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Fighting the freeloader effect : cooperation, attitude, and achievement in a Jesuit secondary math classroom

Kevin Quattrin

The University of San Francisco

FIGHTING THE FREELOADER EFFECT: COOPERATIVE LEARNING, ATTITUDE, AND ACHIEVEMENT IN A JESUIT SECONDARY MATH CLASSROOM

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Kevin Quattrin

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This dissertation, written under the direction of the candidate's dissertation committee and approved by the members of the committee, has been presented to and accepted by the Faculty of the School of Education in partial fulfillment of the requirements for the degree of Doctor of Education. The content and research methodologies presented in this work represent the work of the candidate alone.

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Dissertation Committee

Br Raymond J Vercruysse, CFC — Chairperson — April 26, 2007

Virginia Shumabukuro — April 26, 2007

Robert Burns — April 26, 2007

DEDICATION

With great love and appreciation,
this dissertation is dedicated to my mother, wife, and children,

Dolores Quattrin
Carol Quattrin
Rudraigh, Cian, Ceri, and Joanna Quattrin

for supporting me through this process,
as well as through all the years of coaching, teaching, directing,
and all the other aspects of my vocation that ate into my time with them.
I hope I have brought additional honor to the family name.

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CHAPTER I

THE RESEARCH PROBLEM

Introduction

In *The New Division of Labor* (Levy & Murnane, 2004), the description of the world for which students are being prepared is different from that for which previous generations were prepared. Clerical and blue-collar jobs are being replaced by computers or being outsourced abroad. The jobs that will replace them for college-bound students will be high-level competency jobs and the two main skills needed for these jobs will be expert thinking (that is, problem solving) and complex communications.

Math is a field that is often associated with problem solving and is considered key to access and success in desirable fields of study and occupation (Lewis, Lazarovici, & Smith, 2001). It is often viewed as a subject at which some are capable and others are not. Fairly or unfairly, people who can do math are considered smart, and it is socially acceptable for people to say they were never good at math (Paulos, 1988).

For many college freshmen, calculus is the class that represents the transition from high school to college (Silverberg, 2006). At Roger Williams University, where Silverberg is employed, as much as 45% of the freshmen taking Calculus I either dropped the class or received a grade below C-. In fact, McNeil (2004) claimed that calculus is a gatekeeper class in college. It is not a gateway class that leads into higher topics, but rather a bottleneck class, one used as a filter to weed out those deemed less capable.

Kaput (1997) made a distinction between Calculus as an institution (I-CALC) and Calculus as a system of knowledge and technique (K-CALC). He stated that I-CALC continues to serve only 10% of the students and denied the rest access to the key aspects of

K-CALC. For larger percentages of students to pass through this gate, techniques must be developed in the pedagogy to make the material more accessible. Cooperative learning is one pedagogical tool that may facilitate this.

Mathematics and science education have been hallmarks of Ignatian education since early in its tradition. Jesuit schools were the first since the ancient Greeks to require mathematics as part of their standard curriculum (Smolarski, 2005). The first 200 years of Jesuit history coincided with the discovery and development of calculus, and many Jesuits priests were influential in that growth (MacDonnell, 1989).

Over the years, Ignatian education has developed into a distinct style. Day et al. (1987) mapped out the 28 characteristics that make Ignatian education distinct (Appendix A). These will be explored more in depth in Chapter II, but they all center around promoting excellence, educating the whole person for the good of the community, dealing with the individual as an individual, and preparing students for an active life committed to justice. Duminuco et al. (1993) described Ignatian education in action and referred to it as the Ignatian Pedagogy Paradigm (IPP). Figure 1 describes this learning process as a cycle of Experience, Reflection and Action, set in a particular context and evaluated. The experience is nested within the reflection, which leads to action. The triangle represents the relationship between the student, the teacher and the material.

A competent Ignatian educator makes this teaching intentional and does it in a way that integrates the various aspects of that education. Day et al. (1987) summed up the place of an Ignatian educator in this process of development:

> Growth in the responsible use of freedom is facilitated by the personal relationship between student and teacher…In these and other ways, the adult members of the educational community guide students in their development of a set of values leading to life decisions that go beyond "self" that include a concern

> for the needs of others…*Cura personalis* (concern for the individual person) remains a basic characteristic of Ignatian education. (pp. 21-22)

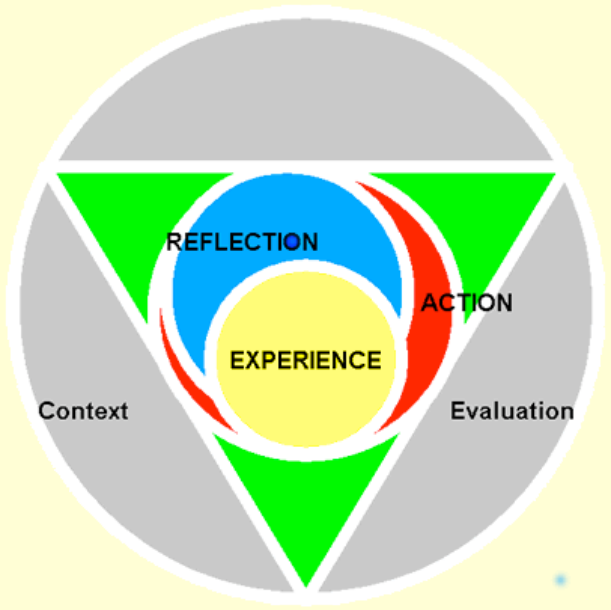

Figure 1. The Circles of the Ignatian Pedagogical Paradigm (from http://www.jsea.org/)

Cooperative learning is a valuable and fitting experience within the IPP (Duminuco et al., 1993) and the IPP has the flexibility to adjust to the established knowledge base regarding cooperative learning. The establishment and maintenance of the relationship between teacher and student is all important, whether that relationship comes into existence one at a time or with a full class of 28 or through seven groups of four at a time. Cooperative learning may give an Ignatian educator more opportunities to tap into each individual than traditional teaching and help achieve one of the goals of Ignatian education, which is intellectual competence. Intellectual competence sums up Levy and Murnane's (2004) expert thinking and complex communication, and includes mathematical competence.

Statement of the Problem

Cooperative learning has been shown to be related to an increase in student achievement (Johnson & Johnson, 1989) and thus holds potential for opening access to calculus for a wider range of students. At higher levels of mathematics, such as calculus, where the material and techniques are already difficult to learn, students of all ability levels benefit from study groups and cooperative efforts (Treisman, 1986).

There are four interrelated problems with using cooperative learning as a solution to the calculus-access problem in a Jesuit college preparatory school. The first obstacle is to determine if freeloading is occurring and if the sucker effect results from the freeloading.

The second obstacle to cooperative learning's effectiveness for higher-achieving students is their resentment toward the process, which results from the so-called freeloader effect (Johnson, Johnson, & Smith, 1998). The freeloader effect describes the situation wherein one student does most of the work while the others do little or nothing, but get the same grade. This is also called "hitch-hiking" or "free-riding." The competent students who did the work often are resentful about the situation. This can lead to what Orbell and Dawes (1981), Kerr (1983), and Salomon and Globerson (1989) referred to as the "sucker" effect. This theory asserts that some people may reduce or withhold their efforts from the cooperative action for fear that others will take advantage of them. Being a sucker is aversive to many people because it is an outcome that violates the norms of equity and reciprocity (Kerr & Bruun, 1983). Salomon and Globerson (1989) noted that the avoidance of the sucker effect occurred both when the better

member believed the others were capable but not trying hard and when the other members showed poor performance because of lack of ability.

Individual accountability, one of the five fundamental elements of cooperative learning, is designed to eliminate the freeloader effect, but it is often missing from traditional group work. Traditional group work occurs in the situation where students are put in groups and a task is assigned, but the structure does not insure cooperation. Rather, traditional group work has members working individualistically instead of cooperatively. Not knowing the differences between cooperative learning and traditional group work, the students in jeopardy of the freeloader effect often may develop a resistance to cooperative learning.

The third problem is that cooperative learning is a student-centered, group experience. Ignatian education and the Ignatian Pedagogy (Duminuco et al., 1993) are founded on *cura personalis*, or care for the individual, and founded upon the one-on-one relationship between teacher and student. This concept will be explored more fully in the next chapter, but this concept, which is central to Ignatian education, could be diminished when learning occurs within the group rather than between the teacher and student.

The fourth problem is the dearth of research on the effect cooperative learning has on achievement in pre-calculus. There is extensive research about cooperative learning in middle school arithmetic and lower division high school, which includes Algebra 1 and Geometry. There is some research on cooperative learning in Calculus, but it is at the university level. While the research in the field indicates cooperative learning may be a key that opens the gatehouse that is Calculus, little deals directly with college preparatory

pre-calculus and none is in the context of Ignatian education. This study sought to add to the body of literature in this area.

Purpose of the Study

In light of the multi-partite problem above, the purpose of this quasi-experimental study was four-fold. The first part of the purpose was to uncover evidence of freeloading and the sucker effect in an Ignatian classroom. The second part of the purpose was to determine the extent to which extended exposure (12 or more weeks) to cooperative learning would impact the attitudes of students toward group work. Cooperative learning could override the freeloader and sucker effects and change student perspective in a way that might open them to the advantages of this instructional technique.

The third part of the purpose was to determine if a change in the students' sense of their relationships with the teacher and their classmates occurred. In other words, can cooperative learning and Ignatian education be intertwined, are they capable of coexistence, or are they mutually exclusive? If this is the case, a school would need to consider carefully before exchanging a pedagogy that arises from the identity and mission of the school for better knowledge acquisition and greater student access to calculus. The existence of this potential pitfall must be explored before deciding on the appropriateness of cooperative learning in an Ignatian school.

The final part of the purpose was to explore the effect of cooperative learning on student achievement in the context of a Jesuit college preparatory pre-calculus classroom. If the achievement related to cooperative learning is not at least commensurate with that of the traditional pedagogy, then the gatehouse of Calculus remains locked to 90% of the

students to whom it was already closed. Without an achievement advantage, the change might not be worth the extra time and effort.

Background and Need

Cooperative learning is a pedagogy that has been around for a long time. The basic cooperative learning approach was used in Talmudic studies and by Quitillion and Seneca in the first century A.D. (Johnson, Johnson, & Smith, 1998). In the 1600s, Johann Amos Comenius of Moravia and, in the 1700s, Joseph Lancaster and Andrew Bell began to promote a version of cooperative learning as an alternative method to the hierarchical lecture method of the Middle Ages (Johnson, Johnson, & Smith, 1998). The first Jesuits were initially formed as a study group at the University of Paris (O'Malley, 1993). The Common School Movement of the early 1800s had some cooperative learning aspects imbedded in its approach to learning. From 1875 to the turn of the century, Colonel Francis Parker, superintendent of the public schools in Quincy, Massachusetts, developed a more formal method and his schools became the model for many educators, including John Dewey. During the first half of the 20th century, cooperative learning fell out of favor among educators (Grisham & Molinelli, 1995). It re-emerged in the late 1960s when Johnson applied Deutsch's (1949) social interdependence theory to education (Johnson, 1970).

What exactly is cooperative learning? According to Johnson and Johnson (1994), cooperative learning is commonly defined as "the instructional use of small groups so that the students work together to maximize their own and each other's learning" (p. 186). Extensive research by Johnson and Johnson (1970, 1975, 1981, 1989, 1998) revealed that cooperative learning exhibits five elements: (a) positive interdependence,

(b) individual accountability, (c) face to face promotive interaction, (d) interpersonal small group social skills, and (e) group processing (Johnson, Johnson, & Smith, 1998).

Not all experts in the field agree that all five elements are essential, and other approaches will be discussed in the Review of the Literature. All agree, though, that positive interdependence is essential to cooperative learning and that the face-to-face promotive interaction is often the only element present in traditional group work. Assigning students to a group and assigning a task does not insure the task will be done cooperatively. It takes substantial energy and time to insure that the other four elements are present. Tasks must be designed to promote positive interdependence. Resources must be allocated in such a way that one individual in the group cannot complete the task alone. Interactions within the groups must be observed, monitored and, when necessary, corrected. Time and format for reflection must be designed and evaluated. Of course, reflection and evaluation are part of the IPP (Duminuco et al, 1993).

Figure 2 conceptualizes how the five elements work together and lead into one another. The positive interdependence and small group social skills occur within and shape the face-to-face promotive interaction. This total experience of the three leads to an evaluation that holds the individual accountable, rather than the group, thus reducing and, hopefully, negating the freeloader effect. The experience and accountability lead to reflective group processing which will shape the next interaction.

Is cooperative learning pertinent in the math, science and technical fields? In the technology and computer industry, breakthroughs occur as a result of teamwork and collaboration, not from an individual sitting in a room alone at his blackboard scrawling formulas. In other words, complex communication is becoming more important in this

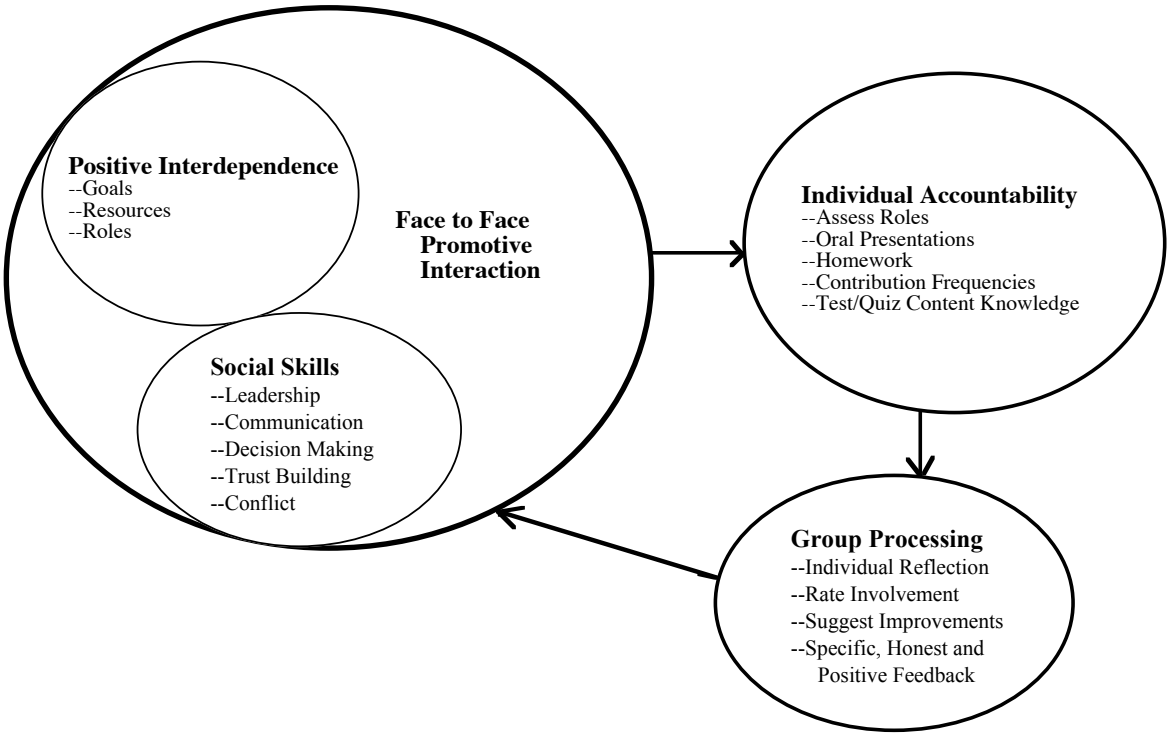

Figure 2. Johnson & Johnson's five elements of cooperative learning lead into and reinforce one another in the students' experience.

fast-changing world (Levy & Murnane, 2004). In the field of mathematics, Andrew Wiles spent eight years working alone to prove Fermat's Last Theorem and, then, a flaw was found in his proof. Only a few months were required to resolve the issue when Wiles worked with Cambridge mathematician Richard Taylor (Nova Online, 2000). On the other hand, Paul Erdos, the most prolific mathematician of the 20th century, published over 1,400 non-trivial papers in his lifetime and none of them bore his name alone (Hoffman, 1998).

Is cooperative learning effective in a math classroom? One of the most dramatic studies of cooperative learning in math is that of Treisman (1986). Treisman actually backed into the topic. In the mid-1970s, he began studying the phenomenon of chronically poor performance in calculus by minority students at the University of

California at Berkeley. His colleagues put forth four explanations for the poor performance: (a) lack of motivation, (b) lack of family emphasis, (c) poor academic preparation, and (d) socioeconomic factors. After eliminating these as plausible explanations, he visited various fraternities on campus and discovered that African-American students, many of whom were failing, studied alone and were reluctant to seek help, while Asian students, who generally did well, often did homework communally. He established a group-based calculus program and reserved two-thirds of the seats for minority students. The students in the program had a higher retention rate after three years than the average for all the university students, while almost all the control group were gone after three years. Treisman's model has been used and adapted at many institutions with comparable success (Conciatore, 1990).

One of the difficulties that arose with cooperative learning in math classes is the confounding with the guided discovery approach. Guided discovery has been around in mathematics since the 14th century, though it has not always had the "guided" aspect. It has always been confounded with collaboration. Much of modern calculus is the result of the discovery and collaboration in the 16th century with Descartes, Fermat, Galileo, Kepler and others working through Friar Mersenne (Boyer, 1991). Competitions sponsored by the PolyTechnique in Paris and the Royal Academy in London during the 18th and 19th centuries provided impetus for the Enlightenment discoveries of L'Hospital, the Bornoulli brothers and Euler (Boyer, 1991).

In the late 1960s, at the same time David Johnson was developing his theory of cooperative learning, the parallel math-learning guided discovery theory was burgeoning. Lee Shulman (1968) wrote a paper comparing the open-ended, exploratory approach of

Bruner and the highly prescriptive, goal-oriented, behavior-learning-hierarchy approach of Gagne. At the end of that paper, Shulman wrote:

> In the published studies, guided discovery treatments generally have done quite well both at the level of immediate learning and later transfer. Perhaps this approach allows us to put the Bruner roller coaster of discovery on the well-laid track of a Gagne hierarchy.
>
> Thus the earlier question of which is better, learning by discovery or guided learning, now can be restated in more functional and pragmatic terms. Under what conditions are each of these instructional approaches, some sequence or combination of the two, of some synthesis of them most likely the appropriate? The answers to such questions ought to grow out of quite comprehensive principles of learning. Where are we to find such principles? (p. 242)

In the mid-20th century, at least three guided discovery models were in use. Polya (1962) described several heuristic problem strategies that relied on a Socratic interchange between an instructor and the class. The process could also be used in individual or small group problem solving and discovery. R. L. Moore used a highly competitive, individual discovery approach in the field of point set topology (Davidson, Reynolds, & Rogers, 2001). On the other hand, in the early 1970s, Neil Davidson responded to Shulman's query by designing a small-group discovery method that maintained the rigor and challenge of the Moore approach but changed the social conditions to build success for a wider range of students (Davidson, Reynolds, & Rogers, 2001).

