancy}$ = 0.65).

Consequently, the results from this pilot study allowed me to consider whether certain survey questions might need to be removed or re-categorized in order increase Cronbach's alpha for certain categories to meet the needed reliability criterion of alpha greater than 0.6 (DeVellis, 2012). For the cost category, removing Q36 increased Cronbach's alpha for this category from 0.57 to 0.78. For the expectancy category, removing Q18 increased Cronbach's alpha from 0.65 to 0.74. Unfortunately, the value category needed to be split into two categories, specifically student-related and faculty-related values, and then regrouped in order to improve Cronbach's alpha to meet the needed criteria of reliability ($\alpha > 0.6$). Following this process, removing Q8, Q15, Q16, Q34, Q42, and Q46 resulted in an increase of Cronbach's alpha from 0.56 to 0.62.

While testing for internal reliability revealed that one or more questions in each perception category on the modified CLIQ needed to be removed to improve Cronbach's alpha, one must take into account the small number of participants (N=41) when comparing results to the original CLIQ survey results (Abrami, Poulsen, & Chambers, 2004). As a result, responses to all questions were included in the analysis for the pilot study. Further discussion about the decision to remove survey questions will occur in the last section of this chapter.

Interview Results. Semi-structured interviews, which were audio-recorded and transcribed, were used to elicit further understanding of two-year college math faculty perceptions and use of cooperative learning in their classrooms, as well as to help refine the interview protocol (see Appendix D). The survey helped locate two-year college math faculty with a range of perceptions about cooperative learning for further study in follow-up interviews.

Two interviews were conducted with two instructors, in relatively different teaching situations. The first participant, Pilot Instructor A, was a female, part-time math instructor at an urban two-year college. The second participant, Pilot Instructor B, was a female, full-time math instructor at a rural two-year college. Each participant was interviewed once. Interviews lasted about twenty minutes, depending on depth of responses, and transcripts produced after the interviews were open-coded for occurring themes.

Major themes arising from analysis of the two interviews showed a difference in how each instructor viewed cooperative learning. Pilot Instructor A defined cooperative learning as students working together in a group on problems that promote dialogue and discussion about the process for solving them. This instructor said, “by verbalizing the mathematical process, they (students) were able to further understand them and learn them (referring to math problems). By having verbal handles, it helped promote the learning." Discussion amongst students and problems that have students think more about a principle or concept were key elements of cooperative learning identified by this instructor.

When asked about her frequency of cooperative learning use, Pilot Instructor A replied "every class, I try to have them (students) cooperatively work." She reported that students are working in groups for about half the time during class. The concept of 'flipping the classroom' influenced Pilot Instructor A's use of cooperative learning because she realized "how valuable it is to have them (students) struggle with homework in my presence." From her experience, students can learn the language behind the math by being involved in dialogue.

Pilot Instructor A reported the availability of faculty supports and incentives for implementing cooperative learning. According to her, the math department "provides a wealth of materials." She was made aware of several resources from the department, including professional development, papers on cooperative learning, support from colleagues, and lessons that support the use of cooperative learning. She also mentioned participating in a couple of classroom observations of different colleagues using cooperative learning.

When asked about possible difficulties to implementing cooperative learning in her courses, Pilot Instructor A mentioned three: getting students to talk to one another; not setting the tone early on with cooperative learning use; and difficulty grouping students. She specifically commented on her experience in the spring 2016 semester, which, according to Pilot Instructor A, was in "stark contrast" to the previous (fall) semester. Students in fall semester were "very gregarious, very talkative, very emotionally-charged students" which she said "made for a very lively classroom." Pilot Instructor A said she started off the first day of class with a cooperative learning activity that groups students by some common interest and has them work together to read, review, and generate a list of questions their group wants answered about the course or course syllabus. This activity introduces students to group dialogue. Unfortunately, Instructor A did not have the same course experience and classroom dynamic in the spring semester compared to the fall semester. According to Instructor A, students from the spring semester course were "extremely quiet." The biggest hurdle she had seen was "getting students to talk to one another," which she blamed on herself for not setting the tone with cooperative learning use. She specifically referenced the first class of the spring semester when she did not use the same cooperative learning activity, which set the tone with cooperative learning use, as she used during the fall semester. When asked what she had done to overcome the mentioned barriers and difficulties, she touched on the use of various grouping strategies to promote discussion and also setting the tone early on when using cooperative learning.

Pilot Instructor B defined cooperative learning as having students actively working together on problems that provided immediate feedback. Active participation, instant feedback, and the use of technology were key elements of cooperative learning identified by this instructor. One example she highlighted involved the use of an online applet that allowed Pilot Instructor B to create an online multiple-choice question for students to answer anonymously through the use of an online link (e.g., Quizlet) that provides immediate feedback on number of students with a corresponding answer choice.

When asked about her frequency of cooperative learning use, Pilot Instructor B said that she incorporated the use of cooperative learning more in the second half of the semester than the first half. She reported several reasons for why she does not use cooperative learning too often at first, which included experimenting with technology to find out what works with the students, making sure students have background and/or prior knowledge, not wanting to let students struggle, and difficulty grouping students. Pilot Instructor B did mention two grouping strategies used (e.g., pick a number, pair with your neighbor), but said she struggles with the idea of letting her students struggle in groups. "Students can see what other level the students are at. I feel bad about that. I don't know if that's proper, good or bad." She went on to say that no teaching strategy will be successful if students do not come to class prepared.

Pilot Instructor B reported that there were no faculty supports or incentives that would lead her to implement cooperative learning more frequently. She did mention that the college provided the technology (i.e., ability to check out laptops, access to computer lab), but this type of support was typically available to all college faculty for any purpose. There was little if any support from her administration besides providing the use of technology.

When asked about possible difficulties to implementing cooperative learning in her courses, Pilot Instructor B mentioned four: grouping students with different levels, unprepared students (e.g., "students who don't do homework"), struggling students, and students who present discipline problems. She also mentioned four barriers to implementing cooperative learning, which include time, amount of course material to cover, difficulty in assessing student work, and difficulty using cooperative learning with certain math topics. When asked what she has done to overcome these barriers and difficulties, Instructor B replied “this is a lifetime project…to work on barriers. You have a different group of students in every class…working on barriers is an ongoing thing.”

Research Question 2. *What does the implementation of cooperative learning look like in two-year college mathematics classrooms?* The pilot study also concentrated on the presence and use of cooperative learning, specifically the presence and use of Johnson and Johnson’s (1999) five elements of cooperative learning in two-year college math classrooms. Two observations were conducted with the same two instructors referred to in the interview reports. Observation 1, which involved Pilot Instructor A, took place in a developmental math class, composed of 8 students, at an urban two-year college in Central Texas. Observation 2, which involved Pilot Instructor B, took place in a developmental math class, composed of 4 students, at a rural two-year college in Southeast Texas. Observation 1 last for 67 minutes and Observation 2 last for 112 minutes.

Classroom Observation Results. Data gathered from two observations, were recorded using a modified version of the Cooperative Learning Observation Guide (Rivera, 2013). The focus of the observations was on the presence and use of cooperative learning, specifically the presence and use of Johnson and Johnson’s (1999) five elements of cooperative learning: positive interdependence, individual accountability, group processing, use of small-group skills, and face-to-face promotive interaction.

During Observation 1, Instructor A made an effort at the beginning of class to group students to solve linear equations on the whiteboard for the warm-up at the front of the classroom. The equations referenced highlighted that students needed to have prior knowledge of simplifying algebraic expressions and using properties of equality to solve linear equations. Instructor A asked one student to solve the first linear equation, $6(x - 2) = -8(x + 4) + 46$, while the other was asked to check their work by plugging in the value for the unknown variable. Another pair of students were given a similar linear equation to solve, $2(4x - 2) = 22$. Each pair was not allowed to sit down unless they prompted the instructor to check their work. Each student was then able to explain how they performed their task (i.e., solve for x or checking the answer). This was an example of positive interdependence and individual accountability. Positive interdependence was displayed because individual students could not succeed in checking their work unless their partner correctly completed their task by solving for the unknown variable. Individual accountability was exhibited as the instructor monitored each group and prompted each student with questions regarding their task for the warm-up. In the schema presented in Figure 2-1, this would be classified as structured or formal cooperative learning (Smith et al., 2005).

Immediately following the warm-up, Instructor A numbered off students and grouped them by the common number to work on a class assignment. This class assignment included problems that review concepts from the previous class meeting, which included mean, median, and mode. Students were provided data sets and prompted to find measures of central tendency for those data sets. Pilot Instructor A appeared to be walking around and monitoring each group's progress by prompting group members to agree or disagree with other group members' reasoning. One student was overheard explaining to another student in a group how they were able to find the median and the process they went about finding the solution. Pilot Instructor A prompted the students to check each other's work when two students were at a disagreement with their solution. This disagreement allowed other group members to explain their reasoning to help others understand how they arrived at their solution. This was an example of face-to-face promotive interaction and the use of small-group skills. Group members respected each other and listened as different group members were explaining their reasoning.

Although Pilot Instructor A was noted in another instance for prompting groups with questions to generate discussion amongst group members, there was little use of this during the second half of class. During the second half of class, the instructor gave a brief lecture on plotting points in a rectangular coordinate system before introducing new lesson content on conversions. Students were seen taking notes and not working in groups. After the brief lesson, students appeared to be solving practice problems individually. Although some discussion amongst individual students was taking place, students were not sitting in groups or working cooperatively with other students. Even with scaffolding provided by the Pilot Instructor A beforehand, students were not able to work together effectively in groups.

During Observation 2, Pilot Instructor B did not make an effort to group students at the beginning of class although one pair of female students sat together at a table. This could be explained by the low number (four) of students present. Instead, Pilot Instructor B used an online applet to display a warm-up question that students answered anonymously using a provided link. Although the two female students were seen working together on the warm-up question, the other two students (one male and one female) worked individually. In the schema presented in Figure 2-1, this would be classified as collaborative or informal cooperative learning (Smith et al., 2005).

After the warm-up, Instructor B showed a video that began to describe how to graph the function "$y=2^x$." Since students were just calculating values for this function during the warm-up, the instructor presented an example that generated discussion based on different answers (specifically, find the value of 2^0). The two paired female students disagreed, which allowed them to revisit their work. While the female pair were reworking the problem, the male student working individually was heard agreeing with one of the responses. Although these students were not necessarily grouped within proximity of one another, students were noted for assessing each other's responses, which indicates some presence of face-to-face promotive interaction.

After the video, Pilot Instructor B lectured on simple/compound interest and models of change. The instructor presented two examples that dealt with writing simple and compound interest formulas. Students were seen recording formulas and calculations for the amount accrued over time in their notebooks. The next two examples asked students to compare a linear and exponential model. Students were asked to compare the linear model, $y = 2x + 1$, to the exponential model, $y = 3(2)^x$, by graphing each model on a coordinate plane and making visual distinctions. While working on these last two examples that asked students to find coordinates to plot, I noted one instance in which a female student from the paired group asked the male student working individually if he also computed the same data point values in his table for the exponential model. The students then discussed a pattern that emerged in the table of values they calculated (i.e., values are doubling over time). This is another example of face-to-face promotive interaction because groups are providing feedback to one another. Following these examples, the instructor reviewed PowerPoint slides that noted differences when comparing and contrasting the linear model, $y = 2x + 1$, and exponential model, $y = 3(2)^x$. No group work or discussion took place during this segment.

The only other instance of cooperative learning that took place occurred in the second half of class after the instructor briefly introduced compound interest. After this brief lecture, Pilot Instructor B passed out a worksheet that asked students to compare the effects of different compounding periods on the interest an investment earns. The instructor then specifically asked students to get into groups. The two female students continued working together. The individual male student gathered his belongings and moved to join the individual female student. The first example on the worksheet asked students to find the amount accrued on the investment after ten years compounded annually. Students had to work in pairs to write both the amount accrued on the investment as well as the equation used for the calculation. During this segment, I noted an instance in which the paired female group took time to discuss their progress on table calculations for finding the amount accrued on an investment after ten years compounded at different periods. This was an example of group processing because the female students were taking time to discuss their progress on calculations to complete the table. During this segment, the instructor could be seen monitoring and assessing this female pair's work informally because she walked over to help the pair figure out how to properly enter the calculation into the calculator by following the order of operations. She prompted the female pair with questions about how to enter the exponential model, with all of its parameters, into the calculator to determine the amount accrued on an investment after ten years compounded at different periods. While this task may not have required elements of cooperative learning, the instructor was noted for the way she assessed her students.

Discussion

In this pilot study, I examined the perceptions and use of cooperative learning by two-year college math faculty members. Data for the pilot study came from self-reported information provided by forty-one respondents to an online survey, most of which is based on a vetted survey instrument (Abrami, Poulsen, & Chambers, 2004), semi-structured interviews, and observations from two two-year college math instructors.

Research question 1. *What are two-year college mathematics faculty perceptions regarding cooperative learning?* This pilot study focused on the perceptions and use of cooperative learning by two-year college math faculty. Faculty perceptions were grouped based on cost of implementation, value (or usefulness), and expectancy of cooperative learning. Perceptions regarding possible barriers to implementation, support/incentives provided by the college, and professional learning were also included in the results.

The results from this pilot study suggested that these two-year college math faculty participants did not perceive cooperative learning as a costly instructional strategy. Similar to Hunter's (2011) results, only a small percentage (15%) of the respondents reported that the cost of implementing cooperative learning is great, and that over half (59%) of them indicated that cooperative learning is an efficient classroom strategy. While roughly half of participants said that implementing cooperative learning does not take too much preparation or class time, Pilot Instructor B noted that students must come to class prepared for any instructional strategy to be successful. Likewise, over half of participants indicated that there is too little time available to prepare students to work effectively in groups, which brings attention to the need for small-group skill development. On the other hand, Pilot Instructor A noted that setting the tone early on with the use of cooperative learning can promote group discussion throughout the semester. This anecdotal example is one instance in which a faculty member experienced lower (physical and time) costs when implementing cooperative learning.

The results also suggested that this group of faculty participants valued cooperative learning as an instructional strategy. The majority (73%) of the respondents agreed or strongly agreed that cooperative learning is a valuable instructional approach. A majority of them (83%) also reported to agree or strongly agree that the peer interaction of cooperative learning helps students gain a deeper understanding of content. Interview data also suggested that the two instructors value cooperative learning as teaching strategy. Instructor A valued group dialogue and the ability to allow her students to struggle with math. Although Instructor B did not like the idea of letting her students struggle, she did value active participation and the ability to provide instant feedback to her students.

The results suggested that two-year college math faculty will make use of cooperative learning if they believe they will be successful implementing it as a teaching strategy. More importantly, many participants noted that cooperative learning would work with their students. The physical set-up of the classroom and class size did not prevent them from implementing cooperative learning. The most commonly mentioned barriers by math faculty participants to implement cooperative learning included time constraints, students' resistance, and the amount of course material to cover.

Although a majority of faculty participants reported that they understood cooperative learning well enough to implement it successfully, over half said they had not received a proper amount of training on cooperative learning. According to Andersen (2011), a two-year college math instructor's first exposure to cooperative learning was professional training, followed by use of colleagues, experimentation, and research. Similar to Andersen's (2011) study, the top three most commonly mentioned types of professional development or training opportunities that faculty had participated in within the last year that focused on cooperative learning were personal experiences and/or course preparation, local professional development, and the use of mentors and/or colleagues. The same comment was also reiterated when faculty were asked about types of support or incentives the college provides for implementing cooperative learning.

Nearly one-fourth of two-year college math faculty reported that they received no support or incentives from the college for implementing cooperative learning. Pilot Instructor B reiterated this in the interview when she said that her "administration doesn't care if they (faculty) use cooperative learning or not." Unfortunately, she was left with little, if any, support for implementing cooperative learning besides access to technology resources. In contrast, Pilot Instructor A had ample support and available professional development opportunities. She could attend professional development opportunities, access resources and lessons using cooperative learning, get support from her colleagues, and conduct classroom observations. Interestingly, each of these professional development opportunities, as with those mentioned above, placed responsibility on the faculty member to actively participate. In some cases, the college may provide access to these professional learning opportunities and resources and faculty must choose whether or not to make use of them, as was the case for Pilot Instructor A. In other cases, the college may not have sufficient resources and access to professional development opportunities. Part of the concern rests in the type of college where each instructor was teaching. For instance, Pilot Instructor A was from a large, urban college that was composed of several campuses and therefore had the capacity to provide support and access to professional development opportunities. On the other hand, Pilot Instructor B was from a small, rural college that does not have the same capacity and, as a result, limited the availability of resources and support for faculty at the college.

Research question 2. *What does the implementation of cooperative learning look like in two-year college mathematics courses?* Types of student behaviors noted in both observations were those of student discussions, students working together to perform calculations, students providing feedback to each other, students assessing each other's work, and groups explaining their reasoning to other groups (or whole class). Types of instructor behaviors noted were those of monitoring group and individual work, prompting groups with questions, reviewing content, providing feedback, and use of grouping strategies.

One major theme arising from analysis of the two observations showed a difference in how each instructor used cooperative learning in their course. Observation results showed that Pilot Instructor A used cooperative learning more frequently and in a more structured, formal way than Pilot Instructor B. Pilot Instructor A grouped her students into teams for the warm-up and then used another grouping strategy to have students work together on a class assignment reviewing math concepts from a previous class. Although there was little use of cooperative learning during the second half of class, interview data confirmed that Instructor A used cooperative learning for about half the class typically. Instructor B, on the other hand, was noted only one time for intentionally grouping students to work on problems. For most of the class, two students were working individually while two others would naturally work together since they sat next to each other. Given the length of time each observation lasted, it is important to note that Pilot Instructor A provided half of the class for cooperative learning. Even with nearly twice as much class time, Pilot Instructor B did not implement cooperative learning more frequently than Instructor A. Part of this occurrence could be explained by the difference between class sizes, eight as opposed to four students, respectively.

Another major theme that arose from analysis of the two observations was a difference in the use of Johnson and Johnson's (1999) elements of cooperative learning, specifically, Pilot Instructor A showed the presence of more elements of cooperative learning than Pilot Instructor B, four of Johnson and Johnson's (1999) five elements of cooperative learning compared to only two. The number of cooperative learning elements in each episode is not significant, however, Pilot Instructor A's ability to include more elements could highlight a better understanding of cooperative learning in general. These contrasting results of the pilot study indicated that it would be important to observe a greater variety two-year college math faculty who implement cooperative learning.

Important Findings Regarding Survey Instrument. Based on the results of the pilot study, one question was added to the survey asking for number of years that faculty participants have been teaching at their respective two-year college. This question allowed me to further characterize faculty participants that participate in follow-up interviews and observations. This question was intended to allow me to select a range of faculty members that had been at a college longer than others had been at their respective college.

The results from the pilot study showed a large number of two-year college math faculty members that do not receive any type of support or incentive from the college for using cooperative learning. Therefore, the answer choice "None" was added to Q54 asking about the type of support or incentives the college provides for implementing cooperative learning.

Based on the results from the internal reliability mentioned earlier, several of the first forty-eight perception questions were removed in order to improve Cronbach's alpha for each perception category (i.e., cost, value, and expectancy), given that these categories include multiple survey items.

Unfortunately, the value category needed to be split into two categories, specifically student-related and faculty-related values, and then regrouped in order to improve Cronbach's alpha to meet the needed criterion of reliability ($\alpha > 0.6$). Following this process, removing Q8, Q15, Q16, Q34, Q42, and Q46 resulted in an increase of Cronbach's alpha from 0.56 to 0.62. Before throwing these questions out, I carefully considered which questions were pertinent to understanding two-year college math faculty value perceptions of cooperative learning. After thorough consideration, items Q8 (Cooperative learning is consistent with my teaching philosophy), Q34 (Cooperative learning enhances the learning of developmental students), Q42 (I prefer using familiar teaching methods over trying new approaches), and Q46 (I feel a personal commitment to using cooperative learning) were removed. While one may argue a change in fidelity and use of the original CLIQ survey instrument given the removal of the aforementioned items, I argue that these questions would have offered no additional insight into the value perceptions of two-year college math faculty.

Discussion with dissertation committee members and survey researchers also helped to clean the survey in terms of logistics and formatting. A survey research expert, who is Assistant Director of Research at the Center for Community College Student Engagement, suggested that two questions be removed, because one question did not apply to post-secondary education and the other was too vague. These questions, specifically Q14 (Cooperative learning contradicts student goals) and Q18 (Cooperative learning is appropriate for the grade level I teach), which was mentioned above, were also removed from the survey.

Important Findings Regarding Interview Protocol. The interview questions helped to provide an in-depth understanding about how faculty characterize cooperative learning and the reasons why they choose to or not to use cooperative learning. Since the interview protocol was semi-structured, there was already some flexibility for probing follow-up questions that were also included in the original protocol. However, both interview participants had to be prompted to provide more detail and even specific examples that focused on the use of cooperative learning. As a result, two questions were added that asked faculty why they are using cooperative learning and what experiences influenced their use of cooperative learning.