In the 1980s, another math-learning theory developed based on a belief similar to Kohlberg and the other structuralists' views. This theory posits that an individual progresses through stages of learning from actions to process to objects to schema (APOS). In a math class, this consists of disequilibrium caused by a warm-up exercise, or activator, using material that has not been presented yet, followed by class discussion to synthesize the newly discovered knowledge, and follow-up exercises to practice and

solidify the new learning. This is essentially the IPP cycle of Experience, Reflection, and Action (Duminuco et al., 1993). In math, this activity, class discussion, and exercise cycle is called the ACE-cycle and is attributed to Ed Dubinsky (Rogers, Davidson, Reynolds, Czarnocha, & Aliaga, 2001). Dubinsky later applied his ACE cycle to the technological advance of the graphing calculator in calculus to create the C^4L (*Calculus, Concepts, Calculators and Cooperative Learning*) program.

If cooperative learning has been around and supported for so long, why is its use not more wide spread in the math classroom? Many teachers do not understand what cooperative learning actually is and think that just putting the students in groups and assigning a project or task will do. Johnson, Johnson and Smith (1998) referred to this as traditional group work and it is not necessarily cooperative learning. Teachers are often not trained in the intricacies of designing higher-level collaboration.

Cooperative learning takes considerable preplanning to design tasks and situations that require interdependence, instead of individuals sitting near each other while working alone. There are 18 to 22 decisions to be made about the design before the students' task can even start (Johnson, Johnson, & Smith, 1998). During the actual task, teachers cannot sit and grade papers. They must consider themselves as observing members of every group, working the room, intervening where needed, and observing and evaluating the quality and quantity of each student's contribution to the task. There are ways to make the teacher's job more manageable in the moment, but this also must be preplanned.

In addition to the issues of future employment, there are three reasons why cooperative learning is particularly important in an Ignatian classroom. First, it creates

multiple opportunities for each student to become an active participant in his or her own learning. In the ever-popular Socratic method, students only need to be "on" for a minute or two in a 50-minute class. They can easily become passive and disengaged the rest of the time. In a properly designed cooperative learning setting, they cannot hide. The task and the peer pressure force them to engage. Second, the social support makes difficult knowledge easier to acquire and easier to retain. Third, the motto of the Jesuits is *Ad Majorum Dei Gloriam* ("For the Greater Glory of God"). By helping others to improve and realize more of their potential, that motto is more fully realized, by both the giver and recipient of that help.

Theoretical Rationale

The theoretical rationale underlying cooperative learning is social interdependence theory. This theory began in the early 1900s, when one of the founders of the Gestalt School of Psychology, Kurt Koffka, posited that groups were dynamic wholes in which the members experienced and evidenced various levels of interdependence. In the 1920s and 1930s, one of Koffka's colleagues, Kurt Lewin (1935), began researching group decision processes and group dynamics at MIT. Lewin refined Koffka's theory by establishing two principles. First, the essence of a group is the interdependence among the members, which is created by common goals, and which results in a "dynamic whole" so that a change in any member results in a change in the other members. Second, an intrinsic tension within the group motivates movement toward the achievement of these common goals (Johnson & Johnson, 1989).

After his sudden death in 1947, one of Lewin's graduate students, Morton Deutsch (1949), expanded social interdependence theory to explain the interplay of

cooperation, individuation, and competition. Deustch defined social interdependence as existing when individuals share a common goal and each individual's outcomes are affected by the actions of the other members. This is differentiated from social dependence, in which the outcomes of one member are affected by the others, but not vice versa, and from social independence, in which individuals' outcomes are not affected by others. The theory denotes two types of social interdependence: (a) cooperation, the positive form, and (b) competition, the negative form. Competition, in this sense, is not simply striving for a goal, but doing so to the detriment of another. One only wins if another loses. Independence, the absence of interdependence or dependence, results in individualistic efforts. Independence often has outward vestiges of competition, as competition is commonly defined. Many can strive for and achieve the goal, though individuals may measure themselves against each other or their own past performance. However, the failure of another is not required for one to succeed (Deustch, 1949).

According to Deustch (1949), the basic premise of social interdependence theory is that the type of interdependence structured in a situation determines how the members will interact, which, in turn, determines the outcomes. The group members have three ways of interacting: promotively, obstructively, or non-interactively. The type of interaction determines the level of substitutability, cathexis, and inducibility.

Substitutability is the ability to substitute the actions of one person for another. Cathexis is the investment of psychological effort and energy in objects and events outside one's self. Inducibility is openness to influence. Acting promotively leads to all members seeking outcomes beneficial to the others. Acting obstructively, or contirently,

leads to the student seeking selfishly to attain his or her goal to the detriment of the other students (Deustch, 1949).

In the 1960s, social interdependence theory was applied to education by David Johnson (1970) at the University of Minnesota. Together with his brother, Roger, he founded the Cooperative Learning Center, the purpose of which is to develop and refine theory and to develop practical procedures to be used in classrooms, schools, and other settings.

Johnson (1970) asserted that social interdependence is a generic human phenomenon that has impact on many outcomes simultaneously. Many researchers (Aronson, Cohen et al., DeVries & Edwards, Johnson & Johnson, Kagan & Kagan, Sharan & Sharan, and Slavin) have investigated such diverse dependent variables as individual achievement and retention, group and organizational productivity, higher-level reasoning, moral reasoning, motivation, job satisfaction, interpersonal affection and love, prejudice, self-esteem, psychological health, and many others. These numerous outcomes may be subsumed within three broad categories: (a) effort to achieve, (b) positive relationships, and (c) psychological health (Johnson & Johnson, 1989).

Cooperative learning, in its many forms and methods, manipulates the common goals and positive interdependence in order to achieve the educational outcomes for all the students involved. The relationship between interdependence and interaction is cyclic. Positive interdependence leads to promotive interaction, which leads to a higher level of positive interdependence, and so on. According to the literature, cooperative learning leads to higher levels of self-esteem, more numerous positive relationships among individuals, and higher achievement levels (Johnson, Johnson, & Smith, 1998).

Research Questions

In order to assess the effect of cooperative learning in an Ignatian secondary math classroom, this study sought to address the following research questions:

1. To what extent are the freeloader and sucker effects present in an Ignatian pre-calculus classroom prior to and after a cooperative learning experience?
2. To what extent do attitude toward group work change after extended exposure to a cooperative learning experience designed according to the research of Johnson and Johnson?
3. To what extent do the perceptions of students change with regard to the Ignatian concepts of *cura personalis* and to their relationships with teachers and other students as a result of cooperative learning?
4. To what extent does the use of cooperative learning in introductory Calculus topics affect the achievement of students in a pre-calculus class?

Limitations of the Study

This study investigated the effects of cooperative learning on attitude and achievement. There were some limitations. First, the assignment of students to treatment and control groups is not random, as classes are intact groups determined by the scheduling process. Therefore, the demographics of gender, previous teachers or courses, varying levels of algebraic preparation, GPA, motivation, and previous exposure to the subject matter could have affected the outcome. Demographic data were gathered in order to define the similarities of treatment and control groups. Furthermore, treatment was assigned randomly.

Second, many outside factors, such as time of year, the school schedule, and time of day of each class, could have affected the results. The control and treatment groups are not isolated when not in class, so students in the treatment group may help those in the control group learn the material. Students in either group might have sought outside tutoring. Learning disabilities and differences (LD) in either group could have affected the data on the post-test and identified LD students being given extra testing time might have affected outcomes. Initially, this study had planned to only use two classes as the sample. The sample size was doubled to aid in addressing these issues.

The two teachers were a key factor in the study. One was a veteran teacher of 30 years, all of which were at this site. His teacher evaluations and classroom observations indicated that he is an expert in traditional lecture-style teaching. His ability to understand, implement, and manage the cooperative learning might have affected the outcomes. His enthusiasm for the topic and the approach helped outweigh his lack of experience with cooperative learning. The other teacher was a five-year veteran with three years experience at the site, with a Masters degree in Math and college teaching experience. She had more pedagogical training, but less teaching experience, especially in cooperative learning.

Neither teacher was available for the CL workshops offered during the summer. Training in the topic was done by the researcher and a colleague who attended a cooperative learning workshop led by Roger Johnson in 2004. The researcher and his colleague were experienced master teachers who had been designated by the school to attend the Roger Johnson workshop in 2004 with the intention that they become early adopters of cooperative learning in math. They had spent the past three years learning

and imparting this knowledge to the math department both individually and to the department as a whole. Their ability to impart the knowledge of how to design and run a cooperative learning classroom to the teachers might have been a limitation.

The teachers' rapport and relationship with each group might have affected the performance of the control and treatment groups differently. The teachers might not have been comfortable with treating the two classes so differently and might, subconsciously, have provided more support to one or the other. The gender of the teacher might have affected the interaction with each one's particular class. The researcher observed all four classes to look for these possible variations.

Finally, the researcher's long history at and connection to the site could have been a limitation. The textbook used by these students was written by the researcher. None of the subjects had been taught by the researcher, but some were taught other levels of math by his wife or his son. His daughter was a member of the class which formed part of the treatment group. Her data was not used in this study.

Scope and Delimitation of the Study

Cooperative learning research has grown a great deal since David Johnson first applied his mentor Morton Deustch's (1949) social interdependence theory to education. The effect of cooperative learning on the variety of topics (broadly categorized as effort to achieve, positive relationships, and psychological health) has been widely researched (Johnson & Johnson, 1989). This study was limited to achievement and to attitudes toward interdependence, peers, and teachers.

The sample was limited to pre-calculus students in a Jesuit college preparatory school. There were two reasons for this. First, the dearth of research at this level and in

this topic indicated a need (Springer, Stanne, & Donovan, 1999). Second, reflection was a major component in both the IPP (Day et al, 1993) and in Johnson and Johnson's (1998) Active Learning.

The sample was chosen from among honors and accelerated students. This group of honors students has been most affected negatively by the freeloader effect experienced in traditional group work. The group of accelerated students did not rank in the top 100 math students in the school, based on entrance and placement test scores. Yet, they were still headed for the "gate-keeper" class that is calculus. They were the ones most likely to need extra support to be successful.

Significance

A groundswell of cooperative learning use is just beginning at the college level, with math departments at universities such as Michigan, Minnesota, and Berkeley leading the way. If Jesuit secondary schools are to be truly college preparatory, they must look beyond their curriculum and examine their methodology in how they prepare the students for university life and the job market beyond.

While cooperative learning is a well-researched field with a long history and tradition, bringing the content knowledge to bear on math is significant in and of itself. Cooperative learning workshops, like many pedagogy courses, tend to apply most directly to the humanities. Mathematicians often find little direct help in such workshops. The majority of cooperative learning books and research in the field of math are aimed at elementary and middle schools, with relatively few in higher math education. This study expanded on the body of research at this nexus of higher education and mathematics.

Very little research has been done with cooperative learning in an Ignatian setting and little work in the field of Ignatian Pedagogy has attempted to tie into cooperative learning. This study makes a unique contribution in examining the confluence of these two fields.

Another significant effect this study could have is a change in instructional practices. The ease with which an experienced traditional teacher can implement Johnson, Johnson, and Smith's (1998) cooperative learning design and the extent of its influence on achievement could encourage other math teachers to attempt similar adaptations to their curriculum and methodology. The addition of this pedagogy to math teachers' repertoires could make higher-level math, especially calculus, more accessible to their students.

Finally, this study might help delineate the influence of cooperative learning on the attitudes of honors students. These particular students are the ones who, in traditional group work, receive the least benefits and do the most work. They cannot distinguish between traditional group work and cooperative learning and often come to resent the freeloaders, associating them strongly with group work. This can lead to the sucker effect, which manifests itself in less participation or investment by the most able students. The anticipated change in attitude may help to break down these stereotypically negative responses in the future, making them more amenable to and successful in the collaborative situations they will encounter in their futures.

Definition of Terms

Competitive Learning: Learning situation where there exists a negative interdependence among students' goal achievement (Johnson & Johnson, 1998).

Cooperative Learning: Learning situation where there exists positive interdependence among students' goal achievement (Johnson & Johnson, 1998).

Cura Personalis: Ignatian concept of care for the individual person (Traub, 2002).

Face to Face Promotive Interaction: Students working supportively in pairs, threes, or fours in close physical proximity (Johnson & Johnson, 1998).

Five Minute Walk: A monitoring process during which the teacher wanders from group to group gathering data on the social skills and group process.

Freeloader Effect: The situation wherein one student does most of the work while the others do little or nothing, but get the same grade.

Group Processing: Group reflection and debriefing after a group task (Johnson & Johnson, 1998).

Ignatian Pedagogical Paradigm (IPP): Educational process in the cycle of Experience - Action - Reflection set in a context and evaluated (Duminuco et al, 1993).

Individual Accountability: Assessing the quality and quantity of an individual's contributions to the group task (Johnson & Johnson, 1998).

Individualistic Learning: Learning situation where there exists no interdependence among students' goal achievement (Johnson & Johnson, 1998).

Negative Interdependence: Situation where a student believes he or she can only succeed if another student fails (Deutsch, 1949).

Positive Interdependence: Situation where the students need each other to succeed. "We sink or swim together." (Johnson & Johnson, 1998).

Promotive Interaction: Team members help, share, and encourage each other's productivity toward completion of a task (Johnson & Johnson, 1998).

Sucker Effect: The situation wherein one student feels resentful because of shouldering an undue amount of a group's workload.

Before studying the sucker and freeloader effects directly, the context must be set. In the case of this research study, the context is Ignatian education. What follows is a review of Ignatian education, its development from the spirituality of St. Ignatius of Loyola, and how it adapted to modern learning theory in the late 20th century.

CHAPTER II

IGNATIAN EDUCATION

Introduction

What makes this research study unique from other cooperative learning studies is the fact that it is taking place within a Jesuit school. Ignatian education views teaching and learning through a particular lens and from a different perspective than other forms of education.

St. Ignatius of Loyola had not intended to found a teaching order. For the first ten years, the Society of Jesus had no connection with schools. The Jesuits initially opened schools to train their novices, but the quality of the education led local nobility to request that the schools be opened to their sons who might not be destined for a life in the Church. By its golden anniversary, the Society was inextricably associated with education. Ignatius' way of proceeding (*modus procedenci*) was a flexible one that allowed for whatever opportunities and obstacles that God set before him. Throughout his life, he wanted to preach and do missionary work in the Holy Lands, but he saw teaching was just another way to help souls. He recognized that this was the path God had set before him (O'Malley, 1993).

The Transformation from Inigo to Ignatius

St. Ignatius was born Inigo Lopez de Loyola in 1491, in the Basque territories of northern Spain. The last of his father's many children, he was destined for a career in the military and at court. As a young man, he was raised at the court of Ferdinand and Isabella in Aragon. He was considered vain and hot-tempered, a brawler and a womanizer (O'Malley, 1993).

Inigo's transformation began with a war wound. Defending the castle at Pamplona on May 20, 1516, Inigo had his leg shattered by a cannon ball. During his recovery, his only reading materials were the New Testament and a book of the Lives of the Saints. He was inspired by the heroism of these lives. When he recovered, he renounced his noble heritage, pledged himself to God and decided to undertake a pilgrimage to Jerusalem. On the way, he stopped at Manresa and lived in a cave for a month, meditating on the life of Christ. This retreat became the foundation of his Spiritual Exercises (Modras, 2004, O'Malley, 1993).

After his retreat, he began to preach and directed several local women in his Exercises. He was arrested by the Inquisition for heresy, but released on the condition that he stop preaching and directing until he had received an education in Church doctrine. He did finally reach Jerusalem in 1523, but was deported for inciting trouble with his preaching. On returning to Spain, he entered the University of Barcelona, but he was arrested again for continuing to preach. After being released again, he decided to attend the University of Paris, where teaching and learning occurred within a more liberal climate. There, he formed a study group with his roommates, ultimately guiding them in the Spiritual Exercises and founding the Society of Jesus (O'Malley, 1993).

Ignatian Spirituality

Ignatian Spirituality was founded and built upon the twin pillars of the daily examination of conscience and the general examination of conscience. St. Ignatius taught that the key to a healthy spirituality was twofold: (a) find God in all things and (b) constantly work to gain the freedom to cooperate with God's will (Zagano, 2003).

Ignatius created two tools to help achieve these goals: (a) the Examen, and (b) the Spiritual Exercises.

One of the features that distinguished the Jesuits from other religious orders at the time was the idea of being "contemplatives in action." Ignatius did not want his followers in their rooms praying. He wanted them in the streets helping souls. In many of the letters he wrote to various communities, Ignatius expressed his impatience with other Jesuits who were praying too much and not doing enough of God's work (O'Malley, 1993).

The Examen is a short, 15-minute meditation meant to be prayed three times a day: upon rising in the morning, at midday, and at bedtime. Zagano (2003) stated that it is comprised of five parts. First, one recalls that he or she is in the presence of God. Second, one acknowledges the day with gratitude. Third, one asks the help of the Holy Spirit. Fourth, one reviews the day, looking at both the positive and the negative and seeking to find God in all things. Finally, one reconciles with Jesus and resolves to improve. Barry and Doherty (2002) stated that the Examen's purpose is to help one see the world as part of God and part of the individual. The result is the ability to continue within the world and not retreat from it.

The second tool was the Spiritual Exercises. This is a 30-day silent retreat during which the retreatant uses imagination and creative visualization to put himself or herself into the life of Christ. The meditations are broken into four movements referred to as weeks, though they are not literally seven day weeks. The Oregon Province of the Society of Jesus (2005) stated on their website:

> These four movements include consideration of God's generosity and mercy and the complex reality of human sin; an imagining of the life and public ministry of

> Jesus, his proclamation of the gospel, his sayings and parables, his teachings and his miracles; and of Jesus' last days, his arrest and interrogation, whipping, public mockery, passion, crucifixion and death; and then, of Jesus' Resurrection, his Ascension, and the pouring-forth of the Holy Spirit at Pentecost, and Christ's continued life in the world through the Spirit today and in the Messianic People called and missioned to his cause.

Unlike the Examen, which was intended to be completed alone, the Spiritual Exercises are a guided experience. The retreatants meet regularly in private with a spiritual director to discuss their experiences of prayer and reflection. They receive guidance in praying with the Exercises and in the interpretation of what is happening to them (The Oregon Province of the Society of Jesus, 2005). The relationship with the director is extremely important. Mottela (1964) stated that the Holy Spirit is the prime retreat director and the director is his docile instrument. It is through the relationship between the director and retreatant that the Holy Spirit can speak and be heard.

The Spiritual Exercises have been subject to adaptation. While still offered in the original 30-day silent retreat format, the Exercises are available in an eight-day silent format, a weekly format designed for working professionals, and an online format. The weekly and online formats, known as the 19th Annotated Retreat, are offered in some places in a small group format, employing group faith sharing to heighten the effects of the individual meditation and prayer experience.

The flexibility of Ignatius' worldview, his "way of proceeding," permeated all endeavors of the Jesuits. In education, this flexibility manifests itself in the way various methodologies and research are incorporated into the Ignatian classroom, but, at its core, Ignatian education is founded on Ignatian Spirituality.