Important Finding Regarding Observation Protocol. Even though the proposed observation protocol helped to generate important data, two major changes were made for use in the continuing study. I removed the column that asks the observer to classify the 'Type of Cooperative Learning'. I also removed the 'Notes' column, because many of the behaviors that take place in the classroom could be grouped and explained under instructor or student behavior. Because my study eventually focused on understanding how perceptions of cooperative learning influence its implementation, it was important to keep the 'Instructor Behavior' column present in the observation protocol. Another major change included modifying the beginning section by including descriptive information, which included instructor name, college, date of observation, class start time, total number of students, and characteristics of the class and/or classroom. I made an intentional effort to describe the problem(s) and/or task(s) students are engaging in to situate the observation within a particular mathematical task and learning objectives.

Important Findings Regarding Study Design. This study piloted a survey instrument to locate two-year college math faculty with a range of perceptions about cooperative learning for further study in follow-up interviews and classroom observations. The sampling strategy used for this pilot incorporated both purposeful and convenience sampling. Differences between the small rural two-year college and the larger, multi-site urban college observations in the pilot indicated the need for a broader sampling strategy using a combination of purposive and probability sampling for the dissertation study. Since the Charles A. Dana Center has developed a resource that groups Texas two-year colleges by geographical region, I will be able to use cluster and purposive sampling strategies (Creswell, 2015; Teddlie & Tashakkori, 2009). Two-year colleges are widely distributed geographically across the state, so a cluster sampling strategy helped to generate a more efficient sample in terms of resources available.

Chapter 4 – Methodology

This section will describe the research design that was used to conduct this study. The purpose of this study is to examine two-year college mathematics faculty perceptions and use of cooperative learning in developmental and college-level math courses. The study will also seek to further understand how two-year college mathematics faculty talk about cooperative learning and how they implement it.

Research Design

As in the pilot study, a mixed methods research design was utilized in an effort to examine two-year college mathematics faculty perceptions regarding cooperative learning and how it is used in developmental and college-level math courses. The use of a mixed methods design helped to increase the generalizability of the results through triangulation of the findings (Johnson & Onwuegbuzie, 2004; Creswell & Clark, 2007). A quantitative component, or strand, was used to survey faculty perceptions regarding cooperative learning. In addition to the quantitative component, a qualitative strand, including interviews and observations, provided a deeper understanding of how two-year college mathematics faculty describe and understand cooperative learning and how they implement it in the classroom. According to Teddlie and Tashakkori (2009), a mixed methods research design provided for better inferences and a range of different findings by simultaneously addressing questions that require the use of both quantitative and qualitative approaches.

This study specifically employed a convergent mixed methods research design (see Figure 4-1), which involves separate qualitative and quantitative data collection and analyses that are then merged (Creswell, 2015). The quantitative component consisted of an online survey questionnaire regarding perceptions of cooperative learning based on a survey instrument developed by Abrami, Poulsen, and Chambers (2004). The qualitative component consisted of semi-structured interviews and classroom observations using protocols modified based on results of the pilot study (Kern, Moore, & Akillioglu, 2007; Rivera, 2013) to further understand how two-year college mathematics faculty describe and use cooperative learning in their courses. Convergent designs merge the qualitative and quantitative databases. While the study is exploratory in nature, this convergent design involves triangulation. Creswell (2015) talks about the development of joint displays (i.e., graphs or tables) that display the quantitative results against the qualitative results. Thus, diagrams were generated in response to the research questions.

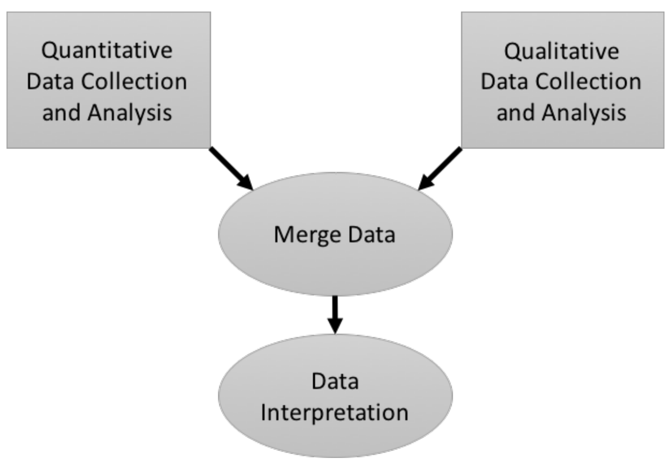

Figure 4-1. Convergent mixed methods research design

Setting

The research setting includes community and two-year colleges in Texas. There was a total of seventy-one two-year colleges that were eligible to participate in the study. Technical colleges were not included in the study. Each college was categorized by state geographical region (see Table 4-1): central Texas (7 colleges), east Texas (8 colleges), north Texas (19 colleges), south Texas (12 colleges), southeast Texas (16 colleges), and west Texas (9 colleges). Grouping colleges by geographical region helped to support a sampling strategy (described in a later section) that was used to produce a more efficient probability sample (Tashakkori & Teddlie, 2003; Teddlie & Tashakkori, 2009).

Central Texas Region	East Texas Region	North Texas Region
Austin Community College Blinn College Central Texas College Hill College McLennan Community College Navarro College Temple College	Angelina College Kilgore College Northeast Texas Comm. College Panola College Paris Junior College Texarkana College Trinity Valley Comm. College Tyler Junior College	Cisco College Collin College Dallas Co. Comm. Colleges Grayson College North Central Texas College Ranger College Tarrant County College Vernon College Weatherford College
South Texas Region	**Southeast Texas Region**	**West Texas Region**
Alamo Colleges Coastal Bend College Del Mar College Laredo Community College South Texas College Southwest Texas Jr. College Texas Southmost College Victoria College	Alvin Community College Brazosport College College of the Mainland Galveston College Houston Community College Lee College Lone Star College System San Jacinto College Wharton County Jr. College	Amarillo College Clarendon College El Paso Comm. College Frank Phillips College Howard College Midland College Odessa College South Plains College Western Texas College

Table 4-1. Texas two-year colleges classified by region

Participants

The participant pool for this study included full- and part-time two-year college mathematics faculty members who taught at a community or two-year college during the fall 2016 or spring 2017 semester. Eligible faculty participants must have been over 18 years old and have been currently teaching or have previously taught at least one face-to-face developmental or college-level mathematics course. The participants were diverse in gender, faculty status (full- or part-time), number of years taught at their respective college, whether they were a former K-12 teacher, whether they were currently teaching a developmental mathematics course, and whether they were using or had plans to use cooperative learning in the immediate future. As noted in the previous chapter, questions that focused on these demographics were added to the survey after the pilot study.

Participation in the study by faculty members was voluntary. Faculty members were informed about participation in the study at two points during the sample selection process: once in the email informing them about the study, and secondly in the introduction to the online survey. In the second instance, the survey link directed faculty participants to the first page of the online survey, which represented the consent form. This consent form informed participants about the study and provided pertinent information including study benefits, risks, privacy, and confidentiality of data. Participants were reminded that participation in the study was voluntary and they could decline to answer any questions and had the right to withdraw from participation at any time during the study.

The survey provided a “Next >>” button at the bottom of the web page for those interested in participating. Those that did not want to participate were simply advised to close the browser window to stop participating. The online consent form browser window and acceptance process were both approved by The University of Austin Institutional Review Board.

Number of Participants

While twenty-three colleges were notified and prompted by an email regarding participation, a total of fifteen colleges (e.g., community, junior, and two-year) participated in the study, for a response rate of sixty-five percent. Participation by a college meant that a college administrator either replied to an invitation email confirming a request to distribute the survey invitation or the administrator directly forwarded my invitation email including me in the address. Information regarding a demographic breakdown by responding colleges can be found in Table 4-2, which was obtained from the 2016 Texas Public Higher Education Almanac (Texas Higher Education Coordinating Board, 2016).

College Name	Enrollment Total	College Size	HBCU/HSI or Neither	Number of Faculty	% Full-time
Angelina College	5,145	Medium	Neither	337	32%
Central Texas College	9,539	Large	Neither	620	37%
Coastal Bend College	4,436	Medium	HSI	170	41%
Galveston College	2,071	Small	HSI	99	56%
Hill College	3,977	Medium	Neither	232	46%
Lone Star College Kingwood	11,477	Very Large	HSI	612	11%
Lone Star College Tomball	7,221	Very Large	HSI	330	12%
McLennan Community College	8,300	Medium	HSI	463	49%
Midland College	5,413	Medium	HSI	258	48%
Navarro College	9,420	Large	Neither	580	31%
North Central Texas College	9,533	Large	Neither	449	30%
Northeast Texas Community College	2,704	Small	HSI	172	34%
Ranger College	2,052	Small	Neither	98	29%
Western Texas College	2,127	Small	HSI	93	44%
Wharton County Junior College	7,416	Medium	HSI	291	58%

Table 4-2. Demographic breakdown of responding colleges

Overall, there were a total of sixty-four faculty participants that completed an online survey out of a total number of 272 participants that were emailed an invitation, which corresponds to a response rate of twenty-four percent. Completion of the survey required a participant to answer over ninety percent of the survey questions and proceed to the completion screen at the end of the survey. Each college included in the study exhibited a different response rate. A breakdown of response rates by college will be included in the results section.

Instrumentation

For purpose of answering the mixed methods research questions, an online survey questionnaire, semi-structured interviews, and classroom observations were gathered and analyzed for the purposes of triangulation (Denzin, 1978).

Online Survey. Faculty participants were asked to complete an online survey, some of which was adapted from the Cooperative Learning Implementation Questionnaire (CLIQ), developed by Abrami, Poulsen, and Chambers (2004). The online survey, as modified based on responses in the pilot study, included multiple-choice and Likert scale questions, using six-point as opposed to five-point Likert scale, that focused on various perceptions of cooperative learning, as well as open-ended questions that asked about use of cooperative learning.

Administration of the survey instrument followed the protocol in the pilot study with the changes noted in the previous chapter. Faculty participants were informed that cooperative learning would be abbreviated as “CL” for most of the survey items to avoid repeating the phrase throughout. They were also informed about the question response scales, next and back buttons, and the progress bar prior to beginning the survey. The final version of the survey instrument is included in Appendix G.

As noted in the previous chapter, a number of demographic items were added based on the results of the pilot study. Section two, demographic questions, consisted of six questions. Participants were asked to report their college name, gender, faculty status (full- or part-time), number of years taught at their respective college (0-1 years, 2-4 years, 5-9 years, 10+ years), whether they were a former K-12 teacher, and whether they were currently teaching a developmental mathematics course. Those that mentioned being a former K-12 teacher were further prompted to report what grade level they taught (e.g., elementary, middle, or high school).

The last section of the survey, current teaching practices, consisted of five questions. However, some participants would not have to answer all five questions. The first, and most important, question in this section asked if the participant currently used or had plans to use cooperative learning in the immediate future. Those faculty participants that selected 'yes' were then prompted to answer the remaining four questions: one multiple-choice and three open-ended questions. The multiple-choice item questioned how often faculty use or planned to use cooperative learning in their courses (e.g., once a semester, once a month, once a week, once a class session). The following three open-ended questions were intended to provide thick descriptions about faculty use and experiences using cooperative learning in their courses. One question asked faculty to describe what aspects of cooperative learning they use. The second question asked why they were using cooperative learning and the last question asked about experiences that have influenced faculty use of cooperative learning.

Interviews. Semi-structured interviews were used to elicit a deeper understanding of faculty perceptions regarding cooperative learning. There were total of twenty-four interviews conducted during the fall 2016 and spring 2017 semester. Interviews typically lasted between fifteen to twenty minutes and included notes.

As in the pilot study, the protocol used for each interview contained eight questions. However, as noted in the above, in the pilot study faculty participants sometimes had to be prompted to provide more insight and detail to previous responses. The revised protocol also included these cues in the event that participants needed to elaborate (see Appendix H).

Observations. Semi-structured observations, along with accompanying field notes, also served as a primary method in data collection for the qualitative component. Observations, which are critical to qualitative research (Marshall & Rossman, 2011), were conducted to provide a further picture of what the implementation of cooperative learning looks like in two-year college mathematics courses. The observation protocol used in the pilot study (adapted from the Cooperative Learning Observation Protocol created by Kern, Moore, and Akillioglu (2007)) was used for the dissertation with the revisions described in the previous chapter. The final protocol is located in Appendix I.

Student artifacts. Group work and other student artifacts (e.g., handouts, photos of student work) produced by groups during classroom observations were also analyzed as part of the study. According to LeCompte and Preissle (1993), student artifacts are considered unobtrusive measures because no numeric information is included since these artifacts result from a human activity that has symbolic meaning. Artifacts can also complement the other data sources to provide a complete picture of two-year college mathematics faculty perceptions and use of cooperative learning. Student artifacts shed light on the resources that support the use of cooperative learning without interfering with or changing the way the instructor uses it.

Data Collection Procedure

This study featured a sequential mixed methods sampling strategy where the quantitative (first) strand directed the methodology used in the qualitative (second) strand. The quantitative component of the study used a probabilistic sampling technique while the qualitative component employed a purposive sampling technique.

A cluster sampling technique was employed for the quantitative component. Given that the population of community and two-year college mathematics is widely distributed geographically across the state, a cluster sampling strategy was used to generate a more efficient probability sample in terms of resources available (e.g., money, time). In particular, a two-stage random cluster sample was drawn in which clusters were selected at random in the first stage of sampling and the units of interest were then randomly sampled within clusters in the second stage (Teddlie & Tashakkori, 2009). For this study, the first stage is composed of community and two-year colleges clustered into six geographical regions in Texas (see Table 4-1). Each region was assigned a random number from one to six. The second stage is composed of individual community and two-year colleges from each geographical region, which were also randomly assigned a number for sampling purposes. The units of interest were the full- and part-time mathematics faculty members at those individual colleges. Since the population of interest was two-year college mathematics faculty at these individual colleges, no further random selection was needed among participants.

Administrators, which include department chairs, deans, and presidents, of the two-year colleges, were contacted to set up correspondence with mathematics faculty members. In some cases, multiple administrators were contacted, because developmental mathematics and college-level mathematics were housed in different academic departments (e.g., Division of Student Success, Department of Developmental Studies). The intent of emailing an administrative contact from each college was to have them setup correspondence with mathematics faculty members directly (given their accessibility to departmental directories) by forwarding an Institutional Review Board approved email informing and inviting faculty to participate in the study. Once the administrator forwarded the email, I used an extensive follow-up process that consisted of weekly reminders and emailing to colleges that did not respond. Some colleges did not respond despite being sent repeated email reminders, and one must consider how this attrition can cause a threat to the generalizability of the findings (Ary et al., 2007).

Using a purposive sampling technique for the qualitative component, a small number of faculty participants were selected to provide valuable, descriptive information linked to how two-year college mathematics faculty perceptions of cooperative learning influence its implementation in the classroom. A purposeful sample of two-year college mathematics faculty members was drawn based on their willingness to participate in an interview and/or classroom observation. Faculty participants were recruited from the quantitative component. As in the pilot study, the completion screen prompted a question asking faculty if they were willing to provide interviews or classroom observations. Faculty participants that were interested in completing an interview and/or classroom observation were contacted to schedule a possible day and time to conduct a phone interview and/or visit their classroom. Reminder emails were sent to participants that took over a week to reply to the original email verifying their interest in being interviewed and/or observed.

Data Analysis

Both quantitative and qualitative data analysis techniques were used to analyze the data collected in the study. The quantitative strand yielded descriptive statistics (e.g., frequency, means), which were analyzed to find trends and patterns among the data. Descriptive statistical analysis techniques help summarize quantitative data in understandable visual displays that help to find patterns, relationships, and better communicate the results (Teddlie & Tashakkori, 2009). An appropriate data file (.csv) from each semester (fall 2016 and spring 2017) was exported to merge into one combined file that could be imported into a statistical software program. For this study, the statistical software SPSS was used to organize, analyze, and display data. In addition, a MANOVA was performed to determine the statistical significance of apparent trends identified in the descriptive data.

The online survey also included several open-ended questions that involved coding to identify emergent themes among participant responses. Themes arising from each question will be presented in a table that includes the theme, number of responses for that theme, and quotes that support the theme.

The qualitative component used the constant comparative method to analyze the qualitative data collected. This qualitative data analysis technique allows for the comparison of various data sources to develop categories and themes while constantly assessing the credibility of the researcher's developing understandings (Glaser & Strauss, 1967; Lincoln & Guba, 1985). Audio recordings were transcribed to search for themes related to faculty perceptions of cooperative learning. Classroom observation notes from the protocols were summarized to highlight how faculty describe and use cooperative learning. Classroom artifacts and field notes from the classroom observations helped to document what the implementation of cooperative learning looks like in community and two-year college developmental and college-level mathematics classes.

For this study, all qualitative data (interviews, observations, classroom artifacts, and field notes) were archived using the MAXQDA software (MAXQDA, 2017) and reviewed numerous times to discover emerging themes that capture the essence of two-year college mathematics faculty perceptions and use of cooperative learning in developmental and college-level math courses. The benefit of reviewing data several times is the ability to select good quotes to illustrate themes (Thomas, 2011). All data sources were triangulated to provide an understanding of how two-year college mathematics faculty perceptions of cooperative learning influence its implementation in the classroom. Triangulation at the end of the study (Tashakkori & Teddlie, 2003) allowed for cross-checking of survey data, interview data, classroom observation data, and their respective data collection strategies to assess the robustness and limitations of the findings. Employing a sequential mixed data analysis increased the validity of the study's findings by corroborating quantitative and qualitative results.

Limitations

One limitation of this study is the use of an online survey. One potential source of error with online surveys is unit nonresponse. According to Czaja and Blair (2005), online surveys receive lower responses rates than mail and interview-administered surveys. While many would argue that it is easier to decline participation in online surveys, this study attempted to address the problem of unit nonresponse by limiting the questionnaire to a specific population, in this case mathematics faculty, either full or part time, teaching at Texas community or two-year colleges. Also, this study uses multiple follow-up efforts, including sending personal e-mail invitations or having a campus administrator forward an e-mail to faculty (Czaja & Blair, 2005), to help increase the response rate.

Another potential limitation with online surveys is item nonresponse. One way to avoid this issue is to program the online survey so that the respondents cannot advance (or complete survey) if they skip a question. Czaja and Blair (2005) see this as a 'mixed blessing' since respondents who feel strongly about skipping a question have the option of providing false responses or merely refusing to complete the survey, although this tactic is known to reduce item nonresponse. The most important tactic to reduce both unit and item nonresponse for this online survey is to indicate to the participants (through e-mail notification) that their college is participating in this survey to help promote mathematics faculty improvement efforts and believes that faculty play a crucial role in this process.

One last limitation of this pilot was the incentive structure that was put in place to recruit participants. During the spring 2016 semester, faculty members who completed an online survey were offered a $10 Amazon e-gift card. Interview and observation participants were not provided an additional incentive for their participation. I wanted to offer some sort of incentive, so faculty participants were at least offered something for completing a survey which was a vital component of this study. Research (Millar & Dillman, 2011; Parson & Manierre, 2014) shows that offering a prepaid incentive, such as an e-gift card, will help to increase response rates.

Chapter 5 - Results

Survey Results

From the eligible math faculty members at the fifteen two-year colleges chosen for this study, sixty-four completed the survey and formed the sample for the survey (N=64). The completers of the survey included thirty-three (52%) full-time and thirty-one (48%) part-time two-year college math faculty members. The group of completers included twenty-one (33%) males and forty-three (67%) females. More than half (N=33, 52%) of two-year college math faculty members that completed a survey were teaching a developmental math course at the time of the survey. Approximately thirty-six percent (N=23) of participants had been teaching ten or more years at their college. Over twenty-eight percent (N=18) of participants have been teaching five to nine years at their college. One-fourth (N=16) of the participants have been teaching two to four years at their college. Less than eleven percent (N=7) of the participants were in their first year of teaching. Over half (N=38, 59%) of the participants indicated that they had formally taught K-12, with nearly half of them (N=31, 48%) reporting that high school (Grades 9-12) was the former grade level they taught.

Faculty members were not required to answer all of the items in the final section of the survey that focused on current teaching practices. The first question in the final section asked participants if they were using or had plans to use cooperative learning in the immediate future. The instructions asked those faculty members who indicated they did not use or had plans to use cooperative learning in the immediate future to stop the survey after that question because the remaining questions referred to the use of cooperative learning. Of the sixty-four faculty members who completed the survey, forty-five (70%) faculty members reported using or having plans to use cooperative learning in the immediate future.