Ignatian Education

There have been many documents and much literature written about the education wrought by the Society of Jesus and about its goals. The oldest is the *Ratio Studiorum*, written in 1587 and finalized in 1599. It set a unified curriculum to be used in all Jesuit schools world-wide. This canon of material was revised in the early 1800s after the suppression of the Jesuits was lifted and served as the underlying rationale for the Jesuit schools until the late 1960s (Bailey et al., 1970).

Vatican II put the Catholic Church in general and Catholic education in particular in a new light. Though there was talk of how terrible life and the world were (implying, to pre-Vatican II ears, that the reason was the sinfulness of Man) and how errors needed to be repressed, Pope John XXIII's (1963) opening speech to the Vatican II Council carried within it lines about "bringing herself up-to-date where required" and "a new order of human relations."

The changing world made a new vision of Ignatian education necessary, and, in 1970, the Jesuit Secondary Education Association (JSEA) was founded. The next two decades saw the JSEA try to provide that new vision. Melrose (1994) compiled the 14 most important documents of the late 20th century (Appendix A) in one volume called *Foundations*. Two of these documents, *Go Forth and Teach* (Day et al., 1987) and *Ignatian Pedagogy: A Practical Approach* (Duminuco et al., 1993) thoroughly described Ignatian education as it had been and what it could become.

Go Forth and Teach (Day et al., 1987) was published in the year that marked the 400th anniversary of the *Ratio Studiorum*, but it was not an attempt at a new *Ratio*, a new canon of curriculum. Fr. Hans Kolvanbach, SJ (1987), then the Superior General of the

Society of Jesus, stated in his accompanying letter that this document was meant to give a common vision and common sense of purpose which was rooted in tradition but was flexible enough to deal with local cultures in a changing world. It was meant as a standard against which Ignatian educators could measure themselves (Day et al., 1987).

Day et al. (1987) delineated and elaborated on 28 characteristics of Jesuit education (Appendix B). These characteristics described Ignatian education as a tool for the apostolic purpose of the Catholic Church that is collaborative, adaptable, pastoral, and committed to justice. The education described followed from St. Ignatius' concept of contemplatives in action. The first characteristic was that Ignatian education was world affirming, not world denying. The goal was not to receive rewards in heaven, but to bring about the Kingdom of God here on earth, bit by bit and day by day (Day et al., 1987).

The 28 characteristics were placed into nine categories. The first category had five descriptors that describe Ignatian education as a tool for faith formation within the real world. The next three delineated the individual personalization of the education with the goal of openness to growth and life-long learning. The third category might be considered contextual in that these three characteristics get at self-knowledge and a realistic worldview within which the formation can occur. Fourth was the personal spiritual aspect of growth, using Christ as the model for life. The fifth category was the justice-oriented characteristics and the sixth were the religious, Church-oriented characteristics. The seventh category emphasized excellence and the eighth described all the stakeholders and the collaborative, communal effort among them. The final three

characteristics were the overarching statements regarding the flexibility and continuity of Ignatian education between schools and the need for professional staff development.

A strong effort was made to ingrain Day et al.'s (1987) information throughout the secondary schools in the United States. Every Jesuit and lay teacher received a copy and faculty meetings were held on each campus to discuss the topic. It was during these discussions that the wording began to shift from "Jesuit" to "Ignatian" education (Metz, 1991).

Duminuco et al. (1993) described the Ignatian Pedagogy Paradigm (IPP) as a cycle of experience, reflection and action, set in a particular context and evaluated so as to lead to a new context and further action. The experience is nested within the reflection, which leads to action. The five steps of the IPP are not necessarily sequential.

Ignatian context includes more than the material presented. An Ignatian teacher must take into account the student's life, cultural and socio-economic situation, and the school environment, as well as the student's previously acquired concepts and knowledge. Duminuco et al. (1993) used the term "experience" to describe "any activity in which, in addition to a cognitive grasp of the matter being considered, some sensation of an affective nature is registered by the student" (p. 249). Reflection is "a thoughtful reconsideration of some subject matter, experience, idea, purpose or spontaneous reaction, in order to grasp its significance more fully" (p. 250). Action refers to "internal human growth based on experience that has been reflected upon as well as its manifestation externally" (p. 251). Evaluation is the feedback that fuels the repetition of the cycle and serves as the new experience to be reflected upon. In the IPP, evaluation is formative rather than summative (Melrose, 1994).

Panitz (1996) stated that collaborative learning is more a worldview or a lens through which to view education. A similar statement could be made about the IPP. It was more a "paradigm" than a "pedagogy." The paradigm offered was a dynamic interplay of Experience, Reflection, and Action, set in a specific context by a prelection, reinforced by repetition, and evaluated. It was not a cycle of one process following another, but a philosophy of the three nested dynamically, rather than concentrically, within one another. The Context and Evaluation of a given experience may differ, but the Experience, Reflection, and Action dynamic was set within the triangle of the relationship that existed between teacher, student, and truth, just as the retreat journey is set within the relationship of Director, Retreatant, and the Holy Spirit.

These ideas culminated in the *Ignatian Pedagogy: A Practical Approach* (Duminuco et al., 1993). To emphasize the importance of these documents and this re-envisioning of Ignatian education, there was a concerted effort to disseminate them to all 46 Jesuit high schools. This was part of a larger effort on the part of the Jesuits and JSEA to insure the Ignatian way of proceeding would be maintained in schools that increasingly were without Jesuits. Copies were given to all Ignatian secondary educators and mandatory workshops were held at each high school, led directly by JSEA members rather than members of the secondary school staffs.

The Ignatian Student

The Preamble (Bailey et al. 1970) to the constitution of the then newly-formed JSEA signaled a renewal of commitment to secondary education and reaffirmed one goal as developing "contemplatives in action" described thus: "Ignatian men and women are

those who strive to perceive those deeper and sweeping realities in the ebb and flow of current events in their own lives and in the larger society around them" (p. 4).

The Commission on Research and Development (CORD) described the desired results of Ignatian education in its *Profile of a Graduate of a Jesuit School at Graduation* (1981). In general, an Ignatian alumnus/a should be a "person for others," or a "Vatican II person." Specifically, this profile, often referred to as the "grad-at-grad," described a person who is: (a) open to growth, (b) intellectually competent, (c) religious, (d) loving, and (e) committed to doing justice. This document was analyzed in faculty meetings and ratified by every Jesuit school in America at the time. The five general categories were accepted by all 46 Jesuit schools. One school, the site of this present research study, added a sixth descriptor: (f) a leader. Several of the other schools added this as well. Recently, this descriptor has been changed to "a leader in collaboration."

Kolvenbach (1989) summed this up: "We aim to form leaders, in imitation of Christ Jesus, men and women of competence, conscience, and compassionate commitment." High school education has a strong but limited influence on the students. Youth culture and societal influences may hinder the full achievement of the ideal profile by the formational process, but Jesuit schools must be intentional in how they bring their resources to bear on fostering their students' growth toward this profile (CORD, 1981).

Connections to the Spiritual Exercises

Newton (1977) made direct comparisons between Ignatian education and the Spiritual Exercises. He stated:

> One who carefully analyses the Spiritual Exercises will likely conclude that they are structured to be an intensive "laboratory" experience aimed at two goals: (a) through an experience of God in prayer, personal acceptance of the Christian message and commitment to the service of God, and (b) through repetition of a

> patterned approach to prayer, development and habitual practice of various forms of prayer and interpretation of important activities, events and choices in one's life from a religious perspective…The process of producing self-initiated learners is not only a fundamental goal of the Spiritual Exercises but also a pedagogical ideal which is consistent with the Jesuit educational tradition and one of today's urgent educational needs. (Newton, pp. 85-86)

Newton (1977) went on to remind the reader that the Spritual Exercises are *exercises* and are meaningless without the active participation of the retreatant. The pedagogical implication of this principle is that truth is not transferred from the mind of the teacher to the mind of the student. Truth must be discovered through the effort of the student and the teaching method should promote self-activity and discovery in every possible way (Newton, 1977).

The IPP was rooted in the Spiritual Exercises of St. Ignatius of Loyola (Duminuco et al., 1993). The teacher-student relationship parallels the relationship between a retreatant and his or her spiritual director. The model is one of individual growth through guidance. The teacher should serve as guide to and initiator of the material. The central role of the spiritual director was that of a conduit for the Holy Spirit and serves as an initiator and motivator, a guide rather than the active participant. The student must be the active one in his or her own experience and reflection. The teacher establishes the context, effectively setting up the experience, but the student must experience the truth at work in the learning, just as the retreatant experiences the Spirit.

To be an effective Ignatian educator, one must experience the Examen and the Spiritual Exercises. McDermot (1976) went so far as to urge all Jesuit high schools to make the Spiritual Exercises available to all lay faculty and students before the following term began. He sited the variety of formats available even then and stated the need for faculty to experience the *dynamics* of the Spiritual Exercises (p. 62). Recently, Jesuit

secondary schools in the California Province have begun to establish offices of Adult Spirituality, with the intention of maintaining and strengthening the Ignatian perspective in schools with limited numbers of Jesuits. In some schools, lay administrators are required to make the Spiritual Exercises as part of their contract.

Ignatian Teaching

Though not promulgated as thoroughly as Day et al. (1987) or Duminuco et al. (1993), *Four Hallmarks of Ignatian Pedagogy: Prelection, Reflection, Active Learning, Repetition* (Metz, 1991) was a valuable resource manual to Ignatian educators, in that it summed up centuries of Jesuit teaching methodology and presented it as an interpretation of modern learning theory. Multiple intelligences, aspects of Bloom's Taxonomy and cooperative learning were all addressed as aspects of what Jesuit education had been doing for centuries.

According to Metz (1991), each Ignatian class follows this four-part sequence. The first part was the prelection, which Metz stated was the most characteristic of all Jesuit teaching techniques. It was a Socratic, interactive setting of context for the day's lesson. He emphasized that it was not a lecture, but rather a cooperative effort with the intent of eliciting the interest of the students.

The majority of the class time was taken up by active learning and reflection. Metz (1991) quoted Day et al. (1987) in declaring that the active role of the retreatant making the Exercises was the model for the activity of a student in personal study, discovery, and creativity. While he stated that all educational techniques are valid, he recognized that some promote active learning better than others. An Ignatian educator

must make time for reflection within the active experience, weaving the active learning and reflection together.

The final hallmark is repetition. This was not just review, but a new savoring and a deeper look at the lesson. Metz suggested that this was an apt time to engage little used intelligences, promote higher level thinking skills, such as synthesis and evaluation, or use fantasy and visualization techniques. Metz concluded: "Through careful prelection, active learning in a reflective way and imaginative repetitions, the teacher begins to instill in the student the tools for learning how to learn, which is the overall goal of Jesuit pedagogy" (p. 219).

The Flexibility of Ignatian Education

Day et al. (1987), Metz (1991), Newton (1977) and Duminuco et al. (1993) all commented on the fact that flexibility and adaptation are a hallmark of Ignatian education, spirituality and mission. Early Jesuit missionaries St. Francis Xavier, Roberto De Nobili, and Matteo Ricci were all successful in their missions to Japan, India, and China, respectively, because of the sense of inculturation, the willingness to adapt to the cultures to which they were ministering (Modras, 2004). The IPP was founded on that same patience and faith in the Spirit to move the person from where he or she is to where he or she is able to go. It allows for creative adaptations in the teacher-learner experience to suit persons and circumstances. The Jesuit way of proceeding was not one of indoctrination or manipulation. This was not a rigid methodology, but truly a paradigm (Duminuco et al., 1993).

Ignatian Education and Social Interdependence Theory

Much of the work of the JSEA in the late twentieth century centered on describing Ignatian education and the Jesuit way of proceeding. This was not an attempt to create a learning theory. As Day et al. (1987), Metz (1991), Duminuco et al. (1993), and others have stated, Ignatian education encompassed and adapted to a variety of learning theories, including those based on social interdependence and cooperative learning.

Johnson, Johnson, and Smith (1998) often referred to the communal nature of cooperative learning. Community is at the foundation of Catholicism. *To Teach as Jesus Did* (1972) stated that

> Community is at the heart of Christian education not simply as a concept to be taught but as a reality to be lived…Building and living community must be prime, explicit goals of the contemporary Catholic schools (p. 23).

The thread of community weaves throughout this and other documents of Vatican II, many of which were influenced and/or written by Jesuits.

Although none of the 28 characteristics mapped by Day et al. (1987) directly addresses social interdependence, three appear most in line with the social interdependence concepts:

> 1.4 Jesuit education is an apostolic instrument. While it respects the integrity of academic disciplines, the concern of Jesuit education is preparation for life, which itself is a preparation for eternal life. Formation of the individual is not an abstract end: Jesuit education is also concerned with ways in which students will make use of their formation within the human community, in the service of others for "the praise, reverence, and service of God." (p. 20)

> 5.3 Jesuit education seeks to form men and women for others. Jesuit education helps students to realize that talents are gifts to be developed, not for self-satisfaction or self-gain, but rather, with the help of God, for the good of the human community…In order to promote an awareness of "others," the Jesuit education stresses community values such as equality of opportunity for all, principles of distributive and social justice and the attitude of mind that sees service of others as more self-fulfilling than success of prosperity. (p. 32)

> 8.0 Jesuit education relies on a spirit of community. As Ignatius came to know the love of God revealed through Christ and began to respond by giving himself to the service of the Kingdom of God he shared his experience and attracted "friends in the Lord," for the service of others. The strength of a community working in service of the Kingdom is greater than that of any individual or group of individuals. (p. 41)

Due to its apostolic nature, Jesuit education seeks to improve the individual so as to improve his or her future actions in society. Through the lens of cooperative learning, this means individual accountability that leads to a positive interdependence. One must practice the social skills necessary for future interactions to be successful. There is an implication that freeloading should be unacceptable to an Ignatian student.

Social interdependence theory described independence and negative interdependence as alternatives to positive interdependence. The fact that cooperative learning research has shown the advantages of positive interdependence in several areas is supported by the long-held Christian belief in community as fundamental and necessary to Christian life. Characteristic 5.3 described a sense of subjugation of self for the good of the community by any Ignatian teacher, student or alumnus/a. The interdependence must precede the service.

The two characteristics under Section 8.0 (Appendix B) deal mostly with collaboration on the adult level, between Jesuits and laity, school and alumni, school and parents. One goal of the adult interaction is to serve as a model for the students. There was one section on students, in which it is stated that students form a community of understanding and support among themselves, but it looked at this collaboration through the lens of school government and activities, rather than the educational process.

Cooperation, collaboration, and group work are mentioned twice in the *Ignatian Pedagogy* (Duminuco et al., 1993): (a) once as invitation for Ignatian teachers around the world to share their individually developed lesson plans to help flesh out the IPP, and (b) in Appendix 3, where small group processes and peer tutoring are listed as experiences within which the IPP can be used. While Duminuco et al. may not have addressed cooperative learning directly, cooperative learning and the IPP are not mutually exclusive. In fact, Metz (1991) pointed to the need for their integration.

Summary

Ignatian education has a 400-year tradition and represents a particular worldview. It grew out of the Spiritual Exercises of St. Ignatius and has the same goal of developing and renewing an individual, reordering his or her attitudes and deepening his or her commitment to God and to his or her role in the world. It seeks to produce persons for and with others, future leaders of competence, conscience, and compassion.

The process of an Ignatian education parallels the process of the Spiritual Exercises (Metz, 1991, Newman, 1977). It relies on the relationship between the director or the teacher as mentor and retreatant or student as mentee. It requires that the student actively participate in his or her experience in a context established and prelected by the teacher. It requires active reflection by the student, initially individually, but subsequently in dialogue with the teacher. Finally, the experience is evaluated and interpreted in terms of future action.

Ignatian education is flexible and adaptable. Just as the format of the Spiritual Exercises has adapted to a modern reality, Ignatian education has adapted to include modern research in education (Metz, 1991). While Metz claimed that Ignatian education

was student-centered and Duminuco et al. (1993) claimed that it was centered in the relationship between student and teacher, both agreed that Ignatian education was not teacher-centered. The shift from the traditional teacher as "sage at center stage" to a modern teacher as the "guide on the side" is fully embraced by Ignatian education.

Ignatian education is not "other-worldly" but firmly set in this world. It parallels and encompasses modern learning theory, including social interdependence theory. This connection is associated with and established by the communal nature of both cooperative learning and Catholic education.

CHAPTER III

REVIEW OF THE LITERATURE

Restatement of the Problem

Cooperative learning has been shown to be related to an increase in student achievement (Johnson & Johnson, 1989) and holds potential for opening access to calculus for a wider range of students. Treisman (1986) stated that, at higher levels of mathematics such as calculus, where the material and techniques are already difficult to learn, students of all ability levels benefit from study groups and cooperative efforts. One obstacle to cooperative learning's effectiveness for higher-achieving students is a resentment towards the process which may result from the freeloader effect. Not knowing the differences between cooperative learning and traditional group work, a resistance to cooperative learning often arises from the students' past experiences.

Overview of the Review

This review is organized into five sections. First, Active Learning (Johnson, Johnson, & Smith, 1998), the form of cooperative learning used in this research study, will be thoroughly explored. Second, the other most common and well-known cooperative learning systems will be reviewed, with an emphasis on similarities to and differences from Active Learning (AL). The intent here will not be to give an in-depth analysis of each method, but, rather, a basic knowledge of each method and to give voice to the other experts in the field.

Where the first two sections define what cooperative learning is, the third section seeks to describe what it is not; namely, collaborative learning or guided discovery. Both developed at the same time as cooperative learning and have the same purpose insofar as

they use small groups to maximize learning. The distinctions of process and intent are noteworthy, though, especially as guided discovery and cooperative learning are closely entangled in math.

In the final section, four meta-analyses of cooperative learning are reviewed. The International Association for Study of Cooperation in Education (2004) stated "over a thousand" research studies have been done in the field of cooperative learning. Johnson and Johnson (1989) stated that such diverse dependent variables as individual achievement and retention, group and organizational productivity, higher-level reasoning, moral reasoning, motivation, job satisfaction, interpersonal affection and love, prejudice, self-esteem, psychological health, and many others have been investigated. For the purposes of this study, the review of the literature has been limited to the dependent variables analyzed: (a) achievement, (b) social support, and (c) attitudes toward cooperation, competition and individualism.

Hunter, Schmidt, and Jackson (1982) stated that when many (100 to 1000) studies are available in the literature, the traditional narrative procedure of reviewing literature can lead to findings across studies that vary in bizarre ways. Cooper and Rosenthal (1980) found that as few as seven studies can lead quantitative and qualitative reviews to very different conclusions. Given the large number of studies in the field of cooperative learning, reviewing the meta-analyses was deemed appropriate. The four meta-studies reviewed here are: (a) a study of all cooperative learning research from 1898 to 1989, (b) a comparative study of the ten different cooperative learning systems, (c) a study of cooperative learning as one of nine best pedagogical practices, and (d) a study of cooperative learning in math, science, and engineering classrooms.

Active Learning:
Johnson and Johnson's Methodology of Cooperative Learning

The first to apply Deutsch's social interdependence theory to education was David Johnson (1970). Together with his brother Roger, they established The Cooperative Learning Center at the University of Minnesota, which resulted in a synthesis and systemization of the knowledge in the field and the creation of a validated theory of concrete strategies and procedures (Johnson, Johnson, & Smith, 1998).