In order to confirm the revised survey instrument maintained sufficient internal reliability, I re-calculated Cronbach's alpha for each perception category (i.e., value, cost, expectancy) using data from the dissertation study. A test of internal reliability using Cronbach's alpha for the items within each of the three categories indicated low to high reliability ($\alpha_{cost} = 0.84$, $\alpha_{value} = 0.41$, $\alpha_{expectancy} = 0.72$). Results from the reliability analysis allowed me to consider whether certain survey questions might need to be removed or re-categorized in order increase Cronbach's alpha in order to meet the needed reliability criterion of alpha greater than 0.6 for each category (DeVellis, 2012). The value category was the only one needing removal of survey items to meet the desired criterion. For the value category, removing Q6, Q13, Q14, Q32, and Q23 would result in an alpha greater than 0.6. However, retaining these survey items would maintain fidelity of the value measurement, allowing for the comparison with other administrations of the survey. Further, these items lowered Cronbach's alpha because of uniformity in the responses. Although the uniformity skewed the survey results, it also indicated that cooperative learning was uniformly valued across the sample.

Research question 1. *What are the perceptions of two-year college math faculty regarding cooperative learning?* As mentioned earlier, there was a total of 56 questions related to faculty perceptions and use of cooperative learning. The following faculty perceptions regarding cooperative learning were examined using this survey: perceptions regarding cost; perceptions regarding value, perceptions regarding expectancy; perceptions regarding types of cooperative learning activities; perceptions regarding barriers or difficulties in implementation; perceptions regarding support for use; and perceptions regarding use and frequency of use.

Perceptions regarding cost. Six survey questions in the first section (Professional Views on Cooperative Learning) related to the perceptions of faculty regarding the cost of implementing cooperative learning. Questions related to the perceptions of faculty regarding the cost of cooperative learning dealt with both physical and time costs. The cost perception items consisted of the following: 3, 17, 24, 29, 33, and 39. Appendix K displays how participants responded to each perception item and responses are grouped into two clusters: whether respondents generally agreed (i.e., somewhat agree, agree, or strongly agree) or generally disagreed (i.e., somewhat disagree, disagree, or strongly disagree).

The results of the pilot study suggest that the faculty participants predominantly do not perceive cooperative learning as a costly instructional strategy. The grand mean value of the means of the seven questions regarding the costs of cooperative learning is 3.27. Although over half (N=35, 56%) of survey respondents somewhat agreed, agreed, or strongly agreed that implementing cooperative learning takes too much class time, nearly sixty percent (N=38) of the survey respondents somewhat disagreed, disagreed, or strongly disagreed that implementing cooperative learning takes too much preparation time. Concerning physical costs, roughly eighty percent (N=50) of respondents reported that they somewhat disagreed, disagreed, or strongly disagreed that the costs involved in using cooperative learning are great. Two-thirds of participants (N=43) somewhat disagreed, disagreed, or strongly disagreed that it is impossible to implement cooperative learning without specialized materials.

Perceptions regarding value. Sixteen survey questions in the first section (Professional Views on Cooperative Learning) related to the perceptions of faculty regarding the value or usefulness of cooperative learning. Questions in this category dealt with both faculty- and student-related values. The value perception items consisted of the following: 4, 5, 7, 11, 13, 14, 18, 19, 22, 23, 26, 28, 31, 32, 34, and 40. Appendix L displays how participants responded to each perception item and responses are grouped into two clusters: whether respondents generally agreed (i.e., somewhat agree, agree, or strongly agree) or generally disagreed (i.e., somewhat disagree, disagree, or strongly disagree).

The results of the entire sample suggest that faculty participants perceived cooperative learning as a valuable instructional strategy. The grand mean value of the means of the twenty-one questions regarding the value of cooperative learning is 3.42. Eighty-eight percent (N=56) of the survey respondents reported to somewhat agreed, agreed, or strongly agreed that cooperative learning is a valuable instructional approach. Faculty also reported not feeling pressured by administration (N=56, 89%) or by other instructors (N=62, 97%) to use cooperative learning. Concerning student-related values, the majority (N=60, 94%) of faculty respondents somewhat agreed, agreed, or strongly agreed that peer interaction helps students obtain a deeper understanding of content and that using cooperative learning enhance students' social skills. Eighty-four percent

(N=54) of faculty respondents generally agreed that using cooperative learning fosters positive student attitudes towards learning.

Perceptions regarding expectancy. Nineteen survey questions in the first section (Professional Views on Cooperative Learning) related to perceptions of desired outcomes of cooperative learning. Questions in this category dealt with expectancy regarding students, knowledge of faculty, and training/support. The expectancy perception items consisted of the following: 1, 2, 5, 8, 9, 10, 12, 15, 16, 20, 21, 25, 27, 30, 35, 36, 37, 38, and 41. Appendix M displays how participants responded to each perception item and responses are grouped into two clusters: whether respondents generally agreed (i.e., somewhat agree, agree, or strongly agree) or generally disagreed (i.e., somewhat disagree, disagree, or strongly disagree).

The results of this entire sample suggest that faculty participants perceived a high expectancy of success when implementing cooperative learning. The grand mean value of the means of the twenty questions regarding the expectancy of cooperative learning is 3.23. Concerning expectancy regarding students, seventy-three percent (N=46) of the survey respondents somewhat disagreed, disagreed, or strongly disagreed that there are too many students in their class to implement cooperative learning effectively. Eighty-four percent (N=54) of faculty somewhat disagreed, disagreed, or strongly disagreed that cooperative learning would not work with their students. Concerning expectancy regarding knowledge of faculty, all (N=64, 100%) faculty respondents believed they are very effective instructors. Eighty-four percent (N=54) of faculty respondents somewhat agreed, agreed, or strongly agreed that they understand cooperative learning well enough to implement it successfully. Eighty-eight percent (N=56) of faculty somewhat disagreed, disagreed, or strongly disagreed that they have too little teaching experience to implement cooperative learning successfully. Concerning perceptions of expectancy regarding training and support, over two-thirds (N=44, 69%) of faculty somewhat agreed, agreed, or strongly agreed that the amount of cooperative learning training they have received had prepared them to implement it successfully. Additionally, sixty-three percent (N=40) of faculty somewhat disagreed, disagreed, or strongly disagreed that their training in cooperative learning was not practical enough for them to implement it successfully.

Perceptions regarding types of cooperative learning activities. One question included in the survey asked faculty participants to select from a list of classroom activities that they would classify as cooperative learning activities. Descriptive statistics were used to report the number of participants that classified a particular activity as one that involved cooperative learning. Half or more of the total number of faculty respondents reported the following classroom activities would classify as cooperative learning activities: think-pair-share (N=62, 97%), team Jeopardy (N=57, 89%), use of study groups (N=55, 86%), group presentations (N=54, 84%), jigsaw groups (N=50, 78%), test-taking teams (N=46, 72%), students sitting side-by-side talking with each other as they work on an individual assignment (N=40, 63%), and whole-class discussion (N=32, 50%). The following classroom activities were identified as those not classifying as cooperative learning activities: students working against each other to achieve an academic goal (N=6, 9%), students working individually to accomplish learning goals unrelated to those of others (N=4, 6%), and lecture (N=0, 0%). Other activities reported include 'Battle Buddies' where students discover concepts together by connecting to prior learning (N=1, 2%), exploration or discovery activities (N=1, 2%), and math relay teams (N=1, 2%).

Perceptions regarding possible barriers or difficulties to implementing cooperative learning. One open-ended question included in the survey asked all faculty participants whether they reported using cooperative learning or not and to list possible barriers or difficulties in implementing cooperative learning in their courses. Results were then exported to an Excel file and coded for arising themes. A total of fourteen themes were identified from this question from a total of forty-eight responses (N=48). One-third (N=16) of two-year college math faculty members reported *time constraints* as the top barrier to implementing cooperative learning. Seventeen percent (N=8) reported *physical setup of the classroom* as a barrier. Fifteen percent (N=7) reported the *amount of course material to cover* as a barrier or difficulty to implementing cooperative learning. Thirteen percent (N=6) of faculty participants reported *student personalities* and *student resistance*. Surprisingly, ten percent (N=5) of faculty participants reported there were *no barriers or difficulties* to implementing cooperative learning. The following barriers or difficulties encompassed less than ten percent of the total number of participant responses: *teaching philosophy or methods* (N=4, 8%), *assessing students* (N=3, 6%), *students only learn a little bit of information or material* (N=3, 6%), *lack of training or support* (N=2, 3%), *class size* (N=2, 3%), *group composition* (N=2, 3%), *underprepared* *or struggling students* (N=2, 3%), and *the type of class* (N=2, 3%). See Table 5-1 for specific quotes grouped by barriers mentioned by participants.

What Participants Mentioned	N (%)	Quotes That Highlight Barriers/Difficulties
Time constraints	16 (33%)	"Lack of sufficient time"; "Time"; "Time factor"; "Planning time creates a barrier for me"; "…using CL properly takes significantly more time than lecturing and presenting examples"; "The time crunch"; "Too little time"; "Time for planning"; "Lack of time for students to prepare"; "Lack of class time"
Physical setup of classroom	8 (17%)	"The layout of tables in the room"; "We move furniture to facilitate group work, if need be"; "Classroom desks are not optimal for getting students into groups"; "Some of the rooms I teach in do not lend themselves to these types of activities"; "The classroom setup has long tables, so students aren't facing each other very often"; "The movement and availability of classrooms"; "…when assigned a room, the desk and chairs are not conducive to CL"; "…layout. When class started, I had 36 students and 36 seats"
Amount of course material to cover	7 (15%)	"Meeting curriculum requirements"; "The amount of material that is required to be covered in a semester forces me to use whole-class instruction most of the time"; "…we don't get to cover all of the necessary material"; "There is an extensive amount of material that needs to be covered within the semester"; "My biggest issue is the large amount of content that I have to cover"; "…difficulty covering all the course objectives when group work is used frequently"; "The amount of material that I have to cover"
Student personalities	6 (13%)	"Each class is different – all classes cannot be run in the same manner. Instructors have to know the personalities of their students"; "…each class has a collective personality"; "…the dynamic of the student"; "I have had students who are shy"; "Unmotivated students"; "Some students may prefer having the opportunity to do work alone"
Student resistance	6 (13%)	"Some students are resistant to working in groups"; "…interpersonal friction between students"; "Willingness of students"; "I struggle with the management of students when they aren't focused on lecture. They easily get off topic and I have trouble bringing them back"; "…they are loners who refuse to work in groups"
No barriers or difficulties	5 (10%)	"I don't think that there are any real barriers to implementing CL"; "I do not see difficulties or barriers to implementing CL in the courses that I teach"; "Individually, there are no barriers"; "None"

Table 5-1. Possible barriers to implementing cooperative learning identified by main study participants (N=48)

Perceptions regarding support or incentives colleges provide for implementing cooperative learning. One question included in the survey asked faculty participants to select from a list of possible supports or incentives a college provides for implementing cooperative learning. Descriptive statistics were used to report the number of participants that reported a listed support or incentive. Over half (N=35, 55%) of faculty members reported the college *provided opportunities to attend professional development or training*. Thirty-nine percent (N=25) of faculty members reported *no support or incentives provided.* Sixteen percent (N=10) of faculty members reported the college *provided money/online/technology resources*. Thirteen percent (N=8) of faculty members reported *professional learning communities*. Thirteen percent (N=8) of faculty members reported that the use of cooperative learning was *included in a formal review process.* Eight percent (N=5) of faculty reported an *increase in review or planning time*. Only three percent (N=2) of faculty members reported the college allowed the *ability to include questions (regarding the use of cooperative learning) on course instructor survey.* Other support or incentives reported include support from an administrator to try new strategies (N=1, 2%) and that faculty are encouraged to travel to research and teaching conferences (N=1, 2%).

Perceptions regarding professional learning or training participated within the last year that addressed/focused on cooperative learning. Another question included in the survey asked faculty participants to select from a list of possible professional learning or training opportunities they had participated in within the last year that addressed cooperative learning. Similar to other questions, descriptive statistics were used to report the number of participants that reported a listed professional learning or training opportunity. Forty-two percent (N=27) reported *personal experiences and/or course preparation.* Nearly thirty-six percent (N=23) reported *no professional development or training*. Approximately thirty percent (N=19) reported *use of mentors and/or colleagues*. Twenty-seven percent (N=17) reported *attending or presenting at a conference*. Nearly one-fourth (N=15, 23%) reported *local professional development*. Eight percent (N=5) reported *administrative/school endorsement*. Six percent (N=4) reported *locally negotiated curriculum planning/training*. Only three percent (N=2) reported online professional development modules. Other types of professional learning or training mentioned include training offered by the Charles A. Dana Center (N=1, 2%) and department meetings (N=1, 2%).

Perceptions regarding use and frequency of use of cooperative learning. One of the most important questions in the survey asked faculty participants whether or not they use or have plans to use cooperative learning in the immediate future. A follow-up question based on whether faculty reported 'yes' to the previous question (saying they use or have plans to use cooperative learning) asked how often they use or plan to use cooperative learning in their course(s). Those participants that reported 'no' did not have to answer the remaining four questions of the survey. Based on descriptive statistics, of the sixty-four faculty members who completed the survey, forty-five (70%) reported using or having plans to use cooperative learning in the immediate future (see Figure 5-1). From this subset of faculty members who used or planned to use cooperative learning in the immediate future, more than half (N=24, 53%) of two-year college math faculty members used or planned to use cooperative learning in their courses at least once a week or at least once a class period. Thirty-one percent (N=14) reported using cooperative learning at least once a month. Thirty-three percent (N=15) reported using cooperative learning at least once a week. Twenty percent (N=9) reported using cooperative learning at least once a class period. Sixteen percent (N=7) reported using cooperative learning at least once a semester (see Figure 5-2).

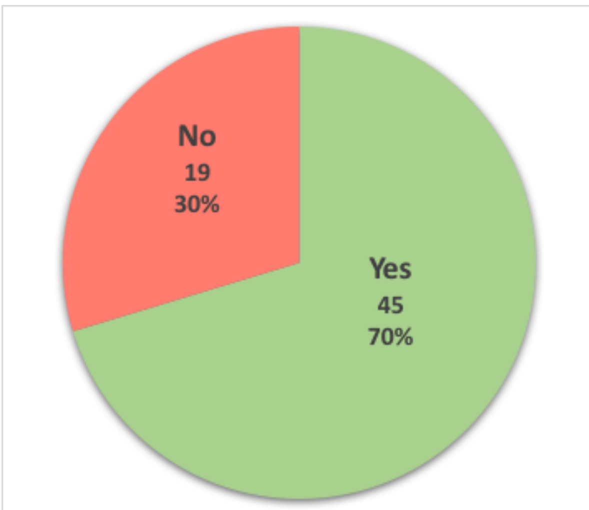

Figure 5-1. Current/planned use of cooperative learning by main study participants

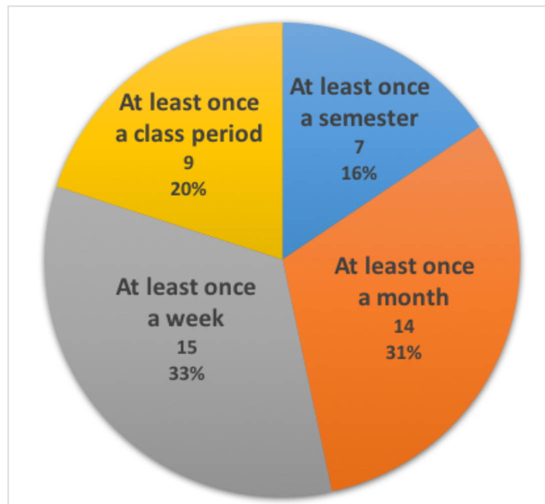

Figure 5-2. Frequency of current/planned cooperative learning use by main study participants

Forty-five (70%) of the sixty-four math faculty participants who reported using or having plans to use cooperative learning in the immediate future were also characterized based on the following demographic items: gender, faculty status, whether they were currently teaching a developmental math course, numbers of years teaching at the college, and whether they were a former K-12 teacher. This group of cooperative learning users included twenty-five (56%) full-time and twenty (44%) part-time two-year college math faculty members. Nearly three-fourths (N=33, 73%) of those who reported using or having plans to use cooperative learning were female. Fifty-eight percent (N=26) of two-year college math faculty who reported using or having plans to use cooperative learning were currently teaching a developmental math course. Thirty-eight percent (N=17) of the forty-five who reported using or having plans to use cooperative learning had taught at their college for ten or more years. One-third (N=15) reported teaching at their college for five to nine years. Eighteen percent (N=8) reported teaching at their college for two to four years. Only eleven percent (N=5) reported it was their first-year teaching at their college. Over sixty percent (N=28, 62%) of faculty participants who reported using or having plans to use cooperative learning reported being a former K-12 teacher, with over three-fourths of them (N=22, 79%) reporting that high school (Grades 9-12) was the former grade level they taught.

Perceptions regarding aspects of cooperative learning used. One open-ended question included in the survey asked faculty participants who reported using or having plans to use cooperative learning to report what aspects of cooperative learning they use in their courses. Results were then exported to an Excel file and coded for arising themes. A total of eleven themes were identified from this question from a total of forty-four responses (N=44). One-fourth (N=11) of two-year college math faculty members reported *students working together in or outside class on assignments, problems, or tasks* as an aspect of cooperative learning they use in their course. Participants did not go into detail about the structure of the task. One-fourth (N=11) also reported *think-pair-share* as an aspect of cooperative learning used. Twenty-three (N=10) percent of faculty participants reported *group work* as an aspect of cooperative learning used in their courses. Fourteen (N=6) percent of faculty participants reported *group presentation*s. Eleven (N=5) percent reported *informal grouping*. The following aspects of cooperative learning were reported by less than ten percent of faculty participants: *study groups* (N=4, 9%), *group projects* (N=4, 9%), *Team Jeopardy or other games* (N=4, 9%), *test-taking teams* (N=3, 7%), *whole-class discussion* (N=3, 7%), and *jigsaw groups* (N=2, 5%).

Perceptions regarding why faculty use cooperative learning. Another open-ended question included in the survey asked faculty participants who reported using or having plans to use cooperative learning to report why they used or planned to use cooperative learning in their courses. Results were then exported to an Excel file and coded for arising themes. A total of five themes were identified from this question from a total of forty-four responses (N=44). Forty-five (N=20) percent of two-year college math faculty members reported using or planning to use cooperative learning because *it is beneficial for their students*. Thirty-two (N=14) percent reported *students learn from one another*. Nine participants (20%) reported *cooperative learning helps students communicate and talk about math content*. Nine (N=4) percent reported *cooperative learning promotes social skills*. Only three (7%) faculty participants reported *cooperative learning is included in their curricular resources*. See Table 5-2 below for specific quotes grouped by aspects of cooperative learning mentioned by participants.

What Participants Mentioned	N (%)	Quotes That Highlight Why Faculty Use Cooperative Learning
CL is beneficial for my students	20 (45%)	"I think it is beneficial for my students"; "I find it to contribute to student success"; "The students remain active and engaged"; "..beneficial to learning because of…thought process"; "…it gives the students time to organize and reflect"; "…students will gain a deeper understanding of the material"; "CL enhances mathematical understanding"; "…promotes engagement and incorporates all learning styles"; "…helps auditory learners"; "…to promote student engagement"; "…when it works well, students buy into the course more, participate, achieve higher grades, and seem to enjoy it"; "I find that it helps relieve students' anxieties and helps them be more comfortable with asking questions"; "Engages students, makes them more aware of what they know and don't know"
Students learn from one another	14 (32%)	"I believe it is important for students to…learn cooperatively from others"; "…it allows the students to teach each other"; "Students learn from helping other students"; "…helps students learn from one another"; "Student to student teaching also reinforces content mastery; "Students learning from one another…exchanging ideas"; "Many students learn best when they hear concepts from other students instead of the instructor"; "The students learn better when the can explain it to another student"; "Students can help other students to understand the material in various ways"; "Provide an opportunity for students to support each other and through the experience to help enhance their own learning"
CL helps students communicate and talk about math content	9 (20%)	"I believe it is important for students to learn to communicate what they know and what they don't know"; "I use CL to engage students and get them thinking and talking about the concepts"; "Students are most likely to ask another student a question"; "…verbalizing problem-solving"; "Many students learn best when they hear concepts from other students instead of the instructor"; "Verbalizing what they are doing helps them to understand"; "Peer language helps other students understand the concepts"; "Explaining concepts to others is a vital tool for learning"

Table 5-2. Reasons two-year college math faculty use cooperative learning (N=44)

Perceptions regarding experiences that influence cooperative learning use. The last open-ended question included in the survey asked faculty participants who used or planned to use cooperative learning to report any experiences that have influenced their use of cooperative learning. Results were then exported to an Excel file and coded for arising themes. A total of six themes were identified from this question from a total of forty-three responses (N=43). Forty percent (N=17) of two-year college math faculty members reported that they *noticed the benefits of cooperative learning use* for students. Twenty-six percent (N=11) of faculty participants reported that they *used cooperative learning in a previous teaching experience*. Sixteen percent (N=7) of faculty participants reported that *professional learning opportunities* and *personal experiences* have influence their use of cooperative learning. Nine percent (N=4) of responses mentioned *student feedback*, while only five percent (N=2) reported *research on student learning* has influenced their use of cooperative learning. See Table 5-3 below for specific quotes grouped by experiences mentioned by participants that have influenced their use of cooperative learning.