In the 1960s, Johnson and Johnson developed a cooperative learning method that has been modified over the years and renamed several times. Initially published as Learning Together and Alone, it was later revised and published as Cooperation in the Classroom. The most recent incarnation, by Johnson, Johnson, and Smith (1998), is Active Learning (AL), wherein the authors attempted to bring cooperative learning back into a university setting. Johnson and Johnson and their adherents just refer to their form as cooperative learning and assume all other forms fall under their umbrella. For the purposes of clarity, this study shall use "cooperative learning" refer to the general process and AL when making specific reference to the Johnson and Johnson form.

Five Essential Elements of Cooperative Learning

Through the 1970s, Johnson and Johnson researched and developed their cooperative learning theory, and they identified and defined five essential elements that make cooperative learning work more effectively than traditional group learning. Traditional classroom learning groups are those in which the assignments are structured in such a way that very little cooperative work is required. Students in this situation believe that they will be evaluated and rewarded as individuals. The five elements of truly cooperative work are (a) positive interdependence, (b) individual accountability, (c)

face to face promotive interaction, (d) small group social skills, and (e) group processing (Johnson, Johnson, & Smith, 1998). While these five elements seem distinct, there is much overlap in how they are implemented, controlled, and assessed. Figure 2 shows a conceptualization of the nestedness of the first three elements and how the process flows through the elements from one to the next.

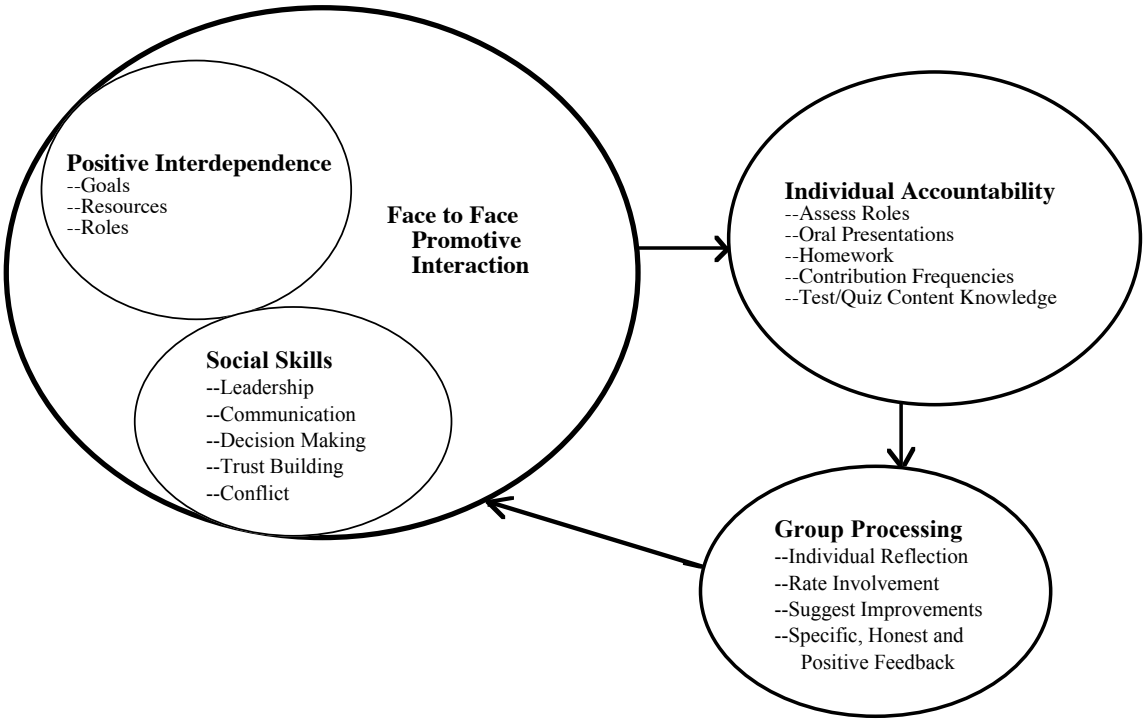

Figure 2. Johnson & Johnson's five elements of cooperative learning lead into, reinforce and grow out of one another in the students' experience.

Positive Interdependence

For a group to learn cooperatively, there must exist a reason or reasons for the individuals to move beyond the individualistic approach to learning that has been their formal classroom experience. Johnson and Johnson (1989) cited this as the heart of social

interaction theory. There are several ways to structure the situation so that cooperation becomes preferable to, and more indicative of, success than the individualistic approach.

The teacher must define the goals in such a way that varying levels of cooperation are necessary. For instance, rather than honoring the first group to reach the answer, the goal might be that an arbitrarily chosen group member will be called on to explain the concept, thus forcing all members to achieve understanding. Rewards are structured to reinforce cooperation, such as extra points for the group with the highest average on a test or for greatest improvement from the previous assessment. Resources are deliberately limited so that individuals must share either the resources or the knowledge attained from them. For example, group members might be given different parts of an article to read and explain to the others, building a knowledge base among them. Finally, specific roles, such as Reader, Recorder and Checker (Johnson, personal communication, 2004) are assigned to force cooperation.

Individual Accountability

According to Johnson, Johnson, and Smith (1998), one of the big differences between traditional groups and truly cooperative groups was that each member became personally responsible for his or her part of the learning. Individual accountability was a necessity. The cooperative learning situation must be designed in such a way that it is difficult (if not impossible) for a member to shirk his or her duty or not learn the material at hand.

Individual accountability can be measured in several ways. Homework may be graded, though one needs to assign homework that is thought-provoking and not merely

routine or mechanical and thus easily copied. Individual tests and quizzes insure accountability. Another source of individual accountability can be found during the task itself. During the face-to-face promotive interaction, the teacher can collect data on contribution frequencies within a group. Oral presentations may require that different individuals present on parts of the same topic. Finally, the roles assigned, as part of the positive interdependence, are assessed orally, in writing, or by ratings by each group member.

Accountability not only applies to the individuals, but also to the group as a whole. Group projects and group tests or quizzes measure group accountability, but they must be designed in such a way that one member cannot do all the work. This is where the freeloader effect may lead to the sucker effect, the negative attitudes toward group work among the more competent individuals.

It is the process rather than the product that is important when assessing group accountability. Roger Johnson (personal communication, 2004) suggested a three-tiered approach that he referred to as Group-Individual-Group (GIG) as one way to assess. This consists of doing test preparation in groups, followed by individual testing, followed by a group retest.

Face-to-Face Promotive Interaction

The element of Face-to-Face Promotive Interaction was the most recognized part of AL and simply meant that the group must be in physical proximity. Roger Johnson (personal communication, 2004) preferred "knee-to-knee and eye-to-eye," without furniture separating the group members. In math, this is not practical because a writing

surface with some space to spread out is often necessary. Even in math, though, close proximity is required. Despite the alacrity with which students communicate via text messaging, instant messaging, and email, there is no substitute for personal contact (R. Johnson, personal communication, 2004).

The "promotive" aspect of this element overlapped with the first and fourth essential elements, namely positive interaction and interpersonal social skills. The interchanges among group members need to be positive in nature and tone. Students also need to promote the goal of success for the group as measured by the success of each member. The process must be emotionally supportive to and caring of all members, as well as intellectually supportive of them.

Interpersonal and Small Group Social Skills

Besides being positive and supportive as noted above, Johnson and Johnson (1974) found five basic social skills that the group members must have been exhibited and learned for AL to be highly effective: (a) leadership, (b) communication, (c) decision making, (d) trust building, and (e) conflict management. There must be leadership; that is, members need to be taught how to influence each other positively. Second, general communications skills must be developed for clear understanding. Third, group members must exhibit good decision-making skills. This can take many forms, such as staying on task, using time wisely, or assuring that everyone participates. Fourth, trust-building is essential within the group. Group members must individually believe the group will be there for them and that they have a reciprocal responsibility. This does not happen by

itself. Individuals make it happen. Finally, the skill of conflict management must be nurtured, because conflicts will arise whenever individuals try to work together.

Johnson, Johnson, and Smith (1998) stated that these skills cannot be assumed at any level. The younger the students are, the more necessary the teacher's role in teaching and instilling these skills becomes. Even at the university level, though, these skills cannot be taken for granted, and the students must be consciously and explicitly exposed to them.

Group Processing

Johnson, Johnson, and Smith (1998) reported that the element of cooperative learning most often missing is group processing. Synthesis of the learning process needs to occur, individually as well as among the group members. The group analyzes how effectively it has achieved its goals and how well the members are working together. The product should be greater than the sum of the parts contributed by each individual. Yager, Johnson, and Johnson (1985) found that high-, medium-, and low-achieving students who used group processing performed higher on daily achievement, post-instruction achievement and retention measures than did comparable students who engaged in group work without processing or who engaged in individualistic learning.

Johnson, Johnson, and Smith (1998) suggested a three-part procedure for the group reflections: (a) each individual rates the involvement of all in both the content and the group process, including reasons why each rating was given; (b) the group members share their self-ratings and the reasons for them; and (c) the group lists three ways in which each member can increase his or her involvement next time. The group retake in

GIG also serves as an opportunity to process, both while testing and as a subject of later shared reflection. The emphasis here is on continuous improvement.

The Teacher's Role

The teacher has a specific role and set of duties at each stage of the AL process. Roger Johnson (personal communication, 2004) stated the face-to-face promotive interaction phase of AL was not an opportunity for the teacher to take a break or catch up on grading. Though the intent of AL was to change the teacher's role from "sage at center stage" to "guide on the side" (Johnson, Johnson, & Smith, 1998, 2:2[1]) and switch the students' mode of operation from passive to active, the teacher's role varied somewhat depending on the type of group being used. The intent was not to make the teacher passive nor to remove the teacher from the learning process.

Johnson and Johnson (1974) considered three types of groups that are cooperative, based on the presence of the essential elements: Formal Groups, Informal Groups and Base (or Home) Groups. There were other types of groups that did not promote cooperation. Psuedo-learning groups were those in which the students were assigned to work together but they believed that they would be ranked by performance and perceived their group mates as competitors. These groups exhibited negative rather than positive interdependence. Traditional groups were those in whichh little interdependence was present and the group members were actually working independently (Johnson, Johnson, & Smith, 1998).

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[1] Johnson, Johnson, & Smith (1998) paginated with chapter and page. Hence, 2:2 is Chapter 2 page 2. This manner of citation will be used throughout this dissertation proposal.

Formal Groups were groups of two to four students centered around a specific task, commonly a project or summary analysis of a lesson. These groups were formed for just one task, and a different grouping was formed for the next task. The duration of the group was usually more than one class period and it lasted until the task was completed.

As its name indicates, Informal Groups were seemingly random pairings of students to allow them to cognitively reorganize and process their thoughts, identify misconceptions, and personalize the learning experience at different points within a lecture. There are both good reasons and poor reasons for lecturing, but lecturing for a more extended time (length depends on the audience) has been demonstrated to be ineffective (Johnson, Johnson, & Smith, 1998, 3:4). Informal Groups may help this. The tasks are less structured than in Formal Groups and the duration is limited to a few minutes. Though the pairings seem random and spur-of-the-moment, they should not be completely random because students paired with different students at different times may get a wider perspective.

Johnson, Johnson, and Smith (1998) defined Base Groups as long-term groupings that serve primarily as personal support over the whole semester (and possibly beyond). Tasks that are formal or informal may be assigned at times to Base Groups, such as homework or shared notetaking, especially in math classes. Just as Informal Groups may be used to frame a class with warm-up exercises, or activators, and summarizers, Base Groups may frame the week. Opening Monday with "touching base" sets a comfortable mood for the class and a final reflection on Friday allows debriefing of the week and goal-setting for the weekend. The University of Michigan Math Department adopted a

Base Group model for all homework assignments in their undergraduate calculus classes (Davidson, Reynolds, & Rogers, 2001). Base Groups may serve as a mode for dealing with routine tasks, such as attendance or clerical necessities, as well as providing a forum for group processing, the fifth (and often missing) element of cooperative learning.

The purposes and uses of Informal and Base Groups, by their nature, require less structure than Formal Group work. The teacher's main role during Informal Groups is to provide focusing questions at key points to allow for summary discussion of a lecture. R. Johnson (personal communications, 2004) stated that the teacher's role with Base Groups is to provide time for routine activities, such as returning tests and taking role, for social interaction that sets an amiable and relaxed tone for the class, and for observation of group dynamics (Johnson, Johnson, & Smith, 1998).

Johnson and Johnson (1994) stated that the groundwork and analysis of the Formal Group work are extensive. There are five tasks in their use: (a) specifying the instructional objectives: (b) making several pre-instructional decisions; (c) explaining the task and the positive interdependence; (d) monitoring and intervening, when necessary, in the process; and (e) evaluating the process and the group functionality. Johnson, Johnson, and Smith (1998) revised this list, combining (a) into (b), thereby making the specifying of instructional objectives one of the pre-instructional decisions.

Where Figure 2 organized the five elements from the student perspective, Figure 3 summarizes and conceptualizes the Formal Group process from the point of view of the teacher and his or her role. Figures 1 and 2 parallel and overlay each other, but the teacher perspective is more web-like and less curvilinear than the student perspective.

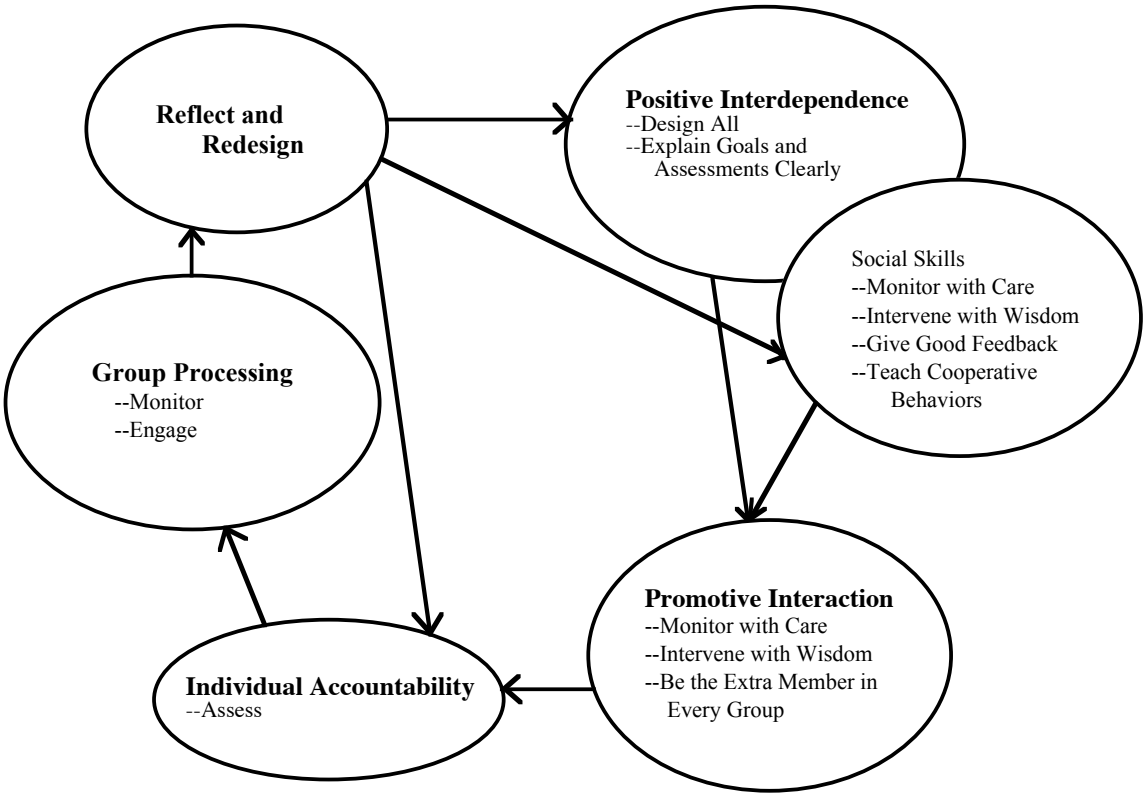

Figure 3. The details of Johnson and Johnson's five elements of cooperative learning determine and affect the teacher's role.

All the parts interplay and affect one another. Johnson, Johnson, and Smith (1998) acknowledged that this complex process took a great deal of time and energy, as well as patience and confidence on the part of the instructor to allow his or her own competence in the process to grow.

Pre-Instructional Decisions

Careful structuring and planning were found to be necessary to achieve the positive interdependence and promotive interaction that distinguish a cooperative group from a traditional group. There are at least six pre-instructional decisions for which the teacher is responsible. First, both the academic and the social skills objectives of the lesson are determined. Second, the group size is set. Depending on the task, groups of

three might be more appropriate than four, or vice versa, as determined by the teacher. Third, students are assigned to groups. This may have been done randomly or selectively to establish heterogeneity. Fourth, members of each group are assigned roles. Fifth, the room is arranged physically to establish the face-to-face element and to allow for a pathway for monitoring. Finally, the materials for the lesson are planned and arranged to promote a "sink or swim together" mentality (Johnson, Johnson, & Smith, 1998).

Explaining the Task and the Positive Interdependence

It was important that the criteria for success, as well as the academic task, be explained clearly and concisely. The AL process should be transparent to all and the teacher should be clear about what the desired result of the lesson should be. The students need to understand the goals of both the task and the overarching social goals of AL in general. The planning of and reasoning behind the structure of the positive interdependence must be explained in light of how they will help achieve the goals. The resource allocation, role assignments, celebrations and rewards, and the establishment of group identity should be made explicit to all students. The benefits of extending cooperation to other groups rather than competing with them must also be explicitly stated (Johnson, Johnson, & Smith, 1998).

Monitoring and Intervening

While AL is occurring, the teacher must be actively involved in monitoring the process. It is not time to relax or to grade papers. R. Johnson (personal communication,

2004) stated the teacher must be both a guardian of the process and an extra member for each group.

As a guardian, the teacher monitors the student behavior, as well as the interaction. Johnson and Johnson (1997) suggested "The Five-Minute Walk." Beforehand, the room must be physically arranged for ease of access to all parts of the room and a route must be decided. The teacher walks around the room for exactly five minutes, timing his or her walk with a stopwatch and taking notes. The teacher must not continue endlessly. While walking, the teacher observes each group and gathers data on the process. This data should be numerical. They can be the number of times a particular person in each group speaks. They can be the number of times a particular social skill is exhibited. The main point is to have an agenda for the walk and not to just go out for a stroll. The purpose of the monitoring, as well as the kind of data to be gathered, should be predetermined as part of the process design (Johnson & Johnson, 1997).

Another way to monitor the process was called "Mystery Person." Rather than monitoring everyone, as on "The Five-Minute Walk," the teacher tells the class he or she has selected one person to watch and on whom to gather data. The teacher then observes the subject without telling or showing the class who is being observed. Unlike the data gathered on "The Five-Minute Walk," this data may be on more than one skill. Feedback is given at the end and the identity of the mystery person is never revealed (Johnson & Johnson, 1997).

R. Johnson (personal communication, 2004) described a third way to monitor the process by assigning the role of observer to a group member. That person remains aloof from the group and gathers data on interchanges in a manner similar to the teacher on

"The Five-Minute Walk." At the end of class, the data serves as a focus for group processing and reflection.