What Participants Mentioned	N (%)	Quotes That Highlight Experiences That Influence Cooperative Learning Use
Noticed benefit of CL use	17 (40%)	"I found out that students are involved and engaged"; "…promotes a positive attitude about learning from the students"; "…better grades and happier students"; "Students enjoy getting to know other students and working together"; "The classroom is alive and engaging"; "Increase in student achievement, increase in student interaction, and increase in learning for struggling students"; "Seeing students gain ownership of material"; "Increased engagement, focus, and desire to learn from students"; "…it allows for friendlier academic environment"; "Watching how students grow as they help each other and work with each other"
Used in previous teaching experience	11 (26%)	"Positive past experience"; "As my classes got larger, I couldn't individually tutor every student"; "I used this in high school classes and have used often in the college setting"; "I taught 6th and 7th grade for one year and picked up lots of different teaching techniques"; "…teaching Grades 6-12 mathematics"; "I have used it in my classes both in high school and in college"; "Teaching in public schools"; "Past elementary and middle school teaching experience"; "I used CL after having used these successfully in high school classes"
Professional learning opportunities	7 (16%)	"I attended a conference under Dr. Michael Starbird from UT on Inquiry-Based Learning"; "Conferences and collaborations with other instructors"; "Training"; "I have seen it successfully used in colleagues' classes"; "Attending training to learn how to incorporate it"; "…professional development"; "Higher Education Teaching Institute for new full-time faculty"
Personal experiences	7 (16%)	"Personal experiences"; "My CL experiences come from my student certification classes at Rice University"; "I was homeschooled throughout elementary school and high school. As the third oldest child in a family of seven children, every element of my early life was cooperation and group work"; "My study techniques as a student"; "My college experience was mostly spent lecturing and teaching fellow students. I enjoyed it and learned more than I did from an instructor"; "I enjoyed working with a study group during my undergraduate and graduate career, and especially enjoyed it during class"; "Course work at Baylor University where I am getting my Ph.D. has heavily influenced my desire to use CL"

Table 5-3. Experiences that influence use of cooperative learning (N=43)

Interview Results

Semi-structured interviews, which were audio-recorded and transcribed, were used to elicit further understanding of two-year college math faculty perceptions and use of cooperative learning in their classrooms. The online survey helped locate two-year college math faculty with a range of perceptions about cooperative learning for further study in follow-up interviews.

From the eligible math faculty members at the fifteen two-year colleges chosen for this dissertation study, twenty-four completed an interview and formed the sample for the interviews (N=24). Of these twenty-four interview participants, fifteen (63%) were full-time and nine (37%) were part-time math faculty members. Seventeen (71%) of the twenty-four participants were female. Less than half (N=11, 46%) of the interview participants were teaching a developmental math course the semester they participated. One-third (N=8) of the interview participants had been teaching ten or more years at their college. One-fourth (N=6) of the interview participants had been teaching five to nine years at their college. One-fourth (N=6) of the interview participants had been teaching two to four years at their college. Seventeen percent (N=4) of the participants were in their first year of teaching. Over half (N=13, 54%) of the interview participants indicated that they were former K-12 teachers, with the majority (N=11, 92%) of them reporting that high school (Grades 9-12) was the former grade level they taught.

Interview participants were asked several questions regarding their perceptions and use of cooperative learning (see Appendix H). Each participant was interviewed once and the interview was audio-recorded. Interviews lasted approximately twenty minutes, depending on depth of responses. Transcripts produced after the interviews were open-coded for occurring themes using MAXQDA software (MAXQDA, 2017). Table 5-4 below indicates both the parent and open codes that were mentioned by at least one-fourth of the interview participants. The table also indicates the total number of coded segments for each code for all twenty-four interview participants.

Parent Code	Open Code	Number/Percent of Interviews That Code Appears	Number of Coded Segments
Implementation	Frequency	23 (96%)	25
Barrier	Time Constraints	20 (83%)	33
Affordance	Students Working Together	19 (79%)	31
Experience	Personal Experience	19 (79%)	29
Implementation	Implementation	18 (75%)	21
Implementation	Grouping	14 (58%)	19
Affordance	Dialogue/Verbalize	13 (54%)	26
Experience	Education/Training	11 (46%)	12
Affordance	Student Engagement/Participation	10 (42%)	13
Affordance	Students Learn From Each Other	10 (42%)	13
Barrier	Curriculum Constraints	9 (38%)	10
Experience	School Experience	9 (38%)	12
Implementation	Use of Technology	8 (33%)	8
Affordance	Students Feel Comfortable	7 (29%)	10
Affordance	Active Classroom	7 (29%)	10
Barrier	Physical Arrangement	7 (29%)	9
Affordance	Group Processing	7 (29%)	11
Barrier	Student Resistance	7 (29%)	8
Implementation	Think-Pair-Share	6 (25%)	8
Barrier	Effect of Student Characteristics	6 (25%)	7
Affordance	Actively Engaged/Talking	6 (25%)	8
Affordance	Positive Feedback	6 (25%)	7
Affordance	Teach Each Other	6 (25%)	6

Table 5-4. Breakdown of interview codes

Major parent codes arising from twenty-three open codes that were mentioned by at least six interview participants (25%) included affordances of using cooperative learning, implementation, barriers to implementation, and experiences that have influenced cooperative learning use.

Affordances. Nineteen (83%) of the twenty-four interview participants indicated that cooperative learning involves students working together. Thirteen (54%) of the twenty-four interview participants indicated that cooperative learning allows students to communicate and dialogue. Ten (42%) of the twenty-four interview participants indicated that cooperative learning improves student engagement or participation and allows students to learn from each other. A summary of these interview codes along with quotes are included in Table 5-5.

Open Codes For Affordance	Number of Interviews Code Appears (%)	Quotes That Highlight Affordances
Students working together	19 (79%)	"Cooperative learning for me is when you can turn a classroom into a student-led classroom where in cooperation they come, that you can put out a problem or whatever your agenda is that day, but it allows the students to work together in a means that they can either raise more questions, come to some conclusion."; "…definitely students working together usually you know to help each other learn something new, most often, but it can be, you know, completing a task or whatever."; "I view cooperative learning as any activity where students are working together instead of me just lecturing or talking students. They're doing some sort of activity with at least one other student."; "…it's all kinds of different things where students are working together"; "…whenever you have one or more, two or more students working together to learn a new concept."
Dialogue/verbalize	13 (54%)	"And a lot of times the student will say differently to each other or go over it in a different manner than what the teacher does and that also helps them learn a difficult concept."; "…by verbalizing the mathematical concepts, they were able to further understand them and learn them. By having verbal handles, it helped to promote the learning."; "Students would have to be actively engaged, which would include speaking, communicating to each other, as well as communicating to the instructor, as opposed to traditional teaching or traditional learning which is the instructor only communicating to the student and them not communicating back more to each other."
Student engagement or participation	10 (42%)	"Cooperative learning is a way, enables students to learn the material from each other from participation."; "…having students participate in class, when you call on them, it might also be you know calling on them individually."; "I think it's something that helps the students engage with one another, which helps them to, I mean, it helps them in aspects that are not just content."; "strategy that promotes student engagement"
Students learn from each other	10 (42%)	"You need to work together, because you are much, much more likely to graduate. You're much more likely to learn the material. If you're explaining it to someone, you're more likely to learn it."; "I've just found that students, it seems like they learn better, you know, from one another. You know, sometimes the student is able to explain a concept more clearly than the instructor as far as retention."; "…students use each other to help master the material."; "…you know, like being together, and essentially learning from each other or at least discussing the topics at hand."

Table 5-5. Breakdown of affordance parent code

Implementation. All but one (96%) interview participant discussed their cooperative learning frequency of use. Three-fourths (N=18) of the interview participants specially discussed the implementation of classroom activities that they believed involved cooperative learning. Fifty-eight percent (N=14) of interview participants talked about group composition, specifically noting how they grouped students. One-third (N=8) of the interview participants noted their use of technology in the classroom. Quotes highlighting these codes are included in Table 5-6.

Open Codes For Implementation	Number of Interviews Code Appears (%)	Quotes That Highlight Implementation
Frequency	23 (96%)	"I tend to use it one to two times a week."; "I use cooperative learning just about every class meeting."; "I use it probably every time I step in the classroom. For the collaborative exam, in each of my courses, I try to do one exam, at least per semester, that is collaborative. And then for the practice things, I don't do it every class time, but just, and it's impromptu."; "I would say that I use cooperative learning in some form nearly every single class meeting."; "So for a lot of my classes, I'm able to do it daily. For other classes, I'm able to do it maybe once a section."
Implementation	18 (75%)	"Okay, here's a good example, in my Calculus class, we have an activity where we match the function graph with the function description with the first derivative graph with the first derivative description. And so, I have these cards already made up ahead of time and put in little plastic bags, it's very structured. But then I put the students in groups and they work on it in groups, and then the groups talk to each other, so that's very structured and very planned at a certain place in the curriculum."; "What I would do is put the students into group of two of three, and I would put a problem on the board, and the students, they would have to, you know, try and work it on their own and then they would share their solutions with others in their group.";
Group composition	14 (58%)	"And then I have a wide age range and I try to make sure that I mix the ages, so that it's not just the teenagers with the teenagers, and the adults with the adults, and sometimes that's a barrier at the beginning because I have different age groups interacting with each other."; "…cooperative learning, like there has to be, like I think by definition, some sort of student grouping together"; "…then occasionally I'll group them by just handing them a card as they walk in the class, and you know, all the spades go to that group, or all the, you know, different ways, occasionally I'll randomly group them"
Use of technology	8 (33%)	"…the technology that we use in the classroom. Promethean boards, SmartBoards, and you know, any kind of technology you can use because it's so much apart of our daily lives."; "I use technology all the time. We use graphing calculators. I have a SmartBoard in my classroom and so everything, this could be an instructional strategy actually, everything I write on the SmartBoard is saved into PDF files and put on the students' BlackBoard so they can access that."; "So, our program uses MyMathLab. It's a little different than most programs, because our homework, quizzes, exams, everything is within MyMathLab."

Table 5-6. Breakdown of implementation parent code

Barrier. Over eighty (N=20) of interview participants noted time constraints. Thirty-eight percent (N=9) of interview participants discussed curriculum constraints. Twenty-nine percent (N=7) talked about physical arrangement of the classroom as a barrier and similarly, seven (29%) interview participants mentioned student resistance as a possible barrier to implementing cooperative learning. Quotes highlighting these codes are included in Table 5-7.

Open Codes For Barrier	Number of Interviews Code Appears (%)	Quotes That Highlight Barriers
Time constraints	20 (83%)	"And as I said, in my other courses I just don't have time"; "And sometimes we don't have the class time for that."; "And there's not time for that in the college setting, because I have an hour and a half to explain. Well, I'm explaining all these things, but I don't have the opportunity for the kids to utilize it in a group setting."; "I think the biggest one is the time constraint."; "In college, it's time because there are so many parts to College Algebra. There are so many parts to Calculus."; "So my issues with my college classes is just flat out, hands down, it's time. We have a set curriculum that must be covered in a certain amount of time."
Curriculum constraints	9 (38%)	"I have other classes, especially things like College Algebra where the content is so packed that I just don't have time to teach it and have them teach themselves."; "And where I taught Pre-Cal before, I mean, with the content for Pre-Cal, you cover all of College Algebra, all of Trig, and Conics, Sequences, Series, like everything in one semester and like my other colleges where they didn't have the attached lab, so it was like you're constantly, constantly having to go over so much information."; "There's just lots of things to cover in every class, and you try and try, and you want to leave a least a little time to review things."
Physical arrangement	7 (29%)	"And my classroom has tables. The students sit at tables, so it's very easy for them to group themselves."; "…and when we had the individual desks, I could reconfigure the room where we had clear paths to travel. And with the tables, you are kind of stuck."; "…one is the setup of your learning environment."; "Okay. The furniture. Believe it or not, that is a big deal."
Student resistance	7 (29%)	"…there is a level of they're an adult, so if they don't want to do it, I can't make them do it."; "Some people just you know, I mean I have students in my college class that would rather work by themselves. They are easily distracted by noise. They don't like meeting in a group where people won't stay on task, you know."; "One of the barriers is students don't want to cooperative. Students don't want to collaborate, and students really would rather kind of sit there and not have to do anything for the time that they're in class, it's a lot of easier."

Table 5-7. Breakdown of barrier parent code

Experience. Nearly eighty percent (N=19) of interview participants indicated how personal experiences influenced their use of cooperative learning. Forty-six percent (N=11) of participants talked about their own education or training and how those experiences have influenced their use of cooperative learning. Only nine (38%) interview participants reported their own schooling experiences when reflecting on cooperative learning. Quotes highlighting these codes are included in Table 5-8 below.

Open Codes For Experience	Number of Interviews Code Appears (%)	Quotes That Highlight Experience
Personal experience	19 (79%)	"…having taught College Algebra and you know Intermediate Algebra and those types of courses, I notice that when students, when I just lecture, like when I first started teaching, I would lecture quite a bit and we would do some examples together, but the majority of it was lecture. And I don't feel that students really learn that way. And drawing upon that, I'm using a lot more, excuse me, cooperative learning just on a smaller scale"; "I have a done a couple of times here at the college. I've had a couple of sessions where I've wanted the students to do certain problems and present them up at the front with those in a select few classes. And they went decently well. Sometimes, you get good results."; "I think mostly the success or failure of what I've tried in the classroom. That probably influences me the most."
Education/training	11 (46%)	"Dr. Wilhite wanted me to attend the UT Dana Center's Mathways Program. So, I went there that summer and they were all about cooperative learning."; "…some of the professional development things that I have gone to that have talked about cooperative learning, or talked about, you know, different techniques that can be used to make a more engaging classroom, have given me lots of good ideas"; "…but certainly from recent professional development workshops and conferences. You know, people have been talking about it."; "When I was in a graduate school at Oklahoma State University, we had to do Teaching Assistants, and the, on the first semester, they had one class that, that they teach how to teach, you know, for the, for all Teaching Assistants. Yeah, all the TAs at that time."
School experience	9 (38%)	"First, it was just a semester class, you know, and this was for teaching class, and not a math class. And we had to write a teaching philosophy and those kinds of things in that class, and that really helps me, you know."; "there was one professor and he used to conduct that class and he, the way he conducted that class was with cooperative learning, you know. He used to put us in a group and ask several questions, and we used to ask questions to him also. So, it was not like a lecture. It was like a conversation and he used to give us some, some group work as well, and he also used to give us the things where we need to, you know, write something about. And sometimes, he used to give us a project and a part of like, 'this is how you have to teach your students, the way I'm teaching you right now will be more effective.' And I was very influenced by his teaching style at that time."

Table 5-8. Breakdown of experience parent code

Classroom Observation Results

Semi-structured observations helped to provide a picture of what the implementation of cooperative learning looks like in two-year college math courses. Similar to the interviews, the online survey helped identify faculty participants familiar with cooperative learning, but not necessarily employing it with fidelity.

From the eligible math faculty members at the fifteen two-year colleges chosen for this dissertation study, seven female instructors participated in a classroom observation (i.e., allowed me to come and observe the instructor's use of cooperative learning). Further, two of the seven participants allowed me to observe two of their courses, providing a total of nine classroom observations. Of the seven observation participants, five (71%) were full-time and two (29%) were part-time math faculty members. All seven (100%) observation participants were female. Only three (43%) faculty members that were observed were teaching a developmental math course the semester they participated in a classroom observation. Three (43%) of the seven observation participants had taught ten or more years at their college. Two (29%) observation participants had been teaching five to nine years at their college. One (14%) observation participant has been teaching two to four years at their college. One (14%) observation participant was in their first year of teaching. Over fifty-seven percent (N=4) of observation participants indicated that they were a former K-12 teacher, with all (100%) of them reporting that high school (Grades 9-12) was the former grade level they taught.

Data gathered from nine observations, with several instructors who also gave interviews, were recorded using a modified version of the Cooperative Learning Observation Guide (Rivera, 2013). The focus of the classroom observations was on the presence and use of cooperative learning, specifically the presence and use of Johnson and Johnson's (1999) five elements of cooperative learning: positive interdependence, individual accountability, group processing, use of small-group skills, and face-to-face promotive interaction. Observation protocols for each participant were also open-coded for occurring themes using MAXQDA. Given that each element of Johnson and Johnson (1999) should stand alone by itself, Table 5-9 below shows each cooperative learning element as its own code, the number of times the element appeared during classroom observations, and the total number of coded segments for each element for all nine observations. For the nine observations, there were a total of 151 coded segments.

Open Code	Number of Observations That Code Appears (%)	Number of Coded Segments
Individual Accountability	9 (100%)	50
Face-to-Face Promotive Interaction	9 (100%)	39
Group Processing	9 (100%)	38
Small Group Skills	7 (78%)	11
Positive Interdependence	6 (67%)	13

Table 5-9. Breakdown of observation codes

The three elements that were noticed in all nine observations were individual accountability, group processing, and face-to-face promotive interaction. Individual accountability is the most frequently noted element that was present in observations, accounting for fifty (33%) out of 151 total coded segments for the nine observations. There were numerous instances during each observation in which the performance of each student was assessed and results were reported back to the group. Students were assessed different ways throughout class. For instance, one instructor, teaching a developmental math class, had each group member present either the mean, median, or mode for a given dataset. Another instructor, teaching Calculus I, walked around during a card-matching activity and prompted different groups with questions related to matched pairs and the process each group used for relating functions, their graphs, and their derivatives.

Face-to-face promotive interaction and group processing were the second and third most frequently noted elements present in the observations, accounting for thirty-nine (26%) and thirty-eight (25%) out of the 151 coded segments, respectively. There were instances during the observations when groups of students were often evaluating their group performance and providing feedback to one another. For example, students were often stopping to check how other group members found their answer. Other examples include groups stopping to describe a concept before continuing on, such as why a function graph is concave up and what that means for the inflection point.

There were also instances during the observation where students were promoting each other's success by encouraging, helping, and supporting each other's efforts to learn. Examples included sharing moments of encouragement and support when needed, discussing how to solve problems, and teaching a concept to another student. During one observation of a developmental math course, students were giving each other a high-five after the instructor confirmed that pair's solutions. There were also instances during the observations where groups of students were discussing how to solve a problem with one another. One example that stands out is a female student discussing how to find the median of a data set when the set has twenty (or an even number of) entries. The female student described how to take the average of a set of numbers when there is an even number of data entries. In this particular case, the students must take the average of the 10^{th} and 11^{th} entries since those are the two middle numbers. There were similar instances that occurred in other observations where students were explaining their solution with their group.

Positive interdependence and small group skills were the fourth and fifth most frequently noted element present in the observations, accounting for thirteen (9%) and eleven (7%) out of the 151 coded segments, respectively. There were instances during the observation in which the success of each student was linked to the success of the group. For example, students were instructed to work together on an assignment, problem, or task. In a developmental math class, students were overheard assigning roles where one student explained why they choose a particular method for solving systems of equations, one student wrote and solved a system using the group's chosen method on the whiteboard, and one student explained the process for solving the system, following instructor directions.

There were also instances where interpersonal and social skills were needed to contribute to the success of group interactions. For example, during the observation of a Calculus I instructor, students were observed gathering materials, moving to sit with their partner, and setting up the activity prior to starting. During the observation of a Statistics course, students were seen distributing and sharing materials (i.e., social skills) with one another as each student entered and started the warm-up activity that asked students to use a piece of string to measure their arm and forearm. During the observation of a developmental math class, three students were seen working together to generate a data set that matched a histogram. Students needed to communicate and decide on which values to use for their designated bins. During this activity, students were able to manage the conflict resulting from using different bin values by comparing and agreeing on appropriate values for each bin based on the histogram provided, in response to instructor directions.

It is also important to note that of the faculty members who allowed me to come and observe their use of cooperative learning, the majority incorporated all five cooperative learning elements at some point during one of the classes they were observed. In the cases in which all five elements were not present, at least three of the five were observed: face-to-face promotive interaction, individual accountability, and group processing.