The teacher may need to intervene, when necessary, in either the social skills or the academic task. As the extra member of each group, the teacher may provide guiding questions or clarify a concept for a group or individual. In extreme situations, the concept may need to be re-presented to the class. The emphasis is "to monitor with care, intervene with wisdom, give good positive feedback, and teach cooperative behaviors that can be maintained over time" (R. Johnson, personal communications, 2004).

Evaluating the Process

Evaluation of the process falls into two categories: (a) the teacher's evaluation of each student's progress and (b) evaluation of the group's processing. The individual assessment may vary according to the academic task. There may be a test or quiz, a project to be graded, an oral presentation, or any of a number of other individual assessment tools. The evaluation is designed along with the task and circumstances that lead to the positive interdependence, before the process occurs (Johnson, Johnson, & Smith, 1998).

The process may be evaluated in a number of ways. The data gathered from "The Five-Minute Walks" and student observers may form a basis for assessment. Group members, as part of the group processing, may score themselves and their group mates on various topics. Other teachers or administrators may be asked to observe the class and write short opinion pieces. All this data should stimulate reflection and possible restructuring of the task by the teacher.

Summary of Active Learning

AL is a complex and energy intensive exercise for the teacher. All five essential elements are incorporated into the design of the task and nurtured carefully in order for the benefits of cooperation over individualistic and competitive methods to be realized.

Active Learning (AL) was, in some ways, an umbrella approach to cooperative learning. Although most of the other cooperative learning methods which were developed during the 1970s, 1980s, and 1990s used the Johnson language, they emphasized different aspects of AL. Some might be interpreted as examples of Base Groups or Formal Groups. AL has changed to incorporate some of these other methods. The Jigsaw Method, Think-Pair-Share, and Interviewing Triads, for instance, were all incorporated from other methods as specific activities within AL. The Johnsons' work has been constantly modified to be an all-encompassing expression of the variety of cooperative learning techniques, methods, and systems.

Cooperative Learning Systems

Sharan (1994) identified nine methods of cooperative learning. They are: (a) Learning Together and Alone (later revised as Active Learning, or AL); (b) Group Investigation (GI); (c) the Jigsaw Procedure (JP); (d) Constructive Controversy (also known as Academic Controversy, or AC); (e) Student Teams Achievement Divisions (STAD); (f) Complex Instruction (CI); (g) Team Accelerated Instruction (TAI); (h) Kagan's Cooperative Learning Structures (KS); and (i) Cooperative Integrated Reading & Composition (CIRC). Johnson, Johnson and Stanne (2000) included Teams-Games-Tournaments (TGT) as a tenth. These are summarized in Table 1.

Table 1
Table of Cooperative Learning Methods Investigated in the 2000 Meta-Analysis by Johnson, Johnson and Stanne and the Five Elements

Method	Positive Interdependence	Individual Accountability	Face-to-Face	Social Skills	Group Processing
Learning Together (LT) (Johnson & Johnson, 1975)	Present	Present	Present	Present	Present
Teams-Games-Tournaments (TGT) (DeVries & Edwards, 1974)	Present	Present	Present	Assumed[1]	None
Group Investigation (GI) (Sharan & Sharan, 1976)	None	None	Present	Present	None
Jigsaw Procedure (JP) (Aronson et al., 1978)	Present	None	Present	None	None
Academic Controversy (AC) (Johnson & Johnson, 1979)	Present	Present	Present	Present	Present
Student Teams Achievement Divisions (STAD) (Slavin et al., 1978)	Present	Confounded[2]	Present	Maybe[3]	Maybe[3]
Complex Instruction (CI) (Cohen et al., 1994)	Present	Maybe[3]	Present	Present	Maybe[3]
Team Accelerated Instruction (TAI) (Slavin et al., 1982)	Present	Confounded[2]	Present	Maybe[3]	Maybe[3]
Cooperative Learning Structures (KS) (Kagan, 1985)	Present	Present	Present	Present	Maybe[3]
Cooperative Integrated Reading & Composition (CIRC) (Stevens et al., 1987)	Present	Confounded[2]	Present	Maybe[3]	Maybe[3]

Notes: Adapted from Sharan (1994) and Johnson, Johnson and Stanne (2000)
[1] "Assumed" means the teacher assumes this element is present and does not need reinforcing.
[2] "Confounded" means the Individual Accountability is present in a form that mixes it with competitive group grading.
[3] "Maybe" means this element might be present in the task materials, but the method does not address it directly.

The Johnson, Johnson and Stanne (2000) meta-analysis compared the various methods in two ways. First, effect sizes on achievement were compared. Second, the methods were coded in five categories to compare them on a scale from most direct to most conceptual. Before looking at Johnson, Johnson and Stanne (2000), a rudimentary explanation of each method is advisable.

Teams-Games-Tournaments

Teams-Games-Tournaments (TGT) developed in the early 1970s at Johns Hopkins University by DeVries and Edwards (1974). Rouviere (1998) described TGT as a process that combined cooperation and competition. Students were placed in heterogeneous groups to learn a topic, then re-formed into homogenous groups to compete, using questions from the end of the chapter. Students randomly selected a numbered card corresponding to the question they were to answer. Their answers may have been challenged by the other students and the winner kept the card. Students earned points (one point for each card won) to bring back to their heterogeneous teams, a team average was taken, the teams' averages were announced, and all congratulated. The competition may have been followed by a graded quiz made up of the competition questions. Johnson, Johnson, and Smith (1998) stated TGT was the precursor to Slavin's work on Student Teams Achievement Divisions.

In terms of the five essential elements discussed above, TGT had some positive interdependence and face-to-face interaction, but individual accountability was muddled by the averaging of the group scores. Social skills were assumed and there was no group processing.

Group Investigation

Group Investigation (GI) was developed in the mid-1970s in Israel by Sharan and Sharan (1976). Sharan and Sharan (1994) stated that the key elements were investigation, interaction, interpretation, and intrinsic motivation. The process began with teacher presentation of a broad topic. The class then discussed what subtopics might underlie the material and groups of four or five were formed around a common interest. The groups investigated their subtopic individually or in pairs and got together to design and deliver a group presentation. The class discussed and evaluated the presentation. Finally, whole class learning was evaluated by a project (such as the creation of a topic-related newspaper) or a quiz comprised of questions submitted by the groups (Sharan & Sharan, 1994).

Compared to the AL approach, this was a formal group process that included promotive interaction which occurred within a face-to-face interaction and employed small group social skills. However, the interdependence was not assured by resource limitations or goal design. There was not individual accountability. This situation is one wherein the freeloader effect was likely to occur, because, as Johnson, Johnson, and Smith (1998) stated, individual accountability is the primary control against freeloading. Though there was synthesis and accountability for the class, there was no individual accountability for the group members. There was no group processing.

The Jigsaw Procedure

The Jigsaw Procedure (JP) was developed by Aronson (1978) in the late 1970s in Austin, Texas. Clarke (1994) declared that the basic idea of JP was to design a process

by which competition and success were incompatible and success could only occur with cooperation. Heterogeneous groups of three or four were formed and each member was assigned a subtopic of the material. Students then broke out into homogeneous groupings around the specific subtopic and engaged in focused exploration. The original groups re-formed and the subtopic "experts" taught their group mates what they learned. The teacher then designed individual, small group, or whole class activities during which students actively integrated the knowledge (Clarke, 1994).

Aronson's version was dubbed Jigsaw I when Slavin (1983) expanded the model into Jigsaw II. In Jigsaw II, the same process was used, but the outcomes were different. The narrative material was revisited through the lens of different perspectives and the interdependence was reinforced by a reward system.

JP was a method that used face-to-face interaction and insured interdependence through resource allocation and group rewards. It did not include individual accountability, teaching of social skills or group processing. Johnson and Johnson (1994), Slavin (1990), and Kagan (1992) incorporated JP as a technique within their cooperative learning systems.

Academic Controversy

Academic Controversy (AC) was developed in the mid-1970s at the University of Minnesota by Johnson and Johnson (1979). It is sometimes known as Constructive Controversy. The process involved heterogeneous groups of four and lasted approximately five class meetings. A topic is introduced and the group splits into two pairs. The pairs are assigned opposing positions on the topic, which they then develop. Each pair presents its arguments to the other pair and discussion ensues. Disequilibrium

is established by the pairs reversing positions on the topic and arguing the other point of view. Advocacy is then dropped and a final synthesis report is developed and presented to the class. An individual test follows with bonus points awarded for groups that achieve a predetermined level of achievement. While this might appear to involve competition, the negative interdependence of competition is carefully ruled out by individual students advocating both positions and a consensus is built rather than a winner declared (Johnson & Johnson, 1994).

All five elements of AL are present, with the addition of a sixth, rational argumentation. Unfortunately, the method does not apply to mathematics: when there is a right answer, there is no controversy.

Student Teams Achievement Divisions

Student Teams Achievement Divisions (STAD) was developed in the late 1970s at Johns Hopkins University by Slavin (1977). Slavin (1994) delineated three basic elements in contrast to Johnson, Johnson, and Smith's (1998) five: (a) team rewards, (b) individual accountability, and (c) equal opportunity for success. Though teams received certificates or other awards for achieving preset criteria, there was no competition because all the teams may achieve the reward. One team's success did not preclude another's. Individual accountability and equal opportunity for success were established by measuring the individual's contributions to the team and improvement over past performance (Slavin, 1994).

Slavin (1994) described the process as follows. Heterogeneous groups by ability, gender and ethnicity were established and lasted for three to five class periods. New material was presented in a traditional lecture-discussion model and teamwork was

centered on STAD worksheets. Individual quizzes were administered and team points awarded for individual improvement. Public team recognition followed.

Positive interdependence, face-to-face interaction and individual accountability are present, but cooperation and competition are confounded in this approach. AL's group processing and social skills elements seem to be absent, though they could be factored into the materials.

Complex Instruction

Complex Instruction (CI) was developed in the early 1980s by Cohen, Lotan, Whitcomb, Balderrama, Cossey, and Swanson (1994) and was based on three elements: (a) a management system that frees the teacher from direct supervision, (b) a multiple abilities curriculum that fosters higher-order thinking skills, and (c) a treatment of the status problem that arises from publicly assigning competence levels.

Heterogeneous groups of four or five are formed and authority is delegated through student roles, developed cooperative norms and activity cards. At the beginning of a unit, the teacher describes the wide variety of skills and abilities needed for a task that is specifically uncertain and open-ended. A mixed set of expectations is created and the students are told explicitly that no one has all the abilities and everyone has a competence to contribute. All are needed to succeed. Teachers must be careful to assign competence publicly to low-status students through positive evaluation. This is not just to raise the individual's self-perception, but also to raise the group's expectations of that individual (Cohen et al., 1994).

This method is strong on social skills and may have group processing built in. Cohen et al. (1994) listed group processing as another social skill rather than an essential

element of its own. Cohen's (1986) great contribution to the field was the emphasis on status and behavior. She and her colleagues found that the learning gains of low-status children can be inhibited by their failure to have as much access to interaction as high-status children. Complex instruction sought to equalize status by acknowledging all students ability to contribute, thus minimizing difficult behavior (Cohen et al., 1994).

Team Accelerated Instruction

Team Accelerated Instruction (TAI) was developed by Slavin, Leavey, and Madden (1982) in the early 1980s. It is a subject specific application of STAD to math in the 3rd through 6th grades.

After a placement test, heterogeneous groups of four or five students are formed by the teacher. The students work on curriculum material appropriate to the individual. Each day, the teacher forms a homogeneous group of students at a particular achievement level and presents small group instruction. The team members help each other work on their different materials, using partner checking to progress through the assignments to a formative test. Individual fact tests are given once or twice a week and a class test is given after three weeks. Team rewards (certificates, not points) are awarded for the average number of units passed by the group (Slavin & Madden, 1994).

This method has the same strengths and weaknesses as STAD. Positive interdependence, face-to-face interaction and individual accountability are present. Cooperation and competition are confounded, and group processing and social skills seem to be absent, though they could be factored into the materials.

Cooperative Learning Structures

Kagan's (1985) Cooperative Learning Structures (KS) was developed in the mid-1980s in California. Kagan identified 55 different cooperative learning structures and aligned each to a particular goal or objective. The process depends on the structure used. His basic principles (PIES) are (a) positive interdependence, (b) individual accountability, (c) equal participation, and (d) simultaneous interaction. Social skills, such as team building and class building, are built into the structures. Groups of four are established. The make-up of each group can be determined in a variety of ways, based upon purpose. Random assignment may be used, but these groups should only last a day or so, to avoid "loser groups." Interest groups or homogeneous language groups may be formed to last five classes. Heterogeneous groups may be formed to last five to six weeks (Kagan & Kagan, 1994).

KS is very similar to AL in that the groupings are similar to informal, formal and base groups and four of the five AL elements are present. Group processing may be part of the structure used. Grisham and Molinelli (1995) noted that KS was very different from AL in the highly structured materials used. Kagan's (1992) goal was to create an easily implemented and practical approach that any teacher could use with minimal effort. The structures are a series of techniques that have the pre-instructional design decisions to establish positive interdependence and individual accountability already built in.

Cooperative Integrated Reading and Composition

Cooperative Integrated Reading and Composition (CIRC) was developed in the late 1980s by Stevens, Madden, Slavin, and Farnish (1987). Like TAI, it is a subject specific application of STAD. In this case, STAD is applied to reading and writing.

CIRC includes pairs and trios in teacher-led reading groups, partner checking within heterogeneous groups, and story activities. There are planned weekly whole class instruction on comprehension, comprehension quizzes every three meetings, and biweekly book reports. A unique feature of CIRC is the integration of a special education reading specialist (Slavin & Madden, 1994).

As with STAD and TAI, positive interdependence, face-to-face interaction and individual accountability are present. Cooperation and competition are confounded, and group processing and social skills seem to be absent, though they could be factored into the materials.

Summary of the Cooperative Learning Systems

There are nine recognized alternatives to Johnson, Johnson, and Smith's (1998) Active Learning. Not all experts in the field agree that all five AL elements are essential. Some de-emphasized group processing, some mixed cooperation with competition, some emphasized practical techniques over theory, and some were more subject specific than others. All the experts agreed, though, that positive interdependence was essential to cooperative learning and that the face-to-face promotive interaction was often the only element present in traditional group work. Assigning students to a group and assigning a task does not insure the task that will be done cooperatively. It takes significant energy and time to insure that the other four elements are present.

Collaborative Learning and the Guided Discovery Approach

Since this study was about cooperative learning, the issues of collaborative learning and guided discovery need to be addressed. Both these approaches use small groups in order to achieve the task at hand. Both are far less structured than cooperative learning and neither have the body of research behind them that cooperative learning has. Other differences exist and will be considered here.

Collaborative Learning

Though cooperation and collaboration are synonymous in everyday English, the Latin roots of collaboration and cooperation hint at the differences. Collaboration's root focuses on the process of working together, while the root of cooperation stresses the product of such work (Myers, 1991). Panitz (1996) wrote that the basic difference between the two is that cooperative learning is a structured interaction that results in an end product, while collaborative learning is a philosophy of interaction and a personal lifestyle.

Collaborative learning has deep historical roots similar to cooperative learning, but collaborative learning developed in England differently from how cooperative learning grew in America. In America, cooperation developed through the philosophical writings of Dewey (1924) on the social nature of learning and on Kurt Lewin's work (1935) on group dynamics, leading to David and Roger Johnson's work in the 1970s. The cooperative learning emphasis has been on the quantifiable measurement of achievement. Panitz (1996) stated that collaborative learning, on the other hand, arose from British literature teachers' attempts to analyze student talk and, thus, has a distinctly qualitative approach.

Myers (1991) made another distinction. Cooperative learning tended to be much more teacher-centered, in that the instructor made all the design decisions from the formation of the groups to the interdependence to the teaching of the social skills. Collaborative learning left many of those decisions in the hands of the students. Groups were formed on the basis of friendships and/or geographical factors rather than on an attempt to establish heterogeneity. The social skills arose more organically, from the student interaction rather than from teacher monitoring and intervening.

Rockwood (1995) found a third distinction in the tasks and outcomes. Cooperative learning was product oriented. The tasks led to results that could easily be graded against a standard or rubric. Collaborative learning asked open-ended questions which might be much more difficult to grade than cooperative learning because there were no "right" answers.

Bruffee (1993) cited the New Pathways program at Harvard University Medical School as a good example of collaborative learning. The students formed consensus groups of six to eight and the groups were given six weeks to resolve diagnostic problems that had medical or scientific ramifications. Each group had a faculty mentor and access to the school's resources, but the particular problem and solution belonged to the group, collaboratively and uniquely.

There were many common beliefs underlying both approaches: (a) both viewed learning as an active rather than passive endeavor; (b) the teacher was seen as facilitator or guide; (c) small groups helped with success and retention; (d) articulation among peers helped the thought process; (e) consensus building was a fundamental part of a liberal education (Matthews, Cooper, Davidson & Hawkes, 1998). These methods fell near each

other on the spectrum of pedagogy and they shared the "transaction" orientation that Piaget, Vygotsky, Kohlberg, and Bruner explored (Myers, 1991; Panitz, 1996).

Cooperative and collaborative learning shared common resistance. Both approaches take time and instructors fear the potential inability to cover all their material. In the field of mathematics, where curriculum has been described as being "a mile wide and an inch deep" (Stigler & Hiebert, 1999), teachers are often afraid of this issue (Matthews, Cooper, Davidson & Hawkes, 1998). Another issue is the teacher's desire to retain control of the classroom (University of Michigan Math Website, 1997). Students accustomed to lectures are more resistant to becoming active in their learning and tend to complain that their teachers are not teaching (Matthews, Cooper, Davidson & Hawkes, 1998). Based on traditional group experiences, students might assume that they will have to take up the slack for someone in the group (University of Michigan Math Website, 1997).

Because of the maturity level required for collaborative learning, it may be more suited to higher education, whereas cooperative learning might be better suited to secondary and elementary education. Rockwood (1995) concluded that, in his teaching experience, cooperation represents the best means to approach mastery of foundational knowledge. Once students became reasonably conversant in this knowledge, they were ready for collaboration, discussion and student assessment.

Guided Discovery

Another philosophy/pedagogy that has been confused with cooperative learning is guided discovery. There has been a longstanding confounding of cooperative learning and subject-specific issues, especially in mathematics. Treisman (1992) commented that

his program was designed around "interesting questions" rather than traditional calculus problems. There have been many textbooks published in the last twenty-five years that were a mixture of cooperative learning and guided discovery. College Prep Math (CPM), the Interactive Math Project (IPM), Serra's Geometry: An Inductive Approach, and the University of Chicago Science and Math Project (UCSMP) are but a few. They all confounded cooperative learning with the guided discovery approach.

Davidson's (1970) small group discovery method was a collaborative rather than cooperative learning approach. The idea was that groups of three or four would work together on challenging math problems that an individual might give up on. The emphasis was on the design of the problem rather than on the interaction of the group. At the beginning of the semester, the teacher would tell the students how to work cooperatively in group leadership roles and intra-group dynamics were left to the group to develop. Even how the groups were to be formed was largely unexplored at the time (Dancis & Davidson, 1970). Davidson, Reynolds, and Rogers (2001) stated that, over the years as cooperative learning was explored and developed, the discovery method borrowed from cooperative learning but the heart of the discovery approach remained the subject matter to be discovered.