Exemplar Observation Cases

Three exemplar case descriptions of female two-year college math instructors, representing the three categories in Figure 2-1, will be presented. All faculty participants allowed me to come and observe their use of cooperative learning in the classroom. As presented in Table 5-10, these three instructors have similar characteristics regarding their gender, faculty status, teaching experience, and reported frequency of cooperative learning use. These cases are presented in descending order in terms of the frequency of observation of the five essential elements.

Faculty Participant	Instructor A	Instructor B	Instructor C
Gender	Female	Female	Female
Faculty Status	Full-time	Full-time	Full-time
Years Teaching at College	10+ years	10+ years	5-9 years
Teach Developmental Math	No	Yes	No
Former K-12 Teacher	Yes (HS)	No	Yes (HS)
Frequency of Cooperative Learning Use	At least once per week	At least once per week	At least once per week

Table 5-10. Relevant demographics of the exemplar cases

The First Case: Instructor A. The observation conducted with Instructor A's Calculus I course occurred during the spring 2017 semester. Notably, this instructor, where the highest number of cooperative learning elements were observed, implemented instruction that would be classified in the informal cooperative, or collaborative learning category. Instructor A had twelve students present and the lesson for that day involved students using their knowledge of calculus and pre-calculus to relate functions, their graphs, and their derivatives.

There were two lesson activities that occurred during the observation. The first activity involved seven exercises where students had to work together in pairs to label the graphs of a function and its derivative, which were shown on the same set of coordinate axes. Teams also had to write a short explanation stating the reasoning behind their selection. Two of these seven exercises required teams to label the graphs of a function, its first derivative, and second derivative. The second activity titled "Calculus Card Matching," involved students relating a function to its derivative. Students were provided with a bag of forty-eight cards that had either a function graph, a function description, a derivative graph, or a derivative description. The goal of this second activity was for students to use their knowledge to relate functions, their descriptions, their graphs, and their derivatives. Although taking derivatives may be easy for some students, this activity required students to completely analyze all aspects of a function and its derivative.

After coding for the frequency of the cooperative learning present during the observation, there were twenty-three instances of codes present during the 75-minute classroom observation. Each of the five cooperative learning elements occurred at least three times throughout the class period, with group processing (N=6, 26%) as the most frequently noted element that was present during Instructor A's observation. One example of group processing occurred towards the end of the class when one pair of students (one male and one female) was overheard checking their arrangement of grouped cards. These two students were reflecting on their matched cards, such that they were checking to see that they both agreed on the function and derivative graphs, as well as their associated descriptions. Once the pair of students agreed on the matched cards, Instructor A was called on to come and check their work. A similar instance occurred with this same pair of students early during this card matching activity. Just as the male student attempted to match another set of cards, the female student stopped him to ask about the previous matched set and whether he is sure about the function graph being matched with the derivative graph. This instance indicates an occurrence of group processing, since the female student followed-up on the pair's decision to match a function graph and its derivative. In this particular instance, the female student was checking to see that the matched set of cards was supported by both partners.

Individual accountability was tied for the second most frequently noted element present in Instructor A's observation, accounting for five (22%) out of the twenty-three coded segments. Instances of individual accountability occurred as Instructor A continuously walked around the classroom monitoring progress and prompted individual students to explain the reasoning behind a matched set of cards. There were even moments during the first activity in which the instructor called on individual students to help her label the graphs of a function and its derivative. At one point, Instructor A asked a male student sitting in the back of the classroom to explain what happens when the second derivative graph has a zero, or a value of x that makes the value of the second derivative function equal to zero.

Face-to-face promotive interaction was also tied for the second most frequently noted element present in Instructor A's observation, accounting for five (22%) out of the twenty-three coded segments. Instances of this element primarily occurred when pairs of students were either overheard discussing function graphs and their derivative graphs or explaining the reasoning behind matching functions, their graphs, and their derivatives.

Positive interdependence was the fourth most frequently noted element present in Instructor A's observation, accounting for four (17%) out of the twenty-three coded segments. This code occurred more frequently during the second activity than the first activity. Although both class activities involved students working together in pairs, the card matching activity was structured in a way where the goal was for each team to work together to match cards by thinking about their card and what information can be gathered from it. This example highlights an instance of positive goal interdependence because students and their partners understood that they had to coordinate their actions to ensure that both partners can relate functions, their graphs, and their derivatives.

Essentially, students recognized that they not only need to be able to do their part and explain their reasoning, but to make sure that others can do and explain as well.

Last but not least, small group skills were the fifth most frequently noted element present in Instructor A's observation, accounting for three (13%) out of the twenty-three coded segments. Instances of small group skills occurred through the sharing of resources or taking turns when talking. There were two occurrences in which students were observed taking turns when talking. Surprisingly, there was no need for the instructor to encourage these interactions.

The Second Case: Instructor B. The observation conducted with Instructor B's Developmental Math II course occurred during the spring 2017 semester. Instructor B, where the second highest number of cooperative learning elements were observed, implemented formal cooperative learning, with assigned roles and interdependence structured into the lesson. Instructor B had fifteen students present and the lesson for that day focused on students understanding of central measures of tendency, specifically mean, median, and mode.

There were three segments that occurred during Instructor B's observation. The first segment was focused on an instructor-led lecture introducing central measures of tendency. Class began by students working on a warm-up problem that asked them to find the average of a set of five numbers. The instructor provided a follow-up question asking whether a student in the class would pass the class if the five numbers each represented that student's grade on exams. Instructor B provided a real-world connection and then introduced "mean" as what people typically refer to as average. Instructor B wrote the term and definition on the board. She did the same when introducing the terms "median" and "mode" by first providing an example problem and then providing a real-world connection. Students were responsive to instructor-prompted questions, particularly noting the process to go about finding each measure of central tendency and special cases (e.g., even vs. odd set of numbers when finding median, data sets with no mode).

The second segment involved an activity where students would work together in groups of three to find the mean, median, and mode of a given data set. Instructor B formally grouped students by numbering off students from one to five and assigned a specific problem for each of the five groups to reference in the course textbook. While students appeared to be working in groups, Instructor B is noted for not walking around the class to monitor student and group progress. Rather, Instructor B visually appeared to be monitoring groups' progress occasionally from a center desk located at the front of the classroom. Each student then presented one of the three measures for their respective group's data set to the entire class.

The third segment involved Instructor B creating a classroom data set based on number of pets each student owns. Instructor B was observed asking each student in the class the number of pets they own and writing that number in a list on the board, essentially creating a data set to reference. Students were then asked to find the mean, median, and mode of the classroom data set. A whole-class discussion followed where students were asked to report the measures of central tendency and whether they agree with the reported response.

Coding for the frequency of the cooperative learning elements present during Instructor B's observation, resulted in eleven coded incidents during the 47-minute classroom observation. All five cooperative learning elements occurred at least once, with individual accountability (N=6, 55%) as the most frequently noted element that was present during Instructor B's observation. The most common occurrence of this element happened when each individual student had to present either the mean, median, or mode of their group's data set and then explain their reasoning to the class. The other key instance occurred when Instructor B asked the whole-class to find the mean, median, and mode of the classroom data set related to the number of pets each student owns and to report out during the whole-class discussion.

Group processing (N=2, 18%) was the second most frequently noted element present in Instructor B's observation. Instances of group processing occurred when students were reflecting on each group member's reported measure (i.e., mean, median, or mode) and confirming that each group member could explain how to find the mean, median, and mode of the given data set. Positive interdependence, face-to-face promotive interaction, and small group skills were tied for the third most frequently noted elements present in Instructor B's observation, each accounting for one (9%) of the ten coded segments. The only instance of positive interdependence occurred when Instructor B informed the entire class that each student would have to present one of the three measures of central tendency to the whole-class tendency and explain the reasoning behind their reported answer. This highlights an instance of positive role interdependence because Instructor B provided three roles and let students decide amongst themselves which role they would take. The success of finding and reporting the mean, median, and mode depends on whether each student was able to find their assigned measure. The single instance of face-to-face promotive interaction happened when one female group member was overheard explaining to a male group member the process for finding the median of their given data set. The only instance of small-group skills occurred when groups were overheard considering and acknowledging which roles group members preferred. The fact that students were able to negotiate and assign roles indicates students' use of interpersonal skills.

The Third Case: Instructor C. The observation conducted with Instructor C's Introduction to Statistics course occurred during the fall 2016 semester. Instructor C, where the least number of cooperative learning elements were observed, fell in the category of primarily lecturing. Instructor C had thirteen students present and the lesson for that day focused on the basics of hypothesis testing and testing a claim about a proportion and mean.

There were three segments that occurred during Instructor C's observation. The first segment of class, which lasted about twenty minutes, consisted of Instructor C reviewing the steps to formally test hypotheses. During this review segment, Instructor C also clarified terminology and reviewed how to find the appropriate statistical tests using their calculator. The second segment involved students working together in groups, if they chose, to complete a multi-part problem where they conducted hypotheses testing of claims about a proportion. About twenty minutes into this second segment, Instructor C noticed that students were struggling with the problem and then proceeded to show students every step to use when conducting hypothesis tests for this multi-part problem. Instructor C worked the entire problem at the front of the classroom on the ThinkPad. While Instructor C did prompt student questions about each step when performing hypotheses tests of a claim about a proportion, the majority of the discussion was led by the instructor. The last segment of the class, which lasted about forty minutes, involved a lecture on testing a claim about a mean. During this segment, Instructor C introduced students to the Confidence Interval method when testing hypotheses. While there were example problems for students to work on during this instructor-led lecture and discussion, most of this work occurred individually.

Coding for the frequency of the cooperative learning present during Instructor C's observation identified nine coded incidents during the 80-minute classroom observation. Only three out of the five cooperative learning elements were observed during Instructor C's observation, with positive interdependence and the use of small-group skills noted as the elements that were not observed. Similar to Instructor B, individual accountability was the most frequently noted element present in Instructor C's observation, accounting for five (56%) out of the nine coded segments. The most common occurrence of individual accountability occurred as Instructor C prompted questions about each hypothesis testing step during the instructor-led lecture and discussion segments. Face-to-face promotive interaction was the second most frequently noted element that was present during Instructor C's observation, accounting for three (33%) out of the nine coded segments. Instances of this element mainly occurred when groups of students were overheard discussing with one another how to test a claim about a proportion and mean.

Students were noted for explaining the steps they took when conducting a hypothesis test. The final element present during Instructor C's observation was group processing which occurred once (11%) when one group of three students was overheard making sure each member understood how to conduct a hypothesis test before continuing on to the next problem.

Chapter 6 – Discussion, Conclusion, and Implications

Discussion

This study examined the perceptions and use of cooperative learning by two-year college math faculty members. Quantitative data for the study came from self-reported information provided by faculty members from an online survey. Qualitative data for the study came from interviews, and classroom observations. Findings in regard to each of the research questions will be discussed.

Research Question 1. What are the perceptions of two-year college mathematics faculty members regarding cooperative learning and its use?

- Finding: Two-year college math faculty report a spectrum of perspectives, based on affordances and barriers, in regard to their use of cooperative learning (see Figure 6-1). Faculty fell into three bins: barriers outweigh affordances, affordances balance barriers, affordances outweigh barriers.

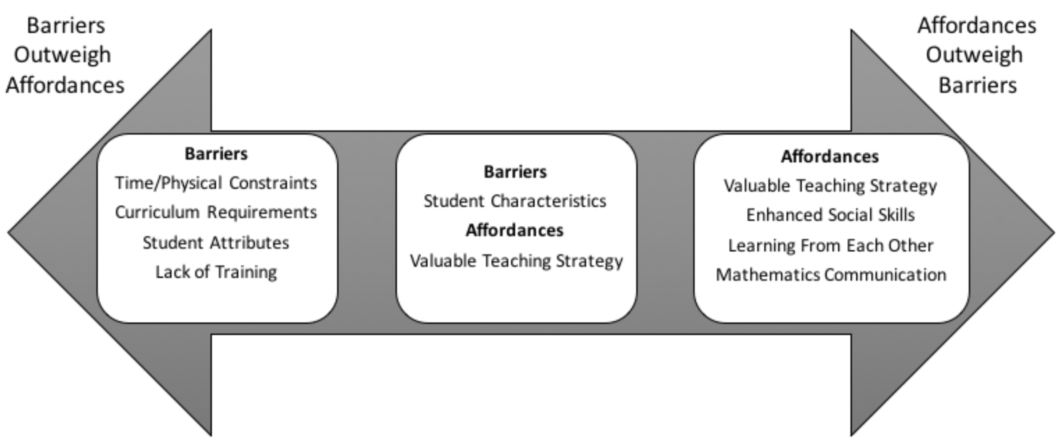

Figure 6-1. Spectrum of reported perceptions of affordances and barriers

Based on survey data, faculty who fell towards the left end of the spectrum typically reported cooperative learning as a high-cost, lower-value instructional strategy with less expectation for success. This group also reported minimal or no use of cooperative learning. Results from a one-way MANOVA revealed a statistically significant difference in the mean subscale scores (i.e., dependent variables) for cost [$F(6,55) = 8.66$, $p < 0.05$; Wilks' $\Lambda = 0.51$; partial $\eta^2 = 0.49$] , value [$F(16,45) = 2.83$, $p < 0.05$; Wilks' $\Lambda = 0.5$; partial $\eta^2 = 0.5$], and expectancy [$F(19,39) = 3.23$, $p < 0.05$; Wilks' $\Lambda = 0.39$; partial $\eta^2 = 0.61$] perceptions between respondents who identified as cooperative learning users (N=45) and those who identified as non-users (N=19) on the survey.

Cost perception items indicated that this group of instructors reported not using cooperative learning because of the perceived physical and psychological demands of implementation that act as a barrier (Abrami, Poulsen, & Chambers, 2004). These perceptions aligned with their top reported barriers to implementing cooperative learning. Two-year college math faculty who use cooperative learning minimally or do not use cooperative learning at all reported time constraints, the physical setup of the classroom, and the amount of material to cover as notable barriers. These results also align with Michael's (2007) study, which indicated similar pedagogical impediments (i.e., classroom does not lend itself to active learning, too much class time, lack of content coverage) to using active learning. Non-users felt that students would only learn part of the course material if they implemented cooperative learning. One non-user reported that when they tried to use cooperative learning in the past, the class fell behind schedule and "there were a lot of holes in many students' understanding still." As a result, this instructor described having to lecture to review content with students. This example demonstrates non-users' struggle of managing class time and the coverage of content.

Other notable barriers that affect two-year college math faculty who use cooperative learning minimally or do not use cooperative learning at all include the effect of student characteristics, resisting students, how to assess student learning, and the level of math classes. Collectively, there were a number of barriers, including student characteristics, teacher characteristics, and pedagogical issues, that were associated with this group's lack of cooperative learning use. Students' lack of social skills was one possible explanation for why instructors opted not to use cooperative learning, which was similar to results from Anstrom (2010) and Gillies and Boyle (2010).

Based on responses from the survey, non-users reported limited support and professional learning opportunities. Although the most common support or incentive two-year colleges provided faculty who reported not using cooperative learning was professional development, several of these instructors said their college does not provide support or incentives for implementing cooperative learning. Moreover, of those non-users, nearly two-thirds reported on the survey that they had not participated in any type of professional development or training within the last year that addressed cooperative learning. The fact that faculty have not participated in recent professional learning opportunities that focused on cooperative learning was another possible explanation for why instructors chose not to implement cooperative learning. Research indicates that cooperative learning use is not a straightforward process and requires specific professional development and training for instructors (Angelides, Stylianou, & Leigh, 2007; Sharan, 2010).

Compared to faculty on the left end of the spectrum, two-year college math faculty in the center of the spectrum perceived higher value and lower implementation costs. For faculty in this group, affordances tend to balance the barriers. Faculty towards the center of the spectrum primarily described the effect of student characteristics and attributes as barriers that affect their use of cooperative learning. Faculty described how different student personalities and resisting students are both barriers to implementing cooperative learning. Interview participants even reiterated that students who are shy or who have different ability levels often do not want to work in groups. These faculty noted that students often lack interpersonal and social skills. Survey results confirmed that faculty report that their students lacked the skills necessary for effective group work. As asserted by Johnson and Johnson (2009), asking students who lack small-group skills to work cooperatively in groups is pointless.

Two-year college math faculty who fell on the right side of the spectrum did not perceive cooperative learning as a costly instructional strategy. This group perceived cooperative learning to be a beneficial instructional strategy and had positive expectations about its use. These faculty noted that cooperative learning enhances students' social and interpersonal skills. These results are consistent with reasons faculty implement cooperative learning. Interview data revealed several affordances including cooperative learning is beneficial for their students, students learn from one another, students communicate/talk about math content, and cooperative learning promotes social skills. As a result, two-year college math faculty who fell on the right side of the spectrum experience fewer barriers in the form of student characteristics, teacher characteristics, and pedagogical issues than the others (see Figure 6-1).

Research Question 2. What does the implementation of cooperative learning look like in two-year college math courses?

- Finding 1: Two-year college math faculty characterize and implement cooperative learning differently. However, the entire spectrum of implementation incorporated most, if not all, of the essential elements associated with cooperative learning.

Survey results indicated seventy percent (N=45) of faculty participants reported the use of cooperative learning. However, open-ended survey responses indicated that faculty characterize cooperative learning differently. Faculty ranged in their classification of cooperative learning activities from formally structured activities (i.e., Team Jeopardy, test-taking teams, group presentations) to informal, student-directed tasks (i.e., study groups, students talking with each other in class). Additional data from the interviews and observations corroborate that faculty fell into three groups: those who use cooperative learning very little or do not use it and tend to primarily lecture, those who implement cooperative learning incorporating formally structured group activities (Johnson & Johnson, 2009), and those who use collaborative learning using informal, student directed group activities (Hennessy & Evans, 2006; Smith & MacGregor, 1992).

This study also characterized the implementation of cooperative learning as prescribed by Johnson and Johnson (1999), specifically examining their five essential elements. They argue that instructors must take responsibility for incorporating these elements so that one would expect to see them when the instructor implements highly-structured cooperative learning. They assert that cooperative learning often goes wrong when the instructor does not enforce certain conditions (i.e., five elements) that mediate its effectiveness (Johnson, Johnson, & Holubec, 1994).

In contrast, observation data from this study indicated that the use of formal, structured, cooperative learning does not necessarily correspond to a stronger presence of these elements. Figure 6-2 represents a spectrum arranged according to the preponderance of the five elements as seen in observations.

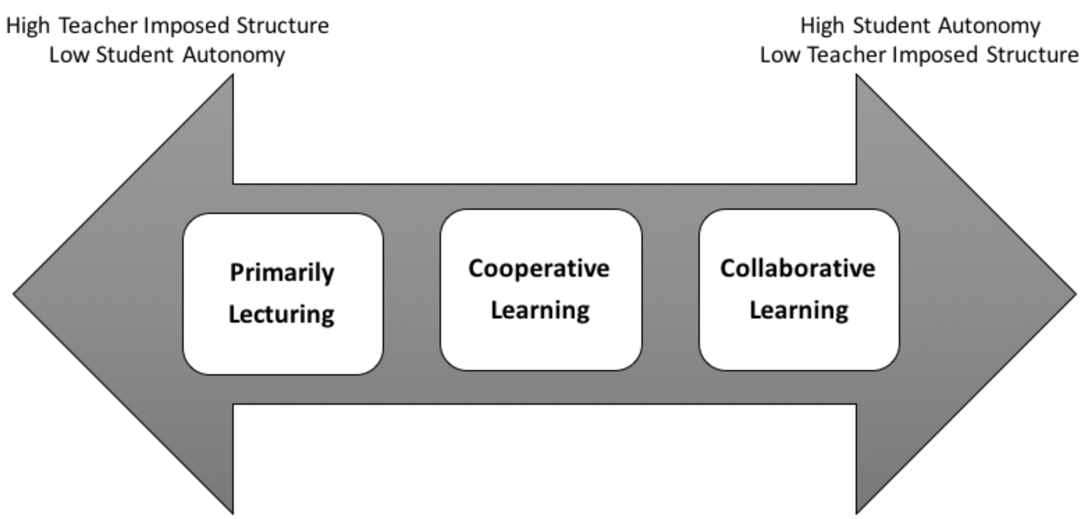

Figure 6-2. Spectrum of small-group learning use

On the left, instructors in the first group are focused primarily on lecturing with minimal use of group work. Instructors who fall into this category rarely (if at all) implement any form of group learning in their math courses. In my study, when lecturers had students informally work in pairs or groups, not all cooperative learning elements were observed. Both Pilot Instructor B and Instructor C fall into this category.

During Pilot Instructor B's observation, there was only one instance where students were told to pair up (i.e., no grouping strategy used) to complete a worksheet that asked students to compare the effects of different compounding periods on the interest an investment earns. During this instance, I observed some students who did not work together even when sitting next to each other. These students appeared to be working individually on the worksheet and occasionally checking in with their partner. Pilot Instructor B was also noted for not walking around (i.e., staying at front of classroom) and not prompting questions to groups or individual students. This could be explained by Pilot Instructor B's class size of four students. However, it is important to note that four out of the five cooperative learning elements were still observed even in this case.

Instructor C was also an exemplar instructor who did not incorporate cooperative learning elements. During Instructor C's classroom observation, students were provided the option of working together in pairs or groups of three to complete a multi-part problem that asked students to conduct a hypothesis test of a claim about a proportion. Similar to Pilot Instructor A, no formal grouping strategy was used by Instructor C. Although time was given to students to work on the problem, Instructor C noticed several students struggling to carry out the steps to formally test hypotheses, which were reviewed during the first portion of class. It was at this point when Instructor C ended the group task and brought the class together for a whole-class discussion about how to complete the multi-part problem. In this case, Instructor C imposed control when she decided the end the group activity and proceed to an instructor-led lecture. These results are consistent with Johnson, Johnson, and Holubec's (1994) claim that structuring cooperative learning involves more than just sitting students together and asking them to work together. However, even in this case, it is important to note that four out of the five cooperative learning elements were still observed.

Instructors classified as lecturers generally tend to demonstrate more control of classroom interactions and the problem-solving process. Note that Instructor C expected students to follow a specific procedure, limited their time for student engagement, and returned to a teacher-centered classroom as students were struggling to complete the task. There is support in the literature that shows that students benefit from productive struggle when given a task slightly beyond their abilities, however it is important to recognize a "time for telling" (Schwartz & Bransford, 1998). As such, there are circumstances in which lecture is appropriate. Instructor C represents a case in which continued use of cooperative learning was not merited. When this instructor recognized that her students continued to struggle and were not making progress towards a solution, she stepped in to provide more guidance in the form of direct instruction.

Lecturers' classrooms are primarily teacher-centered, where students are expected to take notes and absorb information being presented. Students have little autonomy and must follow teacher instructions. As noted above, those instructors who identified as not using cooperative learning (i.e., non-users) perceived cooperative learning as a costly instructional strategy. These cost perceptions aligned with non-users' notable barriers (i.e., time constraints, physical setup of classroom, amount of material to cover) to implementing cooperative learning as reported on the survey.

The second group is identified as two-year college math faculty who used cooperative learning as prescribed by Johnson and Johnson (1999, 2009). Instructors who fell into this category implemented more structure. Observations indicated that they were successful in implementing Johnson and Johnson's (1999, 2009) five essential elements of cooperative learning: positive interdependence, face-to-face promotive interaction, individual accountability, small-group skills, and group processing (Smith et al., 2005). Instructor B and Pilot Instructor A represent exemplar faculty participants who used cooperative learning as prescribed by Johnson and Johnson (1999, 2009). Note that Instructor B strictly enforced all of the elements of Johnson and Johnson's prescription. By formally grouping students (i.e., numbering students off and grouping common numbers), assigning a specific task (i.e., find three measures of central tendency for assigned data sets) that involves role interdependence (i.e., each student finds one measure of central tendency), and assessing individual students' learning (i.e., each student reports to whole-class their assigned measure), Instructor B formally implemented cooperative learning. Pilot Instructor A was also noted for her use of a similar formal grouping strategy, where she numbered off students and grouped common numbers, and designing a task that involved positive interdependence. During observation of Pilot Instructor A, I also noted positive interdependence and individual accountability displayed during the warm-up activity that had pairs of students solve and check the solution to linear equations at the front of the classroom. Individual students could not succeed in checking their work unless their partner correctly completed their task by solving for the unknown variable in their linear equation. Individual accountability was exhibited as Pilot Instructor A monitored each group and prompted each student with questions regarding steps taken to solve the linear equation. Similar to the responsibilities noted by Smith et al. (2005), two-year college math instructors structured formal cooperative learning by specifying lesson objectives, making pre-instructional decisions (e.g., group size, group composition), prescribing the task and type of interdependence, monitoring group processes, and evaluating students' learning.

The third group is identified as two-year college math faculty who use collaborative learning as prescribed by Smith and MacGregor (1992). This group is characterized by instructors who implement a more informal version of small-group learning (Hennessy & Evans, 2006). According to Davidson and Major (2014), definitions of collaborative learning often describe the importance of students working together in groups and groups working with the instructor in an effort to develop knowledge, consequently shifting the nature of authority in the classroom. Instructors act primarily as a facilitator in the classroom, directing instruction primarily through task design and encouraging students to talk to one another. Students have high learning autonomy and play a direct role in the learning process. Instructor A represents an exemplar faculty participant who used collaborative learning as prescribed by Smith and MacGregor (1992) and Hennessy and Evans (2006). The task assigned by Instructor A promoted students to work together collaboratively. Instructor A not only encouraged and expected students to work in pairs, she walked around the room to monitor their progress.

Even though individually accountability was not formally imposed, Instructor A was noted for probing inquiry questions.

- Finding 2: In this sample, collaborative learning resulted in a stronger presence of five essential elements associated in the literature with cooperative learning (Johnson & Johnson, 1999).

Traditionally, a high number of cooperative learning elements is expected to correspond to structured cooperative learning use as defined by Johnson and Johnson (1999, 2009). Surprisingly, the observation of Instructor A, whom I argue represents an exemplar instructor who uses collaborative learning, included more instances coded as one of the five essential cooperative learning elements than those instructors who implemented formally structured cooperative learning. In Instructor A's case, learning took place in small-groups focused on open-ended, complex tasks without much instructor imposed structure (Cooper & Robinson, 1998; Smith & MacGregor, 1992). By incorporating two collaborative activities in her Calculus course that focused on students' understanding of the relationship between function graphs and their derivatives, Instructor A trusted her students to actively engage in the teaching and learning process (Hennessy & Evans, 2006). Students were either overheard discussing function graphs and their derivative graphs or explaining the reasoning behind matching functions, their graphs, and their derivatives. Discussions occurred naturally rather than Instructor A having to prompt questions to groups or individual students. Students in Instructor A's course exhibited the necessary interpersonal and social skills to work effectively together. Instances of small group skills occurred through the sharing of resources or taking turns when talking. To my surprise, there was no need for the instructor to encourage these interactions.

It appears that faculty who classify as collaborative learning users place a lot of autonomy and responsibility on the students, as noted by Hennessy and Evans (2006). Students are expected to divide up the work, group themselves, and communicate with others. Since Instructor A's second assignment involved students working together in pairs to match cards based on the relationship between a function, its description, its derivative graph, and its derivative descriptive, students had to "participate in informed and spirited debate, and ultimately…negotiate" which cards matched (Hennessy & Evans, 2006, p. 97). The challenge of matching the related function and its derivative drove the activity and everyone was participating and talking to one another, similar to collaborative learning elements noted by Smith and MacGregor (1992). During this second activity, students were also given the responsibility of evaluating their group productivity based on the number of cards they had matched. Rather than Instructor A having to evaluate the group process behind matching cards, Instructor A focused on evaluating the group product deliverable, or all cards matched, in this activity (see Appendix J). This example indicated that collaborative learning required students to take responsibility when working in groups by building knowledge together and creating meaning through a product (Davidson & Major, 2014; Smith & MacGregor, 1992).

This study showed that two-year college math faculty implement group learning differently in the classroom. Not surprising, there are those instructors who do not implement cooperative learning at all and simply lecture and control much of the classroom interactions. Andersen (2011) found that the majority of two-year college math faculty lecture frequently. There are also those math faculty who implement a very structured form of group learning, or cooperative learning as defined by Johnson and Johnson (1999). These instructors still impose some control over activities in the classroom. As noted by Smith et al. (2005), to implement cooperative learning, instructors must make pre-instructional decisions, explain the task and interdependence, monitor groups' performance, and evaluate students' learning. Finally, there are two-year college math faculty who implement a less structured form of group learning, or collaborative learning as defined by Smith and MacGregor (1992). Instructors who implement collaborative learning show little control over classroom activities and interactions beyond the design of the task itself. They were also known for informally monitoring group work. Note that the card matching activity lent itself to pairs of students working together by its nature, and Instructor A was readily available to respond to student work when called upon to do, but she did not enforce individual roles or formally assess students individually through presentations. Students were expected to negotiate learning and relationships within groups (Hennessy & Evans, 2006).

According to Hennessy and Evans (2006), collaborative learning allows for the natural growth in the ability to work and communicate with others, rather than forcing these relationships like cooperative learning. Johnson and Johnson (1999), along with survey participants who identified as non-users of cooperative learning, argue that students must have the necessary interpersonal and teamwork skills to work effectively in groups. Since students often lack social skills, faculty who use cooperative learning often have to teach these skills beforehand, make pre-instructional activities, or formally structure group tasks to include the five essential elements of cooperative learning. Hennessey and Evans (2006) argue that instructors implementing collaborative learning must trust their students to manage themselves. For example, students should be allowed to formally divide and assign work. Moreover, Bruffee (1999) argues that collaborative learning provides the social classroom environment where students can discuss ideas or concepts. Davidson and Major (2014) claim that collaborative learning focuses on working with each other toward discovering knowledge, but not necessarily interdependently as does cooperative learning. Essentially, collaborative learning requires a shift of the control away from the instructor and to the students. By working together to achieve an open-ended, complex task, students create knowledge through their interactions with each other (Cooper & Robinson, 1998; Davidson & Major, 2014).

- Finding 3: In this sample, two potential differences were identified between faculty who report using cooperative learning and those who do not: a gender difference and a difference based on training/support.

Based on expectations of gender and faculty status in reported differences in cooperative learning use (Andersen, 2011), I investigated whether demographic differences in cooperative learning use were present in my sample. The quantitative data revealed variation within instructors who self-identified as using cooperative learning (of any variety). Of those forty-five participants who identified as cooperative learning users, thirty-three were female and twelve were male. There were also twenty-five full-time and twenty part-time faculty that reported the use of cooperative learning. I wanted to determine whether gender is associated with cooperative learning use. There is reason to believe there is a statistically significant difference between gender and cooperative learning use ($\chi^2(1) = 2.60$, $p = 0.107$), with females representing over three-fourths of the participants reporting cooperative learning use. Using tests of the strength of association (Phi and Cramer's V), I noted that the strength of association between gender and cooperative learning use is moderate (0.20). I also wanted to determine whether faculty status is associated with cooperative learning use. There is no statistically significant difference between faculty status and cooperative learning use ($\chi^2(1) = 0.97$, $p = 0.33$); that is, the cooperative learning use among full-time and part-time were equally represented by the participants recruited for the survey. Using tests of the strength of association (Phi and Cramer's V), I noted that the strength of association between faculty status and cooperative learning use is very weak (0.12). This study showed that two-year college math faculty most likely to use cooperative learning were female, which is consistent with Anderson's (2011) findings amongst Michigan two-year college math faculty in which female instructors were more likely than male instructors to frequently use cooperative learning. The fact that only female instructors volunteered to be observed may be a result of this gender difference, however, it poses a limitation to the ability to triangulate survey results with the qualitative data.

Finally, based on survey data, faculty who reported using cooperative learning were more likely to report that they had some type of support or incentive provided by their college for implementing it. Moreover, less than one-fourth of those who reported using cooperative learning on the survey, said they had not yet participated in any type of professional development or training within the last year that focused on cooperative learning. In contrast, over sixty percent of non-users reported that they had received no training or support to incorporate cooperative learning. The most common types of professional learning opportunities reported by users included professional development, personal experiences, and course preparation. These results were also reiterated during interviews with cooperative learning users, who referred to personal experiences, education, and training as the experiences that have influenced their cooperative learning use. These results highlight the importance and role that professional training plays on cooperative learning implementation (Saborit et al., 2016).

Research Question 3. How do two-year college mathematics faculty perceptions of cooperative learning influence its implementation in mathematics courses?

- Finding: Results from this study indicate that two-year college math faculty perceptions of cooperative learning drive their use.

For participants in this study, the spectrum of perceptions in Figure 6-1 corresponds to the spectrum of cooperative learning use shown in Figure 6-2. Two-year college math faculty who use cooperative learning minimally or do not use cooperative learning at all perceived it as a costly instructional strategy, therefore, they rarely use it as the perceived costs of implementation that act as a barrier (Abrami, Poulsen, & Chambers, 2004). This group of instructors describe the effect of teacher characteristics (i.e., perceptions of cooperative learning), student characteristics (i.e., shy, unprepared, unwilling), and pedagogical issues (i.e., too much class time, lack of content coverage) that impact their rare use of cooperative learning, similar to participants in Michael's

(2007) study. Negative perceptions regarding implementation costs aligned with this group's top reported barriers (i.e., time constraints, curriculum constraints, effect of student characteristics, lack of training and support) to using cooperative learning. As a result, this group of faculty often lectures, similar to Instructor C. This was a key case of an instructor who said they were using cooperative learning, but were not necessarily implementing it as prescribed by Johnson and Johnson (1999, 2009), Smith and MacGregor (1992), or Hennessy and Evans (2006). Interview data also confirmed that this group has tried out the use of cooperative learning with their students, but the aforementioned barriers impede their use. As a result, this group will often choose to lecture.

Two-year college math faculty who were classified as using cooperative learning, reported that cooperative learning is a valueable instructional strategy and had high expectations about its use. Contrary to two-year college math faculty who use cooperative learning minimally or do not use cooperative learning at all, faculty who reported using cooperative learning did not perceive it as a costly instructional strategy. Cooperative learning users described how the effect of 'student characteristics' and resisting students served as primary barriers to implementing cooperative learning. Therefore, rather than teacher characteristics or pedagogical issues serving as notable barriers to using cooperative learning, those who implement cooperative learning reported the impact of student characteristics or attributes (i.e., shy, unwilling, immature) on their frequency of cooperative learning use. Two-year college math faculty who were classified as using cooperative learning often talked about the need for structuring groups, designating roles, and teaching students' social skills. To ensure that cooperative learning elements are present, instructors had to impose control over the structure of group activities. Instructor B represented an exemplar case, because this instructor used a formal grouping strategy, used a formal task that involved positive role interdependence, and formally assessed student learning. In order to implement cooperative learning more frequently and successfully by controlling for student characteristics, faculty must control group composition and size, develop students' social skills, and carefully structure a task (Shimazoe & Aldrich, 2010).

Similarly, those two-year college math faculty who were classified as using collaborative learning described it as a beneficial pedagogical approach and had positive expectations about its use. Instructors who classified as using collaborative learning reported that peer interaction helped their students obtain a deeper understanding of course material since students' interpersonal and teamwork skills are enhanced. These instructors talked more about affordances and their experiences using group learning in their courses. According to Smith and MacGregor (1992), collaborative learning allows students to work together informally in an effort to develop and negotiate knowledge, which shifts control from the instructor to the students. Interview data revealed that those who classified as collaborative learning users rarely encounter barriers to use compared to two groups previously referenced. As noted by Hennessy and Evans (2006), students in collaborative learning environments are trusted by their instructor to manage themselves. This study indicates that faculty who were classified as collaborative learning users were able to overcome barriers to implementation, including student and teacher characteristics. Pedagogical issues were not of a concern to collaborative learning users because they did not refer to time, curriculum, or physical constraints as barriers. Moreover, rather than focusing on barriers to collaborative and cooperative learning during the interview, instructors who classify as collaborative learning users often talked about their personal experiences, specifically noting the ineffectiveness of lecture as an instructional strategy. Coupled with instructors' personal experiences and positive perceptions towards collaborative learning, two-year college math faculty implement collaborative learning frequently because it requires a shift of the learning responsibility away from the instructor and to the students (Davidson & Major, 2014). Essentially, the instructors' affordances and experiences of using this approach outweigh costs and barriers. Faculty are willing to use collaborative learning because it allows students to work together, learn from one another, and talk about math.

Conclusion

This study revealed that there are various forms of group learning used among two-year college math faculty participants involved in this study. Two-year college math faculty were categorized as implementing cooperative learning in one of three ways: lecture combined with some group discussion; formal cooperative learning; and informal collaborative learning.

Instruction in the first group was characterized by primarily lecturing with sporadic opportunities to talk with one another and work together. These instructors perceived the value is outweighed by barriers to implementation including student characteristics, teacher characteristics, and pedagogical issues. If group learning does occur, it is rarely structured. The survey data indicated that some faculty in this group recognized a need for support and training focused on cooperative learning. However, these instructional decisions could be based on valid constraints (i.e., time, physical, curriculum) that impede cooperative learning use.

Those who use cooperative learning, as prescribed by Johnson and Johnson (1999, 2009), primarily rely on structured groups and tasks. Faculty in this group perceive student attributes and characteristics as requiring a higher degree of structure within the task and classroom interactions. Although these instructors valued cooperative learning, they found it necessary to impose control. Cooperative learning users often talked about the need for structuring groups, designating roles, and teaching students' social skills.

Those who use collaborative learning, as prescribed by Smith and MacGregor (1992) and Hennessy and Evans (2006), primarily rely on open-ended, complex tasks that have students take considerable responsibility for working and constructing knowledge together. This form of group learning is more free-form than cooperative learning. Collaborative learning users often talked about affordances to using group learning, such as students learn from one another and students communicate about content. Therefore, those who use collaborative learning value its use, believe it has low implementation costs and impose less instructor control. In collaborative learning settings, students are trusted to assign roles, structure groups, and monitor their own progress. This study indicates that collaborative learning in two-year college math classrooms can actually result in a stronger presence of the five essential elements identified by Johnson and

Johnson (1999, 2009) than structured cooperative learning, and may be appropriate in that setting as argued by Hennessey and Evans (2006).

Implications

This study revealed a high use of group learning among two-year college math faculty, at least amongst the population surveyed, interviewed, and observed. However, results from this study indicated that instructors who report that they are using cooperative learning may be actually using a broad spectrum of instructional strategies, dictated by their perceptions of constraints of the teaching environment. This points to a limitation in the ability of survey-only data to inform policy decisions about instructional practice. For example, when comparing CCFSSE and CCSSE data (Center for Community College Student Engagement, 2015; McClenney, 2007), faculty and students often report different perceptions of the frequency of active and collaborative learning. This may in fact be due to differences in how cooperative learning is perceived.

Faculty participants reported that they value cooperative and collaborative learning as pedagogical strategies but their ability to implement them depended on the support and training provided. However, these results hint that support and professional learning opportunities that revolve around structuring teaching strategies alone may not be sufficient. College administrators and math department chairs must continue to collaborate to find ways to provide opportunities for faculty to discuss pedagogy and let two-year college math faculty experience the range of teaching strategies that will leverage the affordances of cooperative learning while addressing the constraints of their teaching environments. While professional training is vital for the successful implementation of cooperative learning (Sharan, 2010), faculty need opportunities to engage in discussions about teaching and learning. Like most college faculty, many had training in their field rather than in pedagogy. Furthermore, a majority of college faculty reported that previous professional learning opportunities typically included attending conferences and workshops, rather than participating in a detailed examination of pedagogical approaches (Bickerstaff & Cormier, 2015).

This study suggests a re-envisioning of the presence of Johnson and Johnson's (1999, 2009) essential elements. Rather than the instructor having to enforce these elements through the use of structured cooperative learning, collaborative learning shifts the responsibility to the students and allows for a more natural growth of students' ability to work and talk with others (Hennessy & Evans, 2006). There are other ways instructors can influence students to work effectively in groups rather than strictly controlling group membership, role assignments, and individual accountability. Collaborative learning demands the instructor share authority with students. While interdependence is formalized through a structured task that assign roles in cooperative learning environments, collaborative learning encourages debate, disagreement, and higher-order thinking through student self-directed tasks (e.g., Instructor A's Calculus Card Matching Activity). According to Hennessy and Evans (2006), the most effective type of small group learning places students in situations where they must debate meaning and investigate unfamiliar, yet complex tasks. When students are afforded an opportunity to negotiate meaning in a small-group setting, students begin to feel a sense of belonging and increased motivation.

On the other hand, these results imply that for some faculty, barriers, including time constraints and student characteristics, may exceed the affordances of cooperative learning. As was the case for Instructor C, there may be times when limited use of cooperative learning is needed.

Limitations of the Study

Although the stratified sampling design enhances its generalizability, the limited response rate in contrast serves as a limitation to the ability to generalize the results. Further, the fact that this study employed a strictly volunteer sample introduces a bias and limits generalizability of the results. It is possible that responding faculty may have more positive views of cooperative learning than those who chose not to respond, thus these results cannot necessarily be generalized to the broader sample of Texas two-year college faculty beyond the participating colleges. Further, the selected colleges also volunteered to participate and may not be representative of the broader sample from which I solicited participation. Thus, there are clear limitations in the generalizability of the survey results.