Dubinsky's (1986) action-process-order-schema (APOS) theory always had the process at its core. According to Reynolds (2001), the important result of Dubinsky's approach is the meta-cognitive process of the activity that prepares the students for a follow-up lecture and discussion (Rogers et al., 2001).

In 1995, two dozen college math teachers participated in the Mathematics Association of America's Project CLUME (Cooperative Learning in Undergraduate

Mathematics Education), an intensive summer immersion workshop. Nearly 150 participants have attended since and several articles and books have been produced cooperatively among them. A discussion about the Dubinsky and Davidson theories arose during these workshops. Rogers et al. (2001) came to the realization that these theories generated distinctly different approaches to cooperative learning in college math. In Davidson's original work, discovery was the whole point of the activities. For Dubinsky, the meta-cognitive process was the key. For Davidson, the teacher is helping the students discover, or uncover, the material themselves, giving them ownership that would lead to understanding and retention. For Dubinsky, the teacher is guiding the students toward constructing ideas about and concepts of their learning as well as of the material (Davidson, Reynolds & Rogers, 2001).

Many colleges and universities have implemented a mixture of cooperative learning, collaborative learning, and guided discovery on a wide scale. Treisman's (1986) Honors Workshop model is present on several UC campuses and now is at the University of Texas, Austin, where Treisman is on the faculty. Davidson, Reynolds, and Rogers (2001) cite Piedmont College (Georgia), Cardinal Stritch University (Wisconsin), Ursinus College (Pennsylvania) and Purdue University (Indiana) as just a few schools which influenced and were influenced by Project CLUME.

The largest program was at the University of Michigan. Since 1997, all freshman calculus classes have been taught using homework teams and a textbook designed on guided discovery principles. The emphasis of the textbook was on writing about and communication of the material, thus addressing the issue raised by Levy and Murnane (2004) of expert thinking and complex communication.

A large website was dedicated to all aspects of the Michigan program, from general information on cooperative behavior, roles, and the team approach, to an instructor's guide that includes answers to the most common complaints of students and instructors. A common complaint from teachers who have not taught the class yet is, again, the issue of coverage of material. However, as one calculus professor stated at the midterm, "I am two weeks behind, but my students are two weeks ahead" (University of Michigan Math Website, 1997). Though he could not cover as much material as he had in the past, his students were learning in more depth, understanding better, and retaining the material.

Student complaints cover freeloading, unfairness of common grades, the time allocation necessary and the perception that the teacher is not teaching. The Michigan Math Department's response to the freeloader question is two-fold. First, they tell the instructors to "point out that when they go to work in the real world, their performance will be judged on how the group works." (University of Michigan Math Website, 1997) Apparently, individual accountability is not used as a freeloader deterrent. Michigan's second solution was for the group to remove the freeloader's name for assignments to which they have not contributed. Neither solution seems well suited to the high school level, particularly in an Ignatian setting.

Summary of Collaborative Learning and Guided Discovery

Collaborative learning and guided discovery are two small group processes that developed alongside cooperative learning in the past 35 years. Both are less structured and require greater maturity on the part of the students. Collaboration is more of a philosophy or style and is very process oriented, whereas cooperative learning is

considered more product-oriented. The debate continues within the mathematical community as to whether guided discovery is process- or product-oriented. Either way, it is a task-centered activity, where cooperative learning is built around structure.

The principles of cooperative learning are being adapted to the university level and they seem to be gaining a foothold in math. Despite massive amounts of research in the field of cooperative learning, a relatively small amount deals specifically with university level math. In order to gain a better understanding in a less researched area such as this, the tools of meta-analysis need to be brought to bear.

Review of Research Literature Concerning Cooperative Learning

Research on cooperative learning falls into one of two categories: theoretical studies or demonstrational studies. Theoretical studies are scientific literature designed and implemented in either a laboratory or a field experiment to validate a particular theory. Demonstrational studies are professional literature comprised of quasi-experimental or correlational field studies. While theoretical studies have high internal validity, they tend to lack credibility among practitioners because they often take place in a lab setting and use college students as subjects. Although they clarify the potential of cooperative learning, they do not, in fact, demonstrate that cooperative learning can work in the "real world." Demonstrational studies, on the other hand, tend to focus on external validity and provide clear models for teachers, but, according to Johnson, Johnson, and Smith (1998), they have at least five drawbacks. First, these studies are situational and may not be generalizable. Second, they have a danger of being biased by the professional, or even financial, needs of the researcher. Third, what is labeled cooperative learning often is not. Some of the methods confound cooperation with

competition (TGT and STAD) or cooperation with individualism (Jigsaw and TAI). It is difficult to separate out the effectiveness of each element. Fourth, demonstration studies often lack methodological rigor. Finally, most of these studies were conducted in elementary or middle schools and few at the secondary or college level. This reduces their relevance to the secondary or college level (Johnson, Johnson, & Smith, 1998).

The large quantity of studies in this field makes meta-analysis an appropriate tool. A meta-analysis is a quantitative review of the literature. The procedure is a statistical analysis of effect sizes and aspects of the study that are applied to large numbers of studies available in a particular field. When studies vary in levels of quality, the technique seeks to include all studies available and replace statistical significance with strength of relationship (Glass, 2000). Glass (1977) developed the technique to apply to the research in the field of psychotherapy. His research and his development of meta-analysis was in reaction to what he perceived as an arbitrary discounting of various studies, leaving the inclusion of a few that led to a specific conclusion.

The main statistic used in meta-analysis is the effect size (ES). ES is calculated by dividing the difference of the experimental and control means by the pooled standard deviation. Cohen (1988) interpreted ES as small (d = 0.2), medium (d = 0.5) and large (d=0.8). Another way that effect sizes can be thought of is as the average percentile that the treatment mean would stand relative to the control mean. In other words, if the mean of the treatment group were a score in the control group distribution, the ES would relate to the percentile where that treatment mean would fall in the distribution. For example, effect sizes of d = 0.5 would be at the 69^{th} percentile of the control, d = 0.8 is at the 79^{th} and d = 1.7 is as 95.5 compared to the untreated groups (Becker, 2000).

The criticisms of meta-analysis were two-fold. First, since the studies may be varied, the meta-analysis may be comparing "apples and oranges." Glass actually found this to be a strength, because it took into account wider and divergent views of the topic under study. Second, in 1982, Cronbach voiced the concern that one-parameter scaling (effect sizing) over-simplifies the topic (Glass, 2000). Glass (2000) admitted that meta-analysis only gave the "big fact" and further digging was needed to tease out particular details. Since the advent of the Internet, data sets have become more readily available to any researchers who wish to plumb more deeply.

Despite the concerns about the demonstrational studies, meta-analysis has become a widely accepted technique for summarizing studies and exploring relationships. In 1981, Johnson and Johnson performed the first meta-analysis on cooperative learning. There have been several since, including an updating of Johnson and Johnson (1989), which is in progress.

Cooperation and Competition: Theory and Research

The explosion of cooperative learning research in the 1970s and 1980s necessitated a comprehensive study in the field and the advent of Glass's (1977) meta-analysis process provided a tool for such a study. Johnson and Johnson (1989) began such a study immediately, in 1977, and worked for 12 years to complete it. A revision, which includes the research of the past 17 years, is in progress.

The meta-analysis of Johnson and Johnson (1989) included 550 experimental and 100 correlational studies from all over the world between 1898 and 1989. Over 1,000 articles were considered and there were four criteria for inclusion. First, an included study had to deal with the relationship between social interdependence and the dependent

variables: (a) achievement, (b) interpersonal attraction, (c) social support, or (d) self-esteem. Johnson and Johnson (1989) stated that, while hundreds of studies with behavior as dependent variables had been done and were valuable, they were not included in this study. Second, an included study must contain measurements of the dependent variables. Third, an included study must have a control group or make a pre-test/post-test comparison. Finally, an included study must be written and summarized in English. This last criterion resulted in 94% of the studies coming from North America. Over half of the studies were conducted between 1980 and 1989.

The studies included were reviewed and coded at least three times over a 12-year period by many professors and graduate students. There were eleven primary judges, and an interrater reliability of 94% was achieved. Three methods of meta-analysis were employed: (a) the voting method, (b) the effect size method, and (c) the z-score method. The findings of each study had an associated effect size calculated. No total number of effect sizes was given. However, the findings were weighted inversely to the number of findings in that particular study to control for possible bias toward multiple-finding studies. Sample sizes of the studies ranged from three to 1,145, so each effect size was adjusted using the Hedges and Olkin (1985) method to correct for differences in variance. For each dependent variable, effect sizes were tested for homogeneity and found homogenous.

The included studies were categorized as “High Quality,” “Pure Operationalizations,” and/or “Mixed Operationalizations.” Mixed operationalization studies are characterized by a mixture of cooperation, individualism and competition. For example, a study might set up cooperative learning groups, but have inter-group

competition. Pure operationalization research studies isolate the particular teaching modalities. Table 2 summarizes the calculated mean ES values.

Table 2
Mean Effect Sizes for Social Interdependence

Conditions	Achievement	Interpersonal Attraction	Social Support	Self-Esteem
Total studies				
CL vs. Comp	0.67	0.67	0.62	0.58
CL vs. Ind	0.64	0.60	0.70	0.44
Comp vs. Ind	0.30	0.08	-0.13	-0.23
High quality studies				
CL vs. Comp	0.88	0.82	0.83	0.67
CL vs. Ind	0.61	0.62	0.72	0.45
Comp vs. Ind	0.07	0.27	-0.13	-0.25
Pure				
CL vs. Comp	0.71	0.79	0.73	0.74
CL vs. Ind	0.65	0.66	0.77	0.51
Mixed				
CL vs. Comp	0.40	0.46	0.45	0.33
CL vs. Ind	0.42	0.36	0.02	0.22

Note: CL= cooperation, Comp = competition and Ind = Individualistic. (Johnson, Johnson, & Smith, 1998, A:12)

The ES values of cooperation versus individualism and competition ranged from .44 to .67, respectively. According to Becker (2000), an ES of .67 would indicate that cooperation is associated with a 26 percentile-point increase for cooperation over competition and .44 would be a 17 percentile-point increase over individualism. In the high-quality studies, the ES were even higher. The numbers indicated that cooperation may be superior to competition or individualistic learning in many circumstances. The separation of pure and mixed operationalizations shows that the effect sizes are higher for pure studies than mixed operationalization studies. The studies consistently showed higher achievement and greater retentions with cooperative learning, as well as higher levels of transfer, positive attitudes and time on task. Further analysis revealed that the

results held constant when assessment was included with individual scores, whether short-term or long-term studies were viewed, and when symbolic as well as tangible rewards were used (Johnson, Johnson, & Smith, 1998).

Though these studies were not concerned with Ignatian education as a distinct pedagogy, this meta-study did consider social support as it relates to teacher-student and peer relationships. Relationships are at the heart of Ignatian education. There were 199 studies using social support as the dependent variable and four factors were considered: (a) teacher's task support, (b) teacher's personal support, (c) peers' task support, and (d) peers' personal support. The ES related to both teacher task and personal support were moderately small, ranging from 0.21 to 0.33. Peer support was stronger, ranging from 0.37 to 0.45. In both personal support areas, the effect of cooperation versus individualistic was higher than the effect of cooperation versus competitive (Johnson & Johnson, 1989).

This study is an example of why meta-analysis is vital. Though the 199 studies covered age groups from 1st grade to adult, only six of the studies were on 10th to 12th grade subjects in mathematics. Johnson and Johnson (1982) dealt with handicapped students. Sawiris (1966) dealt with geometry and was conducted before most of the seminal work on cooperative learning was done. Rabbie and Wilkens (1971) concentrated on inter-group competition. Nevin, Polewski, and Skieber (1984) applied cooperative learning to a unit on decimals in a class with an abundance of special needs referrals and discipline problem. Sherman and Thomas (1986) applied TGT and STAD strategies in a unit on percentages. Webb (1980) conducted a study in Britain and was

characterized as collaborative, rather than cooperative, learning. None of these studies has direct application to a research study on a secondary school pre-calculus class.

Cooperative Learning Methods: A Meta-Analysis

The meta-analysis of Johnson, Johnson and Stanne (2000) summarized 164 achievement studies that used specific cooperative learning methods, which were conducted from 1970 to 2000. There were four reasons for this meta-analysis. First, while there were many studies supporting one or another method, there had never been a study comparing the relative effectiveness of the different cooperative learning methods. Second, there had never been a comprehensive evaluation of how the methods were tested empirically. Third, there had been no comparison among the studies in the field of achievement. Finally, there had been no comparison among the methods regarding the essential elements nor an attempt to place the methods on a continuum from direct methods, which are easier to learn and implement but harder to maintain and do not adapt well, to conceptual methods, which are harder to learn but are more sustainable, adaptable and robust.

An extensive search of the literature was conducted via computer searches of ERIC, DAI, Psychological Abstracts and SSCI, examining relevant bibliographies and reference sections, and contacting various researchers and organizations. Over 900 studies of social interdependence were located. The criteria for inclusion were that the study researched a specific method and that the dependent variable was achievement. 164 studies met the criteria, but, due to overlap, this was reduced to 158 reports. The studies yielded 194 effect sizes. Eight of the ten methods of cooperative learning were

represented. Kagan's (1992) Structures and Cohen's (1985) Complex Instruction were not represented among the literature that met the criteria.

The included studies covered a wide range of ages, ethnic background, and culture. The level of subjects ranged from primary school to adult education, though 46% of the studies were conducted at the elementary level and 26% in middle school. Geographically, the studies were conducted in North America, Europe, Asia, Africa, and the Middle East.

Active Learning (AL) had the strongest effect at 0.85 for cooperation vs. competition and 1.04 for cooperation vs. individualism. Academic Controversy (AC) was second in both categories. It was notable, though, that these two methods were developed by the researchers and that they represented more than half the studies included in the meta-analysis. Slavin's STAD was third in cooperation versus competition, while Sharan and Sharan's (1976) Group Instruction (GI) was third in cooperation versus individualism. DeVries and Edwards' (1973) Teams-Games-Tournaments came in fourth in both categories. Table 3 summarizes the results.

The researchers acknowledged a potential source of bias in that only studies with statistically significant results were published and available for review. This file drawer problem may have been adjusted for by Orwin's (1983) procedure, which assumed that studies left unpublished in a file drawer somewhere have an effect size of zero and then the number of studies needed to change the results of the meta-analysis is calculated. There were 18 mean effect sizes calculated between cooperation versus competition, cooperation versus individualism and competition versus individualism in the various

methods and a "fail-safe" value was determined that represented the number of file drawer studies that would

Table 3
Ranking, by Effect Size, of Cooperative Learning Methods

Method	ES of Coop vs. Comp	n	Method	ES of Coop vs. Indiv	n
AL	0.85	26	AL	1.04	57
AC	0.67	19	AC	0.91	11
STAD	0.51	15	GI	0.62	1
TGT	0.80	9	TGT	0.58	5
GI	0.37	2	TAI	0.33	8
Jigsaw	0.29	9	STAD	0.29	14
TAI	0.25	7	CIRC	0.18	1
CIRC	0.18	7	Jigsaw	0.13	5

Note: Coop = cooperation, Comp = competition and Indiv = Individualistic. (from Johnson, Johnson, & Stanne, 2000, p. 9)

reduce that ES to below the .2 level. All the TAI and CIRC mean ES values were already below the .2 level and had a fail-safe of zero. Of the 18 fail-safe values, only six were in double digits and one (AL cooperation versus individualism) was in triple digits, at 200. This last mean ES had the highest number of averaged effect sizes at 56, more than triple all the other values but one (Johnson, Johnson, & Stanne, 2000).

Another concern about meta-analysis was that effect sizes are sensitive to a variety of extraneous variables. The specific task, the level of critical thinking, or the quality with which each method was implemented may have changed the results of the individual study. Meta-analysis summarized the effects of a group of studies, but did not

draw conclusions about specific ones. The researchers sought not to imply the superiority of one method over another by claiming that all the methods had substantial effect sizes and all found cooperation to produce significantly higher achievement than competition and individualism. Johnson, Johnson, and Stanne (2000) stated that teachers should feel confident and comfortable with any of the eight methods.

In addition to comparing achievement effect sizes (ES), the cooperative learning methods in the Johnson, Johnson, and Stanne (2000) study were each coded by two or more psychology professors as to (a) ease of learning the method, (b) ease of initial use in the classroom, (c) ease of long-term maintenance, (d) robustness of method (that is, applicability to a wide variety of subjects and grade levels), and (e) adaptability. Kagan's (1992) Structures and Cohen's (1985) Complex Instruction were included in this part of the study, since inclusion in the literature was not required. The coding used a five-point scale on each category with an overall rating out of 25. The interrater reliability kappa was 0.82.

This coding attempted to place the methods on a continuum of approaches from most direct to most conceptual. AL had the highest conceptual score (with the maximum points of 25), followed closely by Academic Controversy, Complex Instruction and Group Instruction in that order. TAI and CIRC had the lowest score at seven, with KS at nine. The authors noted that the more conceptual the approach, the higher the ES on achievement (Johnson, Johnson, & Stanne, 2000).

Johnson, Johnson, and Stanne (2000) concluded that the results were valid and generalizable, and the authors were confident that the effectiveness of cooperative learning had been demonstrated. They expressed surprise that some of the methods had

so little empirical validation or evaluation. The authors noted that all the methods had substantial enough effect sizes for teachers to be comfortable using any of them. Finally, though further research was deemed necessary to corroborate this claim, the authors determined that the more conceptual the method, the stronger the effect on achievement (Johnson, Johnson, & Stanne, 2000).

Classroom Instruction That Works

Marzano (1998) conducted a meta-analysis of over 100 research reports on instruction to find the strategies that have high probability of enhancing student achievement at all levels and in all subjects. This study was about general instruction and not specifically about cooperative learning and was a meta-analysis of meta-analyses. Studies included were to be found in three sources. One source was the Fraser, Walberg, Welch, and Hattie (1987) database, which included 135 studies. Only those studies which had a dependent variable that was alterable by the teacher were included. Further studies were found by an ERIC search for "meta-analysis." Finally, a journal search of the Review of Educational Research and the Review of Research in Education over the past 25 years was conducted.

The Marzano (1998) study ultimately utilized 4,057 effect sizes from over 500 studies and involved over 1.2 million subjects. To control for dominance of studies with multiple ES, the less-robust Haller, Child, and Walberg (1988) method was used, wherein each included study was assigned a weight of one and each ES received a portion of that one. For example, if a study yielded 20 effect sizes, each was weighted 1/20.

Marzano, Pickering, and Pollock (2001) summarized, for popular use, the findings of Marzano (1998). Nine strategies that had significant mean effect sizes were outlined:

(a) identifying similarities and differences, (b) summarizing and note-taking, (c) reinforcing effort, (d) homework and practice, (e) nonlinguistic representations, (f) cooperative learning, (g) setting objectives and providing feedback, (h) generating and testing hypotheses, and (i) cues, questions, and advanced organizers. The learning technique dubbed "identifying similarities and differences," sometimes known as "compare and contrast," had the strongest effect, with an ES of 1.61 and associated percentile gain of 45, from 50 to 95. Cooperative learning ranked 6th among the nine strategies (Brabec, Fisher, & Pitler, 2004).