These limitations also extend to the results based on observations and interviews, as those participants were drawn from the survey pool and were not randomly selected from that pool. Therefore, participants in both interviews and observations do not constitute a representative sample. Notably, the gender distribution of respondents does not mirror the gender distribution of two-year college faculty. This is particularly true in the case of the observations, which were limited to female instructors. With these data, it is not possible to assess gender difference in the implementation of cooperative learning and to know whether the results are representative of the larger population.

Further, it is reasonable that these individuals volunteered for interviews and observations based on their confidence in implementing cooperative learning. This sample may be biased towards more frequent and successful use of cooperative learning; therefore, these results cannot be generalized. However, they demonstrate possibilities for the use of cooperative learning in two-year college math classrooms. In that sense, they serve as an existence proof and merit further research.

As in any mixed methods research design, the results are inevitably framed by the researchers' epistemological stance. Choosing the Johnson and Johnson (1999, 2009) framework in which to judge cooperative learning, despite extensive support in the research literature, introduces a bias in the results. Further, the subjectivity of the coding process limits the generalizability of the results.

Monetary incentives, which were used to help motivate survey, interview, and observation participation, also served as a study limitation. While monetary incentives are often used to both facilitate recruitment and motivate participation among individuals who might otherwise not respond (Singer, 2002), research shows that there are various reasons people refuse to participate in studies and how those reasons affect the quality of the data being collected (Groves & Couper, 1998; Singer, Van Hoewyk, & Neugebauer, 2003). Although incentives may exert unwarranted influence, research shows that larger incentives induce respondents to accept risks they would not accept with smaller incentives. Accordingly, incentives were increased in the second semester of the study to garner additional responses.

Another limitation is that the survey instrument, originally based on the work of Abrami, Poulsen, and Chambers (2004), underwent changes for this study. Since the original survey instrument was developed for K-12 educators and not college faculty, this study attempted to adapt the instrument to reflect the population of two-year college math faculty. While some may argue that the additional and removal of survey questions takes away from the fidelity of this instrument, a pilot study was conducted to test and refine survey questions. Czaja and Blair (2005) argue that it is good practice to pilot test a survey instrument after the initial design and formatting are complete, particularly if there is little input from the population of interest. Further research that studies the use of this study's proposed survey instrument, specifically noting the relationship between demographic variables of two-year college math faculty members and the use of cooperative learning, will also be of importance.

A final limitation of this research is that it focuses on two-year college math faculty members who taught face-to-face as opposed online courses. Instructors who teach online courses argue that cooperative learning is possible using online formats, and as a matter of fact, may provide more avenues for collaboration amongst students than face-to-face courses offer (Castle, 2014). Online courses were not included in this study, because such courses provide communication challenges that are in contrast to face-to-face courses (Smith et al., 2011). While some faculty participants acknowledged that they also teach online courses, the purpose of this study was to study cooperative learning in a face-to-face context.

Suggestions for Further Research

While this study focuses on the perceptions and use of cooperative learning in two-year college math courses in a face-to-face setting, one opportunity for future research is to study faculty perceptions and use of cooperative learning using online math course formats. As previously mentioned, this study did not include math faculty participants teaching online courses. However, since a number of trends (e.g., increase in number of college courses offered online, movement towards online communities of practice, use of computer-supported collaborative learning) have started, future studies should compare faculty perceptions of group work in a face-to-face versus an online setting. Smith et al. (2011) discovered that communication issues and personal feelings about group work and their participation played a prominent role in student perceptions about group work. Future research should study whether two-year college math faculty, teaching face-to-face or online, share similar perceptions as students, especially since group work is likely to be used in the work place (Smith et al., 2011). Given the increased number of unprepared students entering (Bailey, Jeong, & Cho, 2010) and online courses offered at two-year colleges (Smith, Heindel, & Torres, 2008), research must examine faculty perceptions and the use of cooperative learning within different instructional modalities (e.g., face-to-face vs. online). Such a study would fill the literature gap in regard to cooperative online learning.

Noting that this study found three elements (i.e., face-to-face promotive interaction, individual accountability, and group processing) were more consistently observed, more research is needed into the relative impact of the five elements, most notably group interdependence.

According to Johnson and Johnson (1999) group interdependence is a key component of cooperative learning which drives the other elements. Castle (2014) positions cooperative learning as showing high interdependence and high structure. In this study, however, these results show that interdependence is possible in a less structured collaborative learning environment. Further research is needed to examine the relatively significance of the different elements in the framework.

Although this study used a rigorous mixed methods sampling strategy, this study warrants replication using math faculty from more community, junior, and two-year colleges. As previously stated, the two-stage cluster sample provided a cost-efficient (e.g., money, time) way to generate a more efficient probability sample. However, such a sampling strategy is not truly representative of the population from where the sample was drawn. Further research on two-year college math faculty should incorporate a more sophisticated mixed methods sampling strategy, one which generates both a representative sample related to the quantitative research questions and saturated information on the qualitative research questions. Results from such studies will help to increase the generalizability of the results and help educational researchers to determine the extent to which findings from similar studies are applicable to postsecondary math courses.

Another important finding of this study is the need for more support and professional learning the college provides for implementing cooperative learning. Faculty participants in this study reported participation in various types of professional learning opportunities. Gillies (2008) and Lopata, Miller, and Miller (2003) highlight the importance of training instructors in the knowledge and skills required to implement cooperative learning in the classroom. Given the complexity of this instructional approach, more research should examine the effects of occasional and ongoing professional training on two-year college math instructors' use of cooperative learning. One possibility could involve a researcher distributing a survey instrument similar to the one this study and then recruiting faculty to participate in a focus group or individual interviews to discuss the influence of professional learning and support on their use of cooperative learning.

One last suggestion for further research includes focusing on two-year college students' perceptions of cooperative learning in comparison with their actual classroom experiences in math courses. Since much of the current research on students' experiences of cooperative learning comes from self-reported data (Center for Community College Student Engagement, 2015; Phipps et al., 2001; Smith et al., 2011), further exploratory research is needed to investigate students' insight about cooperative learning and how they experience it in their courses.

Appendices

Appendix A: Pilot Perceptions on Cost, Value, and Expectancy

Question Breakdown - Percentage of Participants by Bin					
Cost Category					
Item #	**Question**	**D-SD**	**Undecided**	**A-SA**	**Mean**
3	The costs involved in implementing cooperative learning are great.	66%	20%	15%	2.29
20	It is impossible to implement cooperative learning without specialized materials.	54%	12%	34%	2.68
32	Implementing cooperative learning requires a great deal of effort.	24%	12%	63%	3.61
36	Cooperative learning is an efficient classroom strategy.	20%	22%	59%	3.49
27	There is too little time available to prepare students to work effectively in groups.	37%	12%	51%	3.24
38	Implementing cooperative learning takes too much class time.	44%	15%	41%	3.02
45	Implementing cooperative learning takes too much preparation time.	46%	22%	32%	2.78
Value Category					
Item #	**Question**	**D-SD**	**Undecided**	**A-SA**	**Mean**
4	Competition best prepares students for the real world.	48%	23%	30%	2.85
6	Cooperative learning holds bright students back.	71%	12%	17%	2.27
14	Cooperative learning contradicts student goals.	83%	10%	7%	1.85
16	Peer interaction helps students obtain a deeper understanding of the material.	10%	7%	83%	4.05
22	Cooperative learning places too much emphasis on developing students' social skills.	79%	10%	10%	2.15
25	Engaging in cooperative learning enhances students' social skills.	10%	17%	73%	3.8
26	It is impossible to evaluate students fairly when using cooperative learning.	51%	32%	17%	2.59
29	Using cooperative learning promotes friendship among students.	5%	15%	80%	3.93
31	Engaging in cooperative learning interferes with students' academic progress.	78%	12%	10%	2.07
34	Cooperative learning enhances the learning of developmental students.	7%	24%	68%	3.83
39	Using cooperative learning fosters positive student attitudes towards learning.	12%	22%	66%	3.59
47	Cooperative learning gives too much responsibility to the students.	80%	5%	15%	2.17
7	There are too many demands for change in education today.	30%	20%	50%	3.25
8	Cooperative learning is consistent with my teaching philosophy.	20%	15%	66%	3.63
12	Using cooperative learning enhances my career advancement.	38%	40%	23%	2.85
15	Cooperative learning is a valuable instructional approach.	5%	22%	73%	3.9
21	I feel pressured by the administration to use cooperative learning.	66%	20%	15%	2.29
35	I feel pressured by other instructors to use cooperative learning.	73%	12%	15%	2.2
37	Cooperative learning helps meet my college's goals.	17%	22%	61%	3.56
42	I prefer using familiar teaching methods over trying new approaches.	59%	20%	22%	2.44
46	I feel a personal commitment to using cooperative learning.	34%	20%	46%	3.15
Expectancy Category					
Item #	**Question**	**D-SD**	**Undecided**	**A-SA**	**Mean**
1	If I use cooperative learning, the students tend to veer off task.	68%	5%	27%	2.56
9	My students presently lack the skills necessary for effective cooperative group work.	54%	22%	24%	2.61
11	Using cooperative learning is likely to create too many disciplinary problems among my students	78%	12%	10%	2.1
18	Cooperative learning is appropriate for the grade level I teach.	17%	5%	78%	3.8
19	If I use cooperative learning, too many students expect other group members to do the work.	46%	10%	44%	3.05
28	There are too many students in my class to implement cooperative learning effectively.	66%	12%	22%	2.49
30	My students are resistant to working in cooperative groups.	39%	29%	32%	2.88
41	Cooperative learning would not work with my students.	71%	15%	15%	2.29
43	If I use cooperative learning, my classroom is too noisy.	76%	15%	10%	2.17
2	I understand cooperative learning well enough to implement it successfully.	12%	22%	66%	3.61
23	I believe I can implement cooperative learning successfully.	10%	24%	66%	3.76
24	I have too little teaching experience to implement cooperative learning successfully.	80%	12%	7%	1.95
33	Cooperative learning is inappropriate for the subject I teach.	76%	12%	12%	2.02
40	I find that cooperative learning is too difficult to implement successfully.	51%	32%	17%	2.56
44	I believe I am a very effective instructor.	2%	7%	90%	4.29
48	The physical set-up of my classroom is an obstacle to using cooperative learning.	49%	7%	44%	3.02
5	The amount of cooperative learning training I have received has prepared me to implement it successfully.	46%	24%	29%	2.76
10	For me to succeed in using cooperative learning depends on receiving support from my colleagues.	70%	13%	18%	2.25
13	For me to succeed in using cooperative learning requires support from the school administration.	54%	12%	34%	2.71
17	My training in cooperative learning has not been practical enough for me to implement it successfully.	56%	12%	32%	2.71

Appendix B: Modified CLIQ Used for Pilot

Instructions
This survey is designed to identify factors that may have influenced your decision about whether or not to implement cooperative learning.

Definition of 'Cooperative Learning' used in this survey
Cooperative learning is an instructional use of small groups so that students work together to maximize their own and each other's learning.

There are three sections to this survey:

1. Professional Views on Cooperative Learning (50 questions, 8-10 minutes)
2. Demographic Questions (6 questions, 1-2 minutes)
3. Current Teaching Practices (9 questions, 2-5 minutes)

Cooperative learning is abbreviated as "CL" for the survey items. The response scale is indicated for each section. You can go the next page by clicking the "Next >>" button or go back to the previous page by clicking the "Back <<" button at the bottom of the page. A progress bar is also displayed at the bottom of the screen. The end of the survey will prompt a completion screen and ask if you would like to participate in an interview or classroom observation.

Your participation in completing this survey is highly appreciated!

Section 1 – Professional Views on Cooperative Learning
For each of the following statements, please choose the response that best corresponds to your position, according to the following response scale.

Response Scale:

A. Strongly Agree
B. Agree
C. Undecided
D. Disagree
E. Strongly Disagree

1. If I use cooperative learning, the students tend to veer off task.
2. I understand cooperative learning well enough to implement it successfully.
3. The costs involved in implementing cooperative learning are great.
4. Competition best prepares students for the real world.
5. The amount of cooperative learning training I have received has prepared me to implement it successfully.
6. Cooperative learning holds bright students back.
7. There are too many demands for change in higher education today.
8. Cooperative learning is consistent with my teaching philosophy.

9. My students presently lack the skills necessary for effective cooperative group work.
10. For me to succeed in using cooperative learning depends on receiving support from my colleagues.
11. Using cooperative learning is likely to create too many disciplinary problems among my students.
12. Using cooperative learning enhances my career advancement.
13. For me to succeed in using cooperative learning requires support from the school administration.
14. Cooperative learning contradicts student goals.
15. Cooperative learning is a valuable instructional approach.
16. Peer interaction helps students obtain a deeper understanding of the material.
17. My training in cooperative learning has not been practical enough for me to implement it successfully.
18. Cooperative learning is appropriate for the grade level I teach.
19. If I use cooperative learning, too many students expect other group members to do the work.
20. It is impossible to implement cooperative learning without specialized materials.
21. I feel pressured by the administration to use cooperative learning.
22. Cooperative learning places too much emphasis on developing students' social skills.
23. I believe I can implement cooperative learning successfully.
24. I have too little teaching experience to implement cooperative learning successfully.
25. Engaging in cooperative learning enhances students' social skills.
26. It is impossible to evaluate students fairly when using cooperative learning.
27. There is too little time available to prepare students to work effectively in groups.
28. There are too many students in my class to implement cooperative learning effectively.
29. Using cooperative learning promotes friendship among students.
30. My students are resistant to working in cooperative groups.
31. Engaging in cooperative learning interferes with students' academic progress.
32. Implementing cooperative learning requires a great deal of effort.
33. Cooperative learning is inappropriate for the subject I teach.
34. Cooperative learning enhances the learning of developmental students.
35. I feel pressured by other instructors to use cooperative learning.
36. Cooperative learning is an efficient classroom strategy.
37. Cooperative learning helps meet my college's goals.
38. Implementing cooperative learning takes too much class time.
39. Using cooperative learning fosters positive student attitudes towards learning.
40. I find that cooperative learning is too difficult to implement successfully.

41. Cooperative learning would not work with my students.
42. I prefer using familiar teaching methods over trying new approaches.
43. If I use cooperative learning, my classroom is too noisy.
44. I believe I am a very effective instructor.
45. Implementing cooperative learning takes too much preparation time.
46. I feel a personal commitment to using cooperative learning.
47. Cooperative learning gives too much responsibility to the students.
48. The physical set-up of my classroom is an obstacle to using cooperative learning.

<u>Multiple-option select question</u>

49. Which, if any, of the following classroom activities would you classify as cooperative learning activities? (Think-pair-share, Students working against each other to achieve an academic goal such as a grade of "A", Whole-class discussion, Students working individually to accomplish learning goals unrelated to those of others, Use of Jigsaw groups, Test-taking Teams, Lecturing, Team Jeopardy, Students sitting side-by-side talking with each other as they do their individual assignment, Group presentations, Use of study groups, Other [please include a description]

<u>Free response (open-ended) question</u>

50. What do you see as possible barriers or difficulties to implementing cooperative learning in your courses?

<u>Section 2 – Demographic Questions</u>

Please choose the response that best matches you.

51. Gender (Male, Female)
52. Faculty Status (Full-time, Part-time)
53. Are you currently teaching a developmental math course? (Yes, No)
54. How many years have you been teaching at your college? (0-1 years, 2-4 years, 5-9 years, 10+ years)
55. What kind of support or incentives does your college provide for implementing cooperative learning? Choose all that apply. (Included in formal review process; Provided money/technology resources; Ability to include questions on course instructor surveys; Increase review/planning time; Professional learning opportunities; Other [please include a description])
56. What type of professional development or training have you participated in *within the last year* that addressed or focused on cooperative learning? Choose all that apply. (Administrative/school endorsement; Local professional development; Locally negotiated curriculum planning/training; Attending/presenting conference; Use of mentors and/or colleagues; Personal

experiences and/or course preparation; None; Other [please include a description])

Section 3 – Current Teaching Practices

For each of the following statements, please choose the response that best corresponds to your teaching practices.

57. Are you using or do you have plans to use cooperative learning in the immediate future? (Yes, No)

The survey will include a conditional statement. Faculty that selects YES will proceed to remaining questions. Faculty that selects NO will have completed the survey and will not be required to answer the remaining last eight questions.

58. How often do you use or plan to use cooperative learning in your course(s)? (At least once a semester, At least once a month, At least once a week, At least once a class period)

Response Scale:

A. Entirely
B. Largely
C. Somewhat
D. Slightly
E. Not at all

59. Rate the extent to which you structure your cooperative learning activities to ensure that all group members actively work together.
60. In a typical cooperative learning activity in your class, rate the extent to which group members actively participate.
61. In a typical cooperative learning activity in your class, rate the extent to which your students complete their share of the group task.
62. Rate the extent to which you implement cooperative learning in order to increase academic achievement.
63. Rate the extent to which you implement cooperative learning in order to improve social skills.
64. Rate the extent to which you implement cooperative learning in order to motivate students.
65. Rate the extent to which you implement cooperative learning in order to raise self-esteem.

ALL RESPONDENTS

We welcome your feedback. Please type any suggestions or comments in the space provided on the answer sheet.

Please feel free to forward this survey to other community college math faculty who may also be interested in participating in this study. Thank you very much for your participation.

COMPLETION SCREEN

You have successfully completed the survey and are now eligible to receive a $10 e-gift card from Amazon.com for your participation. Please provide your name and e-mail address to arrange electronic delivery of your compensation.

[NAME]: ______________________
[E-MAIL ADDRESS]: ________________________

If you are interested in having the researcher(s) interview you and/or come and observe your use of cooperative learning in the classroom, please provide your contact information below including your name, e-mail address, and phone number. You may be contacted by the researcher(s) to schedule a possible schedule a time for them to conduct an interview and/or visit your classroom. Your response will not affect whether or not you receive compensation. You can select one or both options.

- ☐ Interview
- ☐ Classroom Observation

Appendix C: Permission to Use CLIQ

Phil Abrami <abrami@education.concordia.ca>
To: adamj.castillo@austin.utexas.edu
Re: Possible use of CLIQ in dissertation work - UT Austin student

December 13, 2015 1:55 PM

Permission granted.

No further validation info

Please see:

http://www.concordia.ca/research/learning-performance/knowledge-transfer/instruments.html

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"Castillo, Adam J" <adamj.castillo@austin.utexas.edu> writes:

> Good morning Dr. Abrami,
>
> First off, my name is Adam Castillo, currently a Ph.D. candidate in STEM Education at the University of Texas at Austin. I also work as a graduate research assistant at the Charles A. Dana Center ([http://www.utdanacenter.org/]http://www.utdanacenter.org).
>
> I am currently in the process of writing my dissertation proposal. Last week, as I was reading through articles and searching for related articles/manuscripts related to my dissertation topic, I came across a reference to a dissertation titled "Perceptions and use of cooperative learning by community college faculty members," (Hunter, 2011) which included a survey instrument as part of the research methodology. After reading through the manuscript, I encountered a reference to the instrument, Cooperative Learning Implementation Questionnaire, which was developed by the CSLP. I have come across this survey instrument a few times, so I wanted to reach out to you in regards to possible use.
>
> I am considering a similar study that examines Texas community college math faculty perceptions of collaborative learning and how those perceptions influence it's implementation in developmental math courses. I am seeking permission to use your CLIQ in my proposal, because it would serve as a great resource as I consider possible ways to gather/document faculty perceptions. If permission is granted, I would gladly update you with a copy of my proposal or any other references that include the use of the CLIQ. I would also be interested in any information that's not already reported in your peer-reviewed article (attached below) on the questionnaire's validity and reliability.
>
> Any help is greatly appreciated. Thanks for your time,
>
> Adam

Appendix D: Interview Protocol Used for Pilot

Interviewer Script
Hello, my name is Adam Castillo. Thank for you giving me an opportunity to ask some follow-up questions regarding the implementation of cooperative learning. I would like to briefly ask you some questions about your use of cooperative learning in your community college math courses this semester. The interview should last approximately 10-15 minutes. Let's get started.

The faculty participants will be asked questions similar to those that follow:

(1) How would you define cooperative learning?
- What do identify as key elements of cooperative learning?

(2) How frequently do you use cooperative learning in your courses?

If faculty participants answer to (2) *above is 'Never OR Rarely OR Occasionally/Sometimes', ask the following:*
- What has led to your decision to use it never, rarely or only occasionally?
- What type of support(s) or incentive(s) would lead you to implement cooperative learning more frequently?

If faculty participants answer to (2) *above is 'Often or Always', ask the following:*
- Tell me about your use of cooperative learning.
- What experiences influenced your frequency of using cooperative learning in your courses?

(3) What instructional strategies do you feel are important for student learning?
- How does cooperative learning rank in comparison with the variety of strategies that you use?

(4) What are some barriers or difficulties to implementing cooperative learning in your course(s)?
- Tell me about the classroom arrangement.
- What do you consider to be the ideal environment for implementing cooperative learning?
- Tell me about the curriculum you use in your math course.
- What have you done to overcome particular barriers or difficulties?

Appendix E: Observation Instrument Used for Pilot

Group Activity Description

Group Details

Group #		How was Group formed?	
Number of Students in Group		Additional Comments	

What to Observe

	Type of Cooperative Learning *(Choose from formal, informal, or base groups)*	Participant Behavior *(Provide descriptive, detailed accounts of participant behavior related to cooperative learning)*		Elements of Cooperative Learning *(Indicate frequency of elements with tally marks)*				
Time	Type	Instructor Behavior	Student Behavior	Positive Interdependence	Face-to-face Promotive Interaction	Individual Accountability	Use of Small-group Skills	Group Processing

Appendix F: Observation Instrument Definitions

Positive Interdependence

- The success of individuals is linked to the success of the group. Individual students succeed to the degree that the group succeeds. Group members work together to learn from each other, promote everyone's success, and share in the group's success.
    - Group acknowledgement and commitment to complete specific goals
    - Positive relationship dynamics among team members
    - Team works together to progress in achieving a specific task outcome

Face-to-face Promotive Interaction

- Students promote each other's success by actively helping, supporting, encouraging, and praising each other's efforts to learn. Group members help each other in an efficient manner that accomplishes a specific goal.
    - Group members provide feedback to one another
    - Group members encourage others within the group
    - Group members provide each other with resources

Individual Accountability

- Exists when the performance of each individual student is assessed, and results are reported back to the group. Each group member is accountable for contributing his or her share of the work and the group is also held accountable for reaching its goals.
    - Individual participation by group members
    - Expectations set by group members for individual contributions

Use of Small-Group Skills

- Individual group members use interpersonal and social skills that help to create a positive group dynamic. Group members coordinate their efforts in order to achieve shared goals.
    - Use eye content while talking to group members
    - Respecting (and listening) to ideas of group members

Group Processing

- Students should frequently evaluate their group productivity, where they reflect on and discuss how the group functions and provide feedback to each group member. Groups need to process in order to talk about what actions are helpful and unhelpful and decide what to continue or discontinue in the future.
    - Group pauses to evaluate team efforts
    - Group makes decision on specific actions to continue or change

Appendix G: Online Cooperative Learning Implementation Survey

Instructions
The *Cooperative Learning Implementation Survey* is designed to identify factors and reasons that may have influenced your decision about whether or not to implement cooperative learning.

Definition of 'Cooperative Learning' used in this survey
Cooperative learning (CL) is the instructional use of small groups so that students work together to maximize their own and each other's learning.

There are three sections to this survey:

1. Professional Views on Cooperative Learning (45 questions, 5-7 minutes)
2. Demographic Questions (6 questions, 1-3 minutes)
3. Current Teaching Practices (5 questions, 3-5 minutes)

Cooperative learning is abbreviated as "CL" for most of the survey items. The response scale is indicated for each section. You can go the next page by clicking the "Next >>" button or go back to the previous page by clicking the "Back <<" button at the bottom of the page. A progress bar is also displayed at the bottom of the screen. The end of the survey will prompt a completion screen and ask if you would like to participate in an interview or classroom observation.

Your participation in completing this survey is highly appreciated!

Section 1 – Professional Views on Cooperative Learning
For each of the following statements, please choose the response that best corresponds to your position from 'Strongly Disagree' to 'Strongly Agree'.

Response Scale:

A. Strongly Disagree
B. Disagree
C. Somewhat Disagree
D. Somewhat Agree
E. Agree
F. Strongly Agree

1. If I use cooperative learning, the students tend to veer off task.
2. I understand cooperative learning well enough to implement it successfully.
3. The costs involved in implementing cooperative learning are great.
4. Competition best prepares students for the real world.
5. The amount of cooperative learning training I have received has prepared me to implement it successfully.
6. Cooperative learning holds bright students back.

7. There are too many demands for change in higher education today.
8. My students presently lack the skills necessary for effective cooperative group work.
9. For me to succeed in using cooperative learning depends on receiving support from my colleagues.
10. Using cooperative learning is likely to create too many disciplinary problems among my students.
11. Using cooperative learning enhances my career advancement.
12. For me to succeed in using cooperative learning requires support from the school administration.
13. Cooperative learning is a valuable instructional approach.
14. Peer interaction helps students obtain a deeper understanding of the material.
15. My training in cooperative learning has not been practical enough for me to implement it successfully.
16. If I use cooperative learning, too many students expect other group members to do the work.
17. It is impossible to implement cooperative learning without specialized materials.
18. I feel pressured by the administration to use cooperative learning.
19. Cooperative learning places too much emphasis on developing students' social skills.
20. I believe I can implement cooperative learning successfully.
21. I have too little teaching experience to implement cooperative learning successfully.
22. Engaging in cooperative learning enhances students' social skills.
23. It is impossible to evaluate students fairly when using cooperative learning.
24. There is too little time available to prepare students to work effectively in groups.
25. There are too many students in my class to implement cooperative learning effectively.
26. Using cooperative learning promotes friendship among students.
27. My students are resistant to working in cooperative groups.
28. Engaging in cooperative learning interferes with students' academic progress.
29. Implementing cooperative learning requires a great deal of effort.
30. Cooperative learning is inappropriate for the subject I teach.
31. I feel pressured by other instructors to use cooperative learning.
32. Cooperative learning helps meet my college's goals.
33. Implementing cooperative learning takes too much class time.
34. Using cooperative learning fosters positive student attitudes towards learning.
35. I find that cooperative learning is too difficult to implement successfully.
36. Cooperative learning would not work with my students.
37. If I use cooperative learning, my classroom is too noisy.

38. I believe I am a very effective instructor.
39. Implementing cooperative learning takes too much preparation time.
40. Cooperative learning gives too much responsibility to the students.
41. The physical set-up of my classroom is an obstacle to using cooperative learning.

Multiple-option select question

42. Which, if any, of the following classroom activities would you classify as cooperative learning activities? (Think-pair-share, Students working against each other to achieve an academic goal such as a grade of "A", Whole-class discussion; Students working individually to accomplish learning goals unrelated to those of others; Use of jigsaw groups; Test-taking Teams; Lecturing; Team Jeopardy; Students sitting side-by-side talking with each other as they do their individual assignment; Group presentations; Use of study groups; Other [please include a description])

43. What kind of support or incentives does your college provide for implementing cooperative learning? *Choose all that apply.* (Professional Development; Included in formal review process; Provided money/online/technology resources; Ability to include questions on course instructor surveys; Increase review/planning time; Professional learning communities; None; Other [please include a description])

44. What type of professional development or training have you participated in *within the last year* that addressed or focused on cooperative learning? *Choose all that apply.* (Administrative/school endorsement; Local professional development; Locally negotiated curriculum planning/training; Attending/presenting conference; Use of mentors and/or colleagues; Personal experiences and/or course preparation; None; Other [please include a description])

Free response (open-ended) question

45. What do you see as possible barriers or difficulties to implementing cooperative learning in your courses?

Section 2 – Demographic Questions
Please answer the following questions about yourself.

46. College Name
47. How many years have you been teaching at your college? (0-1 years, 2-4 years,

5-9 years, 10+ years)

48. Gender (Male, Female)
49. Faculty Status (Full-time, Part-time)
50. Are you currently teaching a developmental math course? (Yes, No)
51. Are you a former K-12 teacher?

Question 51 will include a conditional statement. Faculty that select YES will proceed to Question 52. Faculty that select NO will proceed to Question 53.

52. What grade level did you teach? (Elementary School, Middle School, High School)

Section 3 – Current Teaching Practices

For each of the following statements, please choose the response that best corresponds to your teaching practices.

53. Are you using or do you have plans to use cooperative learning in the immediate future? (Yes, No)

Question 53 will include a conditional statement. Faculty that select YES will proceed to remaining questions. Faculty that select NO will have completed the survey and will not be required to answer the remaining questions.

54. How often do you use or plan to use cooperative learning in your course(s)? (At least once a semester, At least once a month, At least once a week, At least once a class period)

Free response (open-ended) questions

55. What aspects of CL do you use in your course(s)?
56. Why are you using CL in your course(s)?
57. What experiences have influenced your use of CL?

ALL RESPONDENTS

We welcome your feedback. Please type any suggestions or comments in the space provided on the answer sheet.

Please feel free to forward this survey to other community college math faculty who may also be interested in participating in this study. Thank you very much for your participation.

COMPLETION SCREEN

You have successfully completed the survey and are now eligible to receive one $10 e-gift card from Amazon.com for your participation. Please provide your name, e-mail address, and phone number below to arrange electronic delivery of your compensation.

[Name]: ________________________________
[E-mail Address]: ________________________
[Phone Number]: ________________________

Follow-up Interview and/or Classroom Observation

If you are interested in having the researcher(s) interview you and/or come and observe your use of cooperative learning in the classroom, you may be contacted by the researcher(s) to possibly schedule a time for them to conduct an interview and/or visit your classroom. Faculty participants can receive one $15 e-gift card from Amazon.com by completing an interview. Faculty participants can also receive one $25 e-gift card from Amazon.com for allowing the researcher(s) to come and observe your use of cooperative learning in the classroom. *You can select one or both options.*

- ☐ Interview
- ☐ Classroom Observation

Appendix H: Modified Interview Protocol

Interviewer Script

Hello, my name is Adam Castillo. Thank for you giving me an opportunity to ask some follow-up questions regarding the implementation of cooperative learning. I would like to briefly ask you some questions about your use of cooperative learning in your community college math courses this semester. The interview should last approximately 10-15 minutes. Let's get started.

The faculty participants will be asked questions similar to those that follow:

(1) How would you define cooperative learning?
(2) What do identify as key elements of cooperative learning?
(3) How frequently do you use cooperative learning in your courses?
    If faculty participant responds that they don't use CL frequently, ask:
    - What has led to your decision to not use CL frequently?
    - Is there any type of support or incentive that would lead you to implement cooperative learning more frequently?

    If faculty participant responds that they do use CL frequently, ask:
    - Tell me about your use of cooperative learning.
    - What aspects of CL do you use in your course?

(4) Why are you using CL in your course?
(5) What experiences have influenced your use of cooperative learning?
(6) What are some barriers or difficulties to implementing cooperative learning in your course(s)?
    - Are there any physical restrictions (e.g., time, arrangement of classroom)?
    - Are there any curriculum pressures?
    - What have you done to overcome particular barriers or difficulties?

(7) How does cooperative learning rank in comparison with other teaching strategies that you either use or have considered?
    - What instructional strategies do you feel are important for student learning?

(8) Are there any additional comments regarding CL you would like to include before ending the interview?

Appendix I: Modified Observation Instrument

Instructor Name: ____

College: ____

Date: ______________________ Class Start Time: ______________

Total # of Students: _________

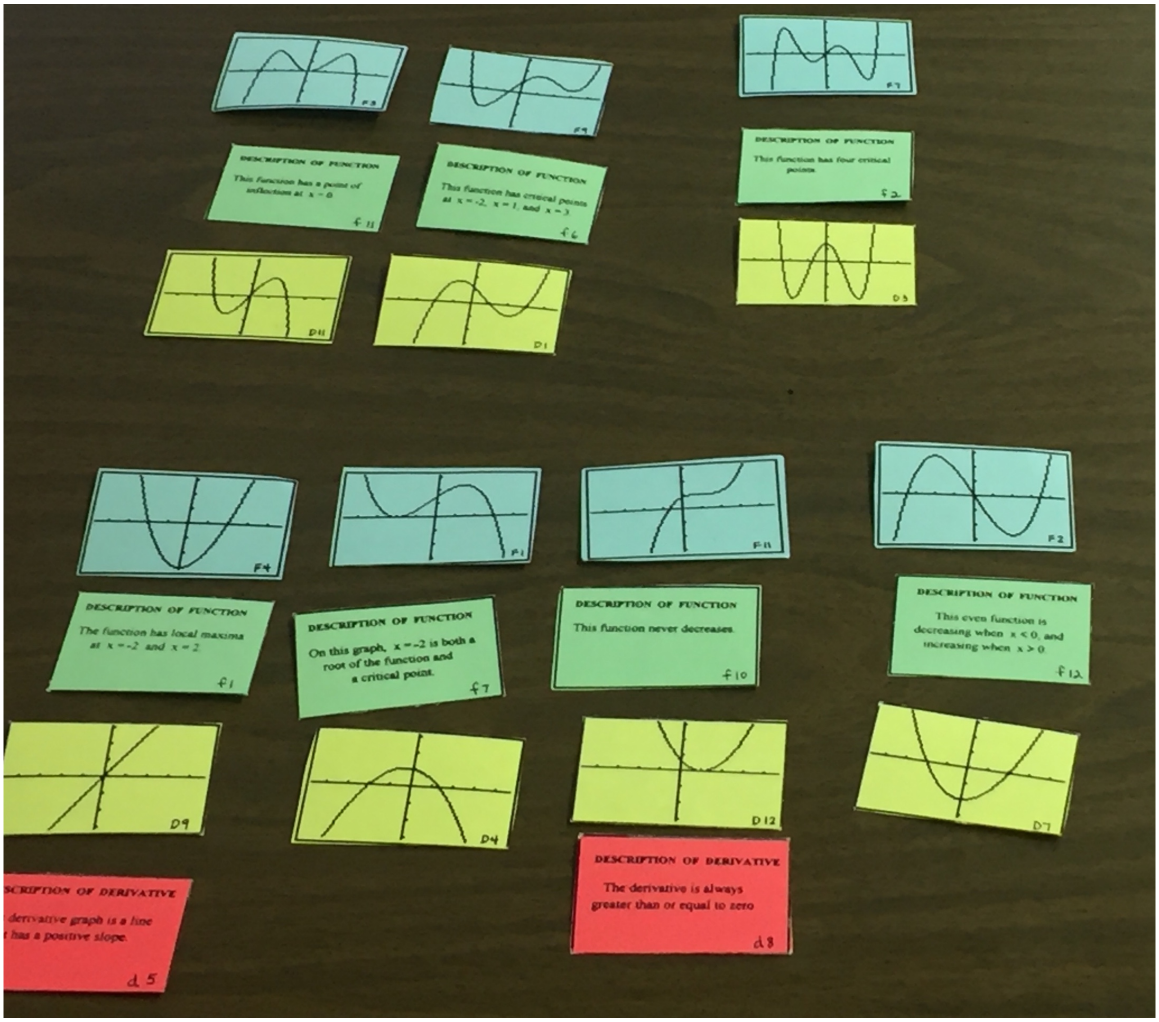
Characteristics of Class and/or Classroom: ______________________________

____

What to Observe

Participant Behavior (Provide detailed descriptions of participant behavior related to CL)			Elements of CL (Note frequency with marks)				
Time	Instructor Behavior	Student Behavior	Positive Interdependence	Face-to-face Promotive Interaction	Individual Accountability	Use of Small Group Skills	Group Processing

Appendix J: Group Artifact from Instructor A's Observation



This artifact represents one group's matched sets for the Matching Card Activity.

Appendix K: Cost Perceptions of Main Study's Participants

Cost Perceptions					
Item #	Statement	SoD/D/StD (%)	SoA/A/StA (%)	Total	Mean
3	The costs involved in implementing CL are great.	50 (79%)	13 (21%)	63	2.56
17	It is impossible to implement CL without specialized materials.	43 (67%)	21 (33%)	64	2.84
24	There is too little time available to prepare students to work effectively in groups.	26 (41%)	38 (59%)	64	3.69
29	Implementing CL requires a great deal of effort.	21 (33%)	43 (67%)	64	3.84
33	Implementing CL takes too much class time.	28 (44%)	35 (56%)	63	3.52
39	Implementing CL takes too much preparation time.	38 (59%)	26 (41%)	64	3.17

Appendix L: Value Perceptions of Main Study's Participants

Value Perceptions					
Item #	Statement	SoD/D/StD (%)	SoA/A/StA (%)	Total	Mean
4	Competition best prepares students for the real world.	18 (28%)	46 (72%)	64	3.89
6	CL holds bright students back.	52 (81%)	12 (19%)	64	2.59
7	There are too many demands for change in education today.	21 (33%)	42 (67%)	63	3.76
11	Using CL enhances my career advancement.	36 (56%)	28 (44%)	64	3.20
13	CL is a valuable instructional approach.	8 (12%)	56 (88%)	64	4.58
14	Peer interaction helps students obtain a deeper understanding of the material.	4 (6%)	60 (94%)	64	4.88
18	I feel pressured by the administration to use CL.	56 (89%)	7 (11%)	63	1.98
19	CL places too much emphasis on developing students' social skills.	54 (84%)	10 (16%)	64	2.56
22	Engaging in CL enhances students' social skills.	4 (6%)	60 (94%)	64	4.50
23	It is impossible to evaluate students fairly when using CL.	37 (59%)	26 (41%))	63	3.17
26	Using CL promotes friendship among students.	5 (8%)	59 (92%)	64	4.48
28	Engaging in CL interferes with students' academic progress.	50 (78%)	14 (22%)	64	2.55
31	I feel pressured by other instructors to use CL.	62 (97%)	2 (3%)	64	1.86
32	CL helps meet my college's goals.	23 (36%)	41 (64%)	64	3.84
34	Using CL fosters positive student attitudes towards learning.	10 (16%)	54 (84%)	64	4.44
40	CL gives too much responsibility to the students.	52 (81%)	12 (19%)	64	2.48

Appendix M: Expectancy Perceptions of Main Study's Participants

Expectancy Perceptions					
Item #	Statement	SoD/D/StD (%)	SoA/A/StA (%)	Total	Mean
1	If I use CL, the students tend to veer off task.	36 (56%)	28 (44%)	64	3.13
2	I understand CL well enough to implement it successfully.	10 (16%)	54 (84%)	64	4.42
5	The amount of CL training I have received has prepared me to implement it successfull	20 (31%)	44 (69%)	64	3.72
8	My students presently lack the skills necessary for effective cooperative group work.	28 (44%)	36 (56%)	64	3.47
9	For me to succeed in using CL depends on receiving support from my colleagues.	49 (77%)	15 (23%)	64	2.70
10	Using CL is likely to create too many disciplinary problems among my students	53 (83%)	11 (17%)	64	2.36
12	For me to succeed in using CL requires support from the school administration.	31 (50%)	31 (50%)	62	3.31
15	My training in CL has not been practical enough for me to implement it successfully.	40 (63%)	23 (37%)	63	3.22
16	If I use CL, too many students expect other group members to do the work.	25 (39%)	39 (61%)	64	3.69
20	I believe I can implement CL successfully.	8 (12%)	56 (88%)	64	4.61
21	I have too little teaching experience to implement CL successfully.	56 (88%)	8 (12%)	64	2.11
25	There are too many students in my class to implement CL effectively.	46 (73%)	17 (27%)	63	2.86
27	My students are resistant to working in cooperative groups.	33 (52%)	31 (48%)	64	3.39
30	CL is inappropriate for the subject I teach.	52 (81%)	12 (19%)	64	2.47
35	I find that CL is too difficult to implement successfully.	50 (78%)	14 (22%)	64	2.61
36	CL would not work with my students.	54 (84%)	10 (16%)	64	2.42
37	If I use CL, my classroom is too noisy.	45 (70%)	19 (30%)	64	2.66
38	I believe I am a very effective instructor.	0 (0%)	64 (100%)	64	5.13
41	The physical set-up of my classroom is an obstacle to using CL.	38 (60%)	25 (40%)	63	3.05

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Vita

Adam Joseph Castillo was born in Austin, Texas. After completing his work at David Crockett High School in Austin, Texas in 2004, he entered St. Edward's University in Austin, Texas. Adam received the degree of Bachelor of Arts in Mathematics from St. Edward's University in May 2008. After completing his undergraduate degree, Adam entered the Graduate School at the University of Texas at San Antonio in August 2008. He received the degree of Master of Science in Applied Mathematics from the University of Texas at San Antonio in May 2010. Upon completion of his master's degree, Adam entered the Graduate School at the University of Texas at Austin in August 2010.

Adam has remained committed to mathematics education. He has served as a tutor and supplemental instruction leader for various mathematics courses. He has been able to teach developmental and college-level mathematics courses as a graduate teaching assistant at the University of Texas at San Antonio and former adjunct instructor at Northwest Vista College. Adam has also helped train pre-service teachers serving as a graduate teaching assistant for upper-division undergraduate education courses in the UTeach STEM teacher preparation program. He is currently finishing up work as a graduate research assistant at the Charles A. Dana Center where he works to generate evidence and disseminate findings on the effectiveness of the Dana Center Mathematics Pathways model (DCMP) (formerly known as the New Mathways Project), which aims to increase successful student transitions to college through mathematics curriculum redesign, improved student support, state and institutional policy change, and continuous institutional improvement.

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