Three aspects of cooperative learning were specifically investigated: (a) general studies relating cooperative learning to achievement, (b) studies on homogeneous versus heterogeneous grouping, and (c) studies of group size. The effect of cooperative learning on attitude was not part of this study. The investigation of cooperative learning centered on nine synthesis studies, five of which were general studies and four of which focused on ability grouping and group size.

In their study of general cooperative learning research, Marzano et al. (2001) cited five synthesis studies in particular: (a) Walberg (1999), (b) Lipsey and Wilson (1993), (c) Schreerens and Bosker (1997), (d) Hall (1989) and (e) Johnson and Johnson (1981). These studies together yielded over 700 ES values. The average effect size was .73, which is an associated percentile gain of 27 percentile points to the 77th percentile. Approximately 200 effect sizes were drawn between cooperation and inter-group competition, individual competition, and individual student tasks. There was no difference between cooperation and inter-group competition (d =.0), but the ES between

cooperation and both individual competition and individual student tasks was significant at d=.78.

Marzano et al. (2001) investigated homogeneous versus heterogeneous grouping methods. Here they reported the results of four synthesis studies by (a) Slavin (1987), (b) Kulik and Kulik (1987), (c) Kulik and Kulik (1991), and (d) Lou, Abrami, Spencer, Chambers, Poulsen, and d'Apollonia (1996), which yielded 136 ES. In particular, they looked at the effects of homogeneous versus heterogeneous grouping for cooperative learning on students in three levels of ability. For low ability subjects, the ES was -.60, for middle ability, it was .51, and for high ability, it was .09. Grouping by ability appeared to have a large negative result for low ability students, causing as much as a 20-point difference in percentile scores, while it had little to no effect on high ability students. Only the middle group appeared to be served by this kind of grouping (Marzano, Pickering, & Pollock, 2001).

Lou et al. (1996) also looked at the ES values which were calculated for various sized groups. Pairs had an ES of .15 (n = 13). For trios or quartets, the ES was .22 (n = 38), and, for groups of five to seven, the ES was -.02 (n = 17). The ES are fairly small, as are the number of studies involved, but it would appear that groups of three or four would be the most effective (Marzano, Pickering, & Pollock, 2001).

Marzano et al. (2001) arrived at three conclusions. First, organizing groups based on ability should be done sparingly. Homogeneous groupings appear to be detrimental to low ability students. Second, cooperative groups should be kept to a relatively small size. Teams of three or four members seem to be the most effective. Third, cooperative learning should be applied consistently and systematically, but not overused. Teachers

must be careful not to use cooperative learning so often as to provide an insufficient amount of time for students to practice skills and processes independently (Marzano, Pickering, & Pollock, 2001).

Measuring the Success of Small-Group Learning in College-Level Science, Math, Engineering, and Technology Teaching: A Meta-Analysis

The meta-analysis by Springer, Stanne, and Donovan (1998) examined research on small group instruction that specifically pertained to science, math, engineering and technology (SMET). It was sponsored by the National Institute for Science Education (NISE). Of the 383 reports on small group learning in SMET from 1980 to 1998 that were found, only 39 qualified for this meta-analysis based on five criteria. The studies had to (a) involve SMET in postgraduate studies in North America, (b) include small group work in or outside the classroom, (c) be published during or after 1980, (d) take place in an actual classroom or under controlled laboratory conditions, and (e) report enough statistical data to estimate ES. Of the 39 studies, 37 presented data on achievement, nine on persistence or retention and eleven on attitudes. Table 4 provides some selected results.

The studies were coded by one analyst who had extensive experience in coding and analyzing research in small group learning. Two additional analysts independently checked the coding and differences were resolved through consensus.

The ES of cooperation versus competition for achievement, favorable attitude, and persistence were all medium. For achievement, $d = 0.51$ represents a 19 percentile-point advantage. For favorable attitude, $d = 0.55$ represents a 21-point advantage. For persistence, $d = 0.46$ represents an 18-point advantage. When looking at heterogeneous versus homogeneous grouping by gender, the difference in ES was .16, which is not

Table 4.
Selected Effect Sizes from the SMET Study

Study	ES on Achievement	ES on Attitude	ES on Persistence
Cooperation vs. Competition	0.51	0.55	0.46
Mostly Female Grouping	0.39	0.72	n/a
Heterogeneous Gender Grouping	0.55	0.44	n/a
Minority Grouping	0.72	n/a	n/a
Primarily Caucasian Grouping	0.46	n/a	n/a
Heterogeneous Grouping by Race	0.42	n/a	n/a

Note: From Springer, Stanne, and Donovan (1998).

significant, but there was a significant benefit in attitudes for female groups. Unfortunately, this difference was due primarily to the results of one study. The positive effect on achievement was significantly higher for minorities (d = 0.72) compared to predominantly white (d = 0.46) or heterogeneous (d = 0.42) groups (Springer et al., 1998).

There were two interesting characteristics of the attitude data. First, the effects varied by field of study. ES values were much higher in the science field (d = 0.87) as compared to allied health (d = .06), math (d = .04) and engineering (d = 0.25). Second, though it should not have been surprising, there was evidence of publication bias. Studies published in journals noted stronger effects (d = 0.77) than those published elsewhere (d = 0.42) (Springer et al., 1998).

The authors came to three main conclusions. The results indicated that small group learning is effective in college SMET and would support widespread implementation. The main effect on achievement was particularly robust as 29 independent samples reporting zero effect sizes would have been needed to lower the average from 0.51 to 0.31. The primary challenge is to move from analysis to implementation (Springer et al., 1998).

In a commentary on the NISE study, Cooper and Robinson (1999) noted that, although the number of studies in this field has greatly increased between 1987 and 1995, the numbers are still small. Most of them were in math. Of the 699 cooperative learning in higher education reports found by Cooper and Robinson (1999) in the ERIC database for the period 1992 to 1996, only 58 citations were of math studies. In contrast, eleven were in chemistry, 12 in physics, 13 in biology and 19 in engineering. Therefore, the research field of SMET and cooperative learning is promising, but relatively immature (Cooper & Robinson, 1999).

Summary of the Research Literature

These four meta-analyses demonstrated the power of cooperative learning in general and in the math and science fields specifically. The effects were strong and consistent across the studies, despite the variety of methods and approaches employed. Effect sizes on achievement ranged from .51 to .88, while those on social support ranged from .62 to.83. The effect size on attitude in SMET was .51.

There is more research to be done, especially at the college preparatory level and in higher education. Though the volume of studies is impressive, the majority of it comes from the elementary and middle school levels. In the Johnson and Johnson (1989) study,

only 32 of the 650 studies were from secondary schools, and, of those, only eight were in math. Only thirteen of the 193 undergraduate studies involved math. Of the 158 studies in the Johnson, Johnson and Stanne (2000) meta-analysis, only 17 were at the high school level.

Some of the methodology was suspect because of the wide range of researchers' abilities. There is a dearth of subject-specific studies in the sciences. Math has a larger body of research available, but Cooper and Robinson (1999) claimed questions regarding how faculty can embrace a paradigm shift in how they view the acquisition of knowledge, assessment, the nature of the student-teacher relationship, and content-coverage remain unanswered for the moment.

Summary of the Literature Review

Cooperative learning, as described and defined by Johnson, Johnson and Smith's (1998) Active Learning (AL), is a complex and intricate undertaking. The five essential elements ((a) positive interdependence, (b) individual accountability, (c) face-to-face promotive interaction, (d) small group social skills, and (e) group processing) need to be carefully designed and supported by the teacher (Figure 1). More than 18 instructional decisions by the teacher need to be made before the cooperative experience can begin. The teacher must be an active member of each group, as well as an evaluator, during the process.

There are other systems of cooperative learning besides AL. They range from highly conceptual to very direct and practical. All include the face-to-face element and most include positive interdependence and individual accountability. Few include group processing and the social skills vary from one to the next. Some of the systems mix their

operationalizations, combining within group cooperation and between group competition. All the systems demonstrated achievement gains, though of varying levels.

Collaborative learning and guided discovery are two other forms of social interdependence that use small groups to enhance learning. They differ from cooperative learning in that collaborative learning is less structured than cooperative learning and relies on the maturity of the students rather than the teacher's design of the process to drive the interdependence. Guided discovery relies on the subject material to establish the interdependence. Guided discovery and cooperative learning are often intermingled in mathematics.

A great deal of research into cooperative learning has been conducted in the latter half of the past century. These numerous studies may be categorized into three broad areas: (a) effort to achieve, (b) positive relationships, and (c) psychological health. This review concentrated on the research into the dependent variables in question, namely achievement, attitude, and social support. Despite the range of quality represented among the studies, the effect sizes for achievement and social support were consistently high. ES of .73 and .67 on achievement indicated that cooperative learning may yield a gain of as much as 27 percentile points over competition or individualism. Social support ES showed comparable, though slightly lower, gains. Studies in which cooperation and competition were mixed showed lower ES in both areas than when cooperation and competition were not confounded. Attitude ES from the NISE study in the science and math fields showed a moderate gain, but most of that occurred in the science field. The ES on attitude in math was not significant.

Though cooperative learning has been demonstrated to be effective in a variety of areas, the field of secondary mathematics is in need of more research. There is a limited amount of research in this particular context and much of what there has been confounds cooperative learning with guided discovery.

None of the research found in the literature was conducted in Jesuit schools. The quasi-experimental methodology, which will be further explained in the next chapter, was chosen in an attempt to make a valuable contribution in this area.

CHAPTER IV

METHODOLOGY

Restatement of the Purpose of the Study

This study sought to explore four issues: (a) the existence of the freeloader and sucker effects among higher achieving students, (b) the potential of for changing students' attitudes toward group work, (c) the potential of interconnectedness (or at least coexistence) between Ignatian pedagogy and cooperative learning, and (d) achievement of knowledge acquisition in the realm of introductory calculus material through cooperative learning.

The underlying premise of this study was that a careful design and implementation of Johnson, Johnson and Smith's (1998) Active Learning (AL) principles might positively affect both the students' attitudes toward group work in general and their ability to successfully attain understanding of complex mathematical material. There is little research at the college preparatory level of math, though, and even less research takes Ignatian education into account. This study sought to add to the body of literature in this area.

Research Design

A quasi-experimental design was employed in this research study. The sample consisted of four classes: (a) two PreCalculus A classes taught by Teacher A, and (b) two Honors PreCalculus B classes taught by Teacher B. One PreCalculus A and one Honors PreCalculus B class served as the control group, while the other two classes served as the treatment group. Thus, each teacher used both AL and traditional pedagogies.

The treatment was assigned randomly to the groups by the researcher. The treatment group was taught four units of material (divided into 23 sections), including: (a) trigonometric identities, (b) solving trigonometric equations, (c) introductory analytic geometry and (d) introductory calculus topics in the context of graphing polynomials. The school has a rotating schedule during which each class meets four days per week. Given vacations, midterm and final exams and other special schedules, the duration of the study was approximately four months, from mid-October to mid-February. The Honors PreCalculus B classes started sooner than the PreCalculus A classes and took less time to finish the three units of study. These classes were subdivided into Base Groups of three to four students each. They experienced the material through short lecture, group identity building and processing, shared note-taking, group homework and board presentations, and group test preparation.

The control groups were be taught the same material in a traditional individualistic format. This included: extended lectures, individual seat-work and board presentations, and individual test preparation. The same tests and quizzes were administered to both control and treatment groups.

The first dependent variable was the student' perceptions regarding their own freeloading. It was measured pre-treatment by a shortened version of the *Classroom Life Instrument* (CLI). The 90 items on the CLI were pared down to 48 items and twelve items designed by the researcher regarding Ignatian education, *cura personalis* and past experience with group work and freeloading were added. This version of the instrument was administered as the pre-test and as the post-test in this research study.

The second dependent variable was attitude toward cooperation, individualism and competition. It was measured by 22 of the items on the CLI which are associated with attitudes toward competition, individualism and cooperation (Appendix E).

The third dependent variable was students' perceptions of *cura personalis,* Ignatian education, the student's perceptions of his or her relationship with the teacher, and the student's perceptions of his or her relationship with his or her peers. These perceptions were measured by 26 items on the CLI which were associated with student-teacher and student-student relationships, as well as the additional Ignatian questions (Appendix E).

The fourth dependent variable was achievement, which was measured by a twelve-item unit test designed by the researcher. Academic data were gathered as potential covariates on achievement. Achievement was measured on the fourth and final unit of material, the introductory calculus unit. The questions ranged from items on knowledge to synthesis and explanation regarding the topics of limits, basic derivatives, the Power Rule, extrema, sketching of functions, and interpreting graphs.

Certain demographic data was gathered, including: (a) gender, (b) ethnicity, (c) algebra GPA, (d) overall GPA, (e) PSAT scores in math, (f) PLAN scores in math, (g) motivation as rated by two previous math teachers, (h) previous algebra course and (i) fall midterm exam grade. These were analyzed through linear regression in order to establish equivalence between the control and treatment groups and to determine which, if any, independent variables might need to be controlled when performing ANCOVA on the dependent variables.

The duration of the study was approximately four months. The administration of the CLI as a pre-test occurred in mid-October, after midterm exams. The CLI post-test and introductory calculus unit test were administered after each class had covered the material.

Student Sample

This study used a convenience sample of 114 students at a coed, Jesuit high school in California, with an enrollment of 1,410 students. One student's parents chose not to have their daughter participate. A second student transferred from PreCalculus B to a PreCalculus A section that was not involved in this study. The researcher's daughter was in one of the classes to which treatment was randomly assigned; therefore, she was excluded from the study. Finally, one student in PreCalculus B was a freshman and much of the academic data used to describe similarities between the control and treatment groups (such as PSAT, PLAN and previous teachers' motivation ratings) were not available for him. This reduced the sample size to 110.

The school ethnic demographics mirrored that of the San Francisco Bay Area, with 57% white, 12% Pacific Islander, 10% Asian, 10% Hispanic, 6% African American, and 5% other. Half the school's population resided in San Francisco County, one-third in San Mateo County, a tenth from Marin County and the remainder in the East Bay. The religious composition reflected that 75% of the students wre Catholic, 15% other Christian and 10% non-Christian. Socio-economic data was not available, other than the fact that 20% of the student population received some form of financial aid.

The students participating in this study were enrolled in two of the three levels of PreCalculus offered at the school: (a) two classes of non-honors PreCalculus A and (b)

two classes of Honors PreCalculus B. Though no longer designated as an honors class, due to a change in the University of California guidelines, the PreCalculus A was an honors class until last year and remained an accelerated class, meaning these students were still ahead of their peers across the nation but were not at the highest level within this school.

This school has several pathways for a student to follow that result in placement in a pre-calculus course. To be placed into PreCalculus A, students must have taken Algebra 1 Accelerated as freshmen or Algebra 1 as freshmen and an Advanced Algebra summer class to move up to PreCalculus A. This year, and for the first time, some seniors were allowed into PreCalculus A, instead of being placed into a senior (non-honors, non-accelerated) pre-calculus course. There were five seniors in PreCalculus A who took Algebra 1 as freshmen and did not take the summer class, but matured late as mathematicians. They were placed into PreCalculus A instead of the senior PreCalculus class to challenge them.

Students in Honors PreCalculus B would have taken Algebra 2H as freshmen or Algebra 1 Accelerated as freshmen and the Advanced Algebra summer class. Four sophomores were in PreCalculus B, having challenged and passed Geometry by means of a final exam. For only the second time in 25 years, there was a freshman in the Honors PreCalculus B class, who challenged and passed out of both Algebra 2H and Geometry.

Freshmen were placed into one of the three classes based on a placement test, their entrance test scores in quantitative and math skills, and their elementary school GPA. The students in Algebra 1 Accelerated fell into roughly two categories: (a) bright math students who had weak elementary school math preparation, or (b) average math

students with strong elementary preparation. PreCalculus A students take either regular Calculus or AP Calculus AB as seniors. Only on very rare occasions is a student from PreCalculus A allowed into AP Calculus BC. Calculus and AP Calculus AB are equivalent to the first semester of a college calculus course. Honors PreCalculus B students are, however, the best mathematicians in the school. Most of them will take AP Calculus BC, which is equivalent to two semesters of a college calculus course. It was due to all these permutations of pathways to pre-calculus that the demographic "previous algebra course" was gathered.

The demographic and academic data will be presented in Chapter V. Gender, ethnicity, and grade level will be considered, as well as several measures of ability and aptitude.

Teacher Sample

Two teachers were involved in this study: (a) a 35-year veteran male teacher who is a former math department chair and business manager, and (b) a fifth-year female teacher. Teacher A taught fulltime for 15 years and served as department chair before moving out of the classroom and into the business office. During each of the 20 years he served as business manager, Teacher A taught one class, including PreCalculus A, Honors PreCalculus B or Algebra 2. He returned to the classroom fulltime two years before this study. He was teaching the two PreCalculus A classes.

Teacher B was a young and enthusiastic female math teacher. Despite having fewer years experience, Teacher B has an MA in mathematics and taught Calculus in a community college. She taught Honors PreCalculus B all five years at this school and

taught AP Calculus BC four times during her career, at this site as well as at another high school.

Though not available for attending a Johnson and Johnson workshop, the teachers were to have read *Active Learning* (Johnson, Johnson, & Smith, 1998) and observed several classes taught by two different teachers who did attend the Cooperative Learning Workshop in 2004 led by Roger Johnson. These two AL-trained teachers, one of whom is the researcher, have taught PreCalculus for a combined 27 years and served as AL trainers for the teachers. These trainers observed the classes bi-weekly through the first three units of study. During the fourth unit, which is the Introductory Calculus unit in which the achievement data was gathered, the trainers observed once per week. The two teachers observed the trainers once each as part of the school's peer observation program.

Instrumentation

Two instruments were be used in this study. The instrument used to measure attitude was the *Classroom Life Instrument* (CLI). The instrument used to measure achievement was a teacher-designed unit test.

Classroom Life Instrument

The Cooperative Learning Center, University of Minnesota, developed the *Classroom Life Instrument* (CLI), which was used to measure attitudes. The instrument has 90 questions on 17 factors, as shown in Appendix E. Roger Johnson stated that this instrument was too long and had too many factors for a dissertation. He suggested that three or four factors be used. Given the purpose of the study and the research questions, the questionnaire was reduced to 48 questions on eight factors (Appendix D). An

additional 12 questions were added to measure freeloader effects, sucker effect, and the students' understanding of Ignatian education.

Factors 1 and 2 involved the student's perception of the student-teacher relationship and will be used to measure the aspects of Ignatian education. Factors 3 and 4 related to the community aspect of the classroom. Factor 6 (fairness of grading) related to the students' personal sense of the freeloader effect. Factors 5, 7, and 8 measured the level of student comfort with cooperative, individualistic, and competitive learning, respectively. While the other factors of the full CLI might have been worth studying, the CLI was too long. The omitted factors did not address the research questions in this study.

The additional 12 questions fell into three factors. Four measured whether the subject considered himself or herself a freeloader. Four measured the subject's feelings about being freeloaded upon. Four questions (Ignatian Factor) were designed to measure the students' understanding and experience of *cura personalis* and its effect on their learning.

Reliability and Validity

SPSS was employed to estimate Cronbach's alpha for the modified version of the CLI used in this study. There were two reasons for this. First, though the reliability for twelve of the factors in the instrument had been established by Johnson, Johnson, Buckman, and Richards (1985), the present version of the CLI had not been fully developed before that study. The four student-teacher relationship factors and the cooperative factor were among those twelve, but the individualistic and competitive

factors were designed later. Second, the sample of that study was from a different population, namely, 7th grade public school students. The sample in this study was sufficiently different to warrant re-establishment of the CLI reliability.

According to Nunnaly (1978) and Vogt (1999), alpha values above .7 suggest that the items in the index measure the same thing. Furthermore, Busk (personal communication, 2005) stated that alpha values above .9 are considered excellent, between .8 and .9 are good, between .7 and .8 are acceptable and below .7 are considered poor. Santos (1999) agreed, but added that lower thresholds are sometimes used in literature. On the pre-test of the CLI, Cronbach's alpha was .84, indicating the measures had a good level of reliability and all the factors reached the acceptable level of $.7 < \alpha < .8$, with the exception of the sucker effect factor. The overall post-test Cronbach's alpha increased to .87. Most of the factors involving student-teacher relationships and peer relationships showed an increase in reliability. The sucker effect factor improved its reliability into the acceptable range at .7, while the freeloader effect factor reliability fell to the poor range for the post-test. Reasons for this drop will be explored in Chapter V. Table 5 shows the reliability alphas obtained.

According to Johnson, Johnson, Buckman, and Richards (1985), validity for this instrument was established "through theory and factor analysis." Specific validity panel information was not given in that article. The use of the CLI, in modified form, was recommended by Roger Johnson.

Face, content, and construct validity of the additional 12 questions were established by a panel of seven teachers. The panel members received a packet including a cover letter, definitions of the three factors covered by the questions, and an evaluation

form (Appendix E). All twelve items were approved by 70% of the panel. Two members were concerned that item #55 ("When working in groups in the past, I have withheld my help or effort from the group because I considered the situation unfair") measured the results of the sucker effect, rather than the feeling itself. In fact, this item did reduce the pre-test reliability alpha on the sucker factor by .07. The sucker factor had the weakest

Table 5.
Cronbach Alpha Reliability Estimates of the Modified Classroom Life Instrument

Factor	Question Number	Pre-test alpha	Post-test alpha
Overall	all	.84	.87
Cooperation	27, 35, 37, 40, 41, 43, 46	.85	.83
Individualistic Learning	4, 6, 13, 19, 28, 29, 34, 39, 44, 45, 47	.78	.73
Competitive Learning	30, 31, 32, 33, 36, 38, 42, 48	.84	.83
Teacher Academic Support	11, 14, 18, 21	.79	.83
Teacher Personal Support	5, 7, 22, 24	.79	.83
Fairness of Grading	8, 17, 23, 25, 26	.79	.79
Ignatian Factor	49, 50, 53, 56	.70	.71
Student Academic Support	1, 2, 9, 12	.72	.79
Student Personal Support	3, 10, 15, 16, 20	.79	.85
Freeloader Effect Factor	52, 58, 59, 60	.70	.62
Sucker Effect Factor	51, 54, 55, 57	.63	.70

pre-test reliability and the freeloader effect had the weakest post-test reliability of all the factors on the CLI. Conclusions based on this bear careful consideration.

It was also noted that reliability alphas on both the sucker and freeloader factors were higher for the PreCalculus A classes than the PreCalculus B classes when their responses were considered separately. These data will be disaggregated for further consideration in Chapter V.

The Introductory Calculus Unit Test

As with previous tests that the students had experienced, the Introductory Calculus Unit (ICU) test was be a two-part test. The first half was be comprised of six questions wherein calculators were allowed. The second half was include six non-calculator questions, the last two of which are synthesis questions about the relationship between a polynomial function and its graph. Two of the questions on the calculator part were foundational to these last two questions.

There were three versions of the test. The first was a practice test based on the previous year's test. It was in the textbook and solutions were available online. This version will be used for the test preparation classes. The second was the test that was used for data collection. The third was used for retest purposes, in the case of absent students or students who did not pass the first time. Data from retests were not be used as part of this research study.

Reliability and Validity

Test-retest reliability would not have been practical in this case. Internal reliability was established as CLI reliability was established, by calculating Cronbach's

alpha on the data gathered. Alpha value for the test scores was .81. When the data were disaggregated by ability level, the test scores proved to have a higher reliability alpha for the higher level course. The PreCalculus B reliability alpha was .84 and the PreCalculus A alpha was .76. There was no difference in reliability between control and treatment group scores.

Face, content, and construct validity were established by a panel of nine math teachers. All panel members had experience teaching pre-calculus or calculus at the high school level (Appendix E). All panel members received a packet including a cover letter, a topic/objective list for the unit, three alternate versions of the test, a scoring rubric for Form B (which were the form used in this study) and an evaluation form. Items receiving an approval rating of 80% were included in the test.

All but one item received 80% approval. Three panel members thought that questions 11 and 12 were redundant. Question 11 was reversed, that is, the graph was given and the question were to find the traits and the equation. This also covered the panel member's concern over the arithmetic rigor of finding $y\left(\frac{8}{3}\right)$ without a calculator.

Other questions raised were answered by the context within which the ICU was set. Knowing the topics and seeing the tests for the preceding and succeeding units relieved concerns about vocabulary and formatting.

Most of the panel members finished the test in less than 25 minutes. Among math teachers, the rule-of-thumb is that the students should get three times the amount of time a teacher takes to finish the answer key. Most panel members felt that, had they taught the unit and were immersed in the content, they would have finished faster. Therefore, it was determined that the students could be expected to complete the test in the 50 minutes

allowed. The researcher's experience with equivalent forms of the test over the past five years has been that, while the time is tight, almost all students finish the test. In an honors class, which prepares students for a timed Advanced Placement exam, pacing needs to be part of the testing process.

Description of Treatment

During the first quarter, all four classes used traditional lecture and board work instruction, with some informal cooperative learning exercises. After the midterm grading-period, treatment was assigned randomly to one PreCalculus A and Honors PreCalculus B class. The CLI was administered to all four classes.

The two treatment classes established base groups of three or four students. The students with the seven lowest midterm percentages were designated as captains. In random order, the captains drafted the first two members of their group. The remaining, un-drafted students chose which group they would join. Again, the order of choosing was random.

Routines associated with Base Groups, including group identity building and processing, shared notetaking, homework and board presentations, and group test preparation, were established during the learning of the first unit (Trigonometric Identities). All these routines continued for the duration of the study.

There were four Base Group tasks, which followed similar formats. The first was the Trigonometric Identities Unit (TIU), which was generally the most difficult unit of the year. The TIU was used to establish routines and procedures for use in the subsequent three units of material. The topics covered in the second and third units were Solving Trigonometric Equations and Introduction to Polynomials. These units were

used to further instill the Base group routines and establish them as habits. The fourth was the Introductory Calculus Unit. The test scores on the Introductory Calculus Unit (ICU) only were to be gathered for analysis.

Identity Building and Processing

Time must be spent developing group identity and cohesion. Each week began with a five-minute check-in period. During this time, group members re-established communication and community, discussing their weekend briefly, before going on to check homework. The teacher performed a "Five Minute Walk" during this time, looking for personal connection rather than just business and emphasizing the small group social skills.

Some of the identity building occurred through boardwork. The teachers took time to applaud the efforts and encourage celebration of group accomplishments. As the weeks progressed, groups began to sign their board work with a group-name they had chosen. The others were encouraged to do the same.

Homework and Boardwork

Though neither teacher required homework to be turned in for grading, nightly homework was assigned. Often, time was given in class to work on the homework in groups. At the beginning of each class, students were asked to present specific problems on the board. Groups were assigned to write the problem on the board together, and the teacher randomly assigned one member of each group to present the problem formally to the whole class. This was designed to increase the positive interdependence.

Shared Notetaking

Note taking was required in all math classes at this site. Formatting details are part of the syllabi for the PreCalculus classes and are available online (Appendix F). In the treatment classes, the groups used the same formatting but undertook shared note-taking. At the beginning of class each day, one member of each group (the Scribe) turned in his or her notes from the previous day, including a corrected version of the homework based on the board work. Another member of each group (the Corroborator) was required to proof and sign off on the notes. The Corroborator, then, became the Scribe for that day and another Corroborator was chosen. Notes were graded according to each teacher's grading policy (Appendix G), but this data was not gathered as part of this study.

Test Preparation and Review

At the beginning of each chapter, one group was chosen at random to be responsible for that chapter. Their shared notes were to be archived in class and available for use by students who had been absent on any given day. On the day before any unit test, the assigned group ran a review session for the class. They wrote a practice test based on previous years' tests to administer to the groups. The resources were limited to one copy for two students in order to increase the interdependence. The members of the assigned group served as tutors to the other groups during the review session and posted the solutions on the board toward the end of class. Their practice test and solution key served as their shared notes for the day.

Every group submitted a study guide on the review day. The responsibility for writing the guide was rotated among the group and each member would do two reviews

over the course of the year. The guide included vocabulary, key concepts, new formulas, and examples. The guide was to be graded and included in the Participation score alluded to in each teacher's grading policy (Appendix G).

Group Processing

At the end of each week, part of the weekend homework assignment was to discuss how the group process went and what could be done better the next week. Time might be available after the quiz on Day 4, or the group might get in contact electronically or by phone over the weekend. One student from each group (the Reporter) was to write a short paragraph on the topic to turn in on Monday. There was also time each Monday to discuss how the quiz went, how the group could improve performance on subsequent evaluations, and for the Reporter to add to his or her report.

The Trigonometric Identity Unit (TIU)

At the beginning of the second quarter, Teacher B designated the lowest seven students in her treatment class as group captains and the captains determined the groups via a draft. In random order, the captains chose their first group member. In the second round, the order of the first round was reversed. In the third round, the remaining students, in random order, chose the group in which they wished to be. Most groups had four students, though due to class numbers, some had three. Teacher A, at the behest of his students, assigned the students to groups based on equalized ability. That is, he assigned the eight best students to separate groups and built each group around them so as to have a balance of ability in each.

A brief overview of the difference between cooperative learning and traditional group work was delivered, and the class was informed of the various AL activities and

assessments that would occur over the course of the next unit. At the start of the unit, one group would be assigned to be responsible for the review, which would include a review sheet, a practice chapter test with solutions and the running of the review session on Day 11.

The first cooperative learning activity was an investigation of the basic Trigonometric Identities. Worksheet 1 (Appendix H) led to deriving the Quotient and Reciprocal rules. Worksheet 2 (Appendix H) led to the nine versions of the Pythagorean Identities. One copy of Worksheet 1 and one copy of Worksheet 2 were given to each group. Working in pairs, the group completed the worksheets. At the end of 15 minutes, additional copies of the sheets were given to the group and the students paired with different group members to explain their worksheets and have the other student explain his or her worksheet.

The second class began with groups checking in together about homework questions for 10 minutes. Groups were randomly assigned to put answers to the homework on the board and one member of each group was selected to verbally explain the work to the class. The groups reassembled to choose the Scribe and Corroborator for the shared notes to be turned in the next day and to begin the next homework assignment, which was on the same topic.

Day 3 began as Day 2 with groups checking in on homework and presenting board work. The lecture was in-depth, on the Composite Argument topic. The groups broke into pairs and began the homework assignment. The corroborator became the new Scribe and a new Corroborator was assigned. This rotation proceeded throughout the duration of this research study.

Day 4 began with a short group check-in to review the Day One assignment. What followed was a teacher-designed, individual quiz on the basic identities. For the last ten minutes of the quiz, the students in the treatment group were allowed to check-in with their group mates. In the control group, the students were allowed to use their notes during this time. Part of the weekend homework assignment was to meet, call, or email/Instant Message each other to discuss how the group process went and what could be done better the next week. One student from each group was assigned to write a short paragraph on the process to turn in on Monday.

Day 5, Day 6 and Day 7 were similar to Day 3, with the topics being the Double Argument, Half Argument and Sum and Product rules, respectively. Each day began with the groups reviewing the homework and the notes from the previous day, and all signed off on what would be turned in before presenting board work. Day 8 began with group review of the three homework assignments for 10 minutes, followed by an individual quiz on using the Composite, Double Argument, and Half Argument Formulas. Groups were given five minutes at the end of class to check-in with one another.

On Day 9 and Day 10, the class went on to a new unit of material. This was using the trigonometric identities in the context of solving equations. The class was informed that this material would not be on the unit test at the end of the week. The class was reminded that a summary review sheet was due from each group the next day.

On Day 11, five minutes were taken for the members of each group to review the summary sheet and sign off on it. The review sheet was turned in for a grade. The group responsible for this chapter provided a practice test modeled on the previous four years'

tests, which were available online. The groups worked on the practice test while the teachers graded the summary sheets. The summary sheets were returned immediately for use during the practice test.

On Day 12, individual accountability was to be established by an individual test with no checking-in at the end. It was corrected and returned the next day, at which time the groups went over the test among themselves. The groups then discussed the three-week process and decided on three ways to improve. The Collaborator wrote up the conclusions as part of that night's homework.

This three-week process is summarized in Appendix I. The Solving Trigonometric Equations and Introduction to Polynomials units followed a similar schedule.

The Introductory Calculus Unit

The treatment for the Introductory Calculus Unit (ICU) was almost identical to the treatment for the TIU, with a few minor variations. The course material under instruction was an introduction to limits and derivatives, in the context of polynomial graphing. The sequencing and lesson plans are delineated in Table 6. On Day 1, the mathematical meaning of a limit was investigated using the graphing calculator. Days 2 through 12 followed as in the TIU, with the lecture topics being the concept of a derivative as a limit of a secant limit, the Power Rule, critical values, the First Derivative Test, optimization, rectilinear motion, and the synthesis section on sketching Polynomials. The Power Rule was investigated, using Worksheet 3 (Appendix H). The quiz topics were algebraic limits on Day 4 and critical values and the First Derivative Test on Day 8.

Table 6
Lesson Plans for the Introductory Calculus Identity Unit

WEEK 1 Day 1	Day 2	Day 3	Day 4
Group Check-in (5 min)	Group homework Check-in (5 min)	Group homework Check-in (5 min)	Group quiz-prep Check-in (5 min)
Teacher lectures overview of the chapter (5 min)	Board presentations (15 Min)	Groups break into pairs; each pair works on Worksheet 3 (15 minutes)	Individual quiz on Limits (30 min)
Teacher lectures Limits and Indeterminate Forms with examples (25 min)	Teacher lectures Derivative as the slope of a tangent line and examples (15 min)	Groups break into alternative pairs; New partners explain their worksheets (15 min)	
Informal pairs within groups work out new example and class discusses results (10 min)	Informal pairs within groups work out new example and class discusses results (10 min)	Teacher summarizes the Power Rule through class discussion (10 min)	
Groups begin homework together (5 min)	Scribe and corroborator check-in (5 min)	Scribe and corroborator check-in (5 min)	Group check-in on quiz (10 min)
WEEK 2 Day 5	Day 6	Day 7	Day 8
Group quiz and homework Check-in (5 min)	Group homework Check-in (5 min)	Group homework Check-in (5 min)	Group quiz-prep Check-in (10 min)
Board presentations (15 Min)	Board presentations (15 Min)	Board presentations (15 Min)	
Critical Values and Extrema and examples (15 min)	Teacher lectures the First Dx Test and examples (15 min)	Teacher lectures Optimization and examples (15 min)	
Informal pairs within groups work out new example and class discusses results (10 min)	Informal pairs within groups work out new example and class discusses results (10 min)	Informal pairs within groups work out new example and class discusses results (10 min)	Individual quiz on Critical Values and the 1st Dx Test (35 min)

Table 6 (cont.)
Lesson Plans for the Trigonometric Identity Unit.

WEEK 3 Day 9	Day 10	Day 11	Day 12
Group quiz Check-in (5 min)	Group homework Check-in (5 min)	Group homework Check-in on chapter summaries (5 min)	Introductory Calculus Unit test (50 min)
Teacher mini-lectures on quiz issues (5 Min)	Board presentations (10 Min)	Board presentations (10 Min)	
Teacher lectures Rectilinear Motion (15 min)	Teacher lectures sketching Polynomials (25 min)	Practice test (35 Min)	
Informal pairs within groups work out new example and class discusses results (10 min)	Informal pairs within groups work out new example and class discusses results (10 min)	Review group posts answers to practice test and fields questions (10 min)	
Scribe and corroborator check-in and group begins homework (10 min)	Scribe and corroborator check-in (5 min)	Scribe and corroborator check-in on way out	

On Day 12, the ICU Test was administered, with no checking with group mates. This test was the individual accountability. It was corrected and returned the next day, at which time the groups went over the test among themselves. The groups then discussed the three-week process.

In the control group, the same quizzes and tests were given, but the process did not include checking-in with partners. All material was presented in lecture-and-seat-work format, and homework and board work were done individually. Notetaking was done individually, with a student assigned to complete and correct his or her notes of that day to be turned in the following day.

School, Parental and Student Permissions

Institutional Review Board for the Protection of Human Subjects (IRBPHS) approved the proposed procedure for this research study. This approval process included obtaining written permission from the site principal.

Human subjects protocol was adhered to. Prior to the execution of this study, letters were written to the parents of potential subjects, requesting their approval for their child's participation (Appendix J). Assent from the students was also requested. The permission was essential because the students involved were required to participate in the pre- and post-testing procedures of the CLI and because their Unit Test scores and archival information were gathered and used in this study as part of the data analysis. Parental consent and student assent forms, as well as teacher consent forms, were attained. Appendix K contains examples of all these forms. Appendix L shows approval of the proposed procedure by the IRBPHS.

Students who chose not to be in the study did not need to make schedule changes because parental permission was not necessary for a teacher to make curriculum and instruction decisions, including those involving methods of delivery. Such choices are typically within the purview of the teacher as long as they conformed to school and departmental requirements. In the case of the one student who opted not to participate in the study, his or her archival data and unit test scores were not gathered and he or she was given other work during the administration of the CLI.

Data Collection

Hagelskamp (2000) stated that in a quasi-experimental control group research design it is essential to consider competing alternatives for any treatment effect that may

occur. Therefore, a variety of data was gathered to establish comparability between the control and treatment groups. Data included: (a) gender, (b) ethnicity, (c) algebra GPA, (d) overall GPA, (e) PSAT scores in math, (f) PLAN scores in math, (g) motivation as rated by two previous math teachers, (h) previous algebra course and (i) fall midterm exam grade, to help differentiate ability and previously observed work ethic.

The unit test scores and post-tests scores of the CLI determined the dependent variable data. Peer scores on group participation were gathered. The teachers also rated each subject based on their observations of group work, board work, and shared notetaking during the three months of the study. Each student was categorized as "cooperative," "dominant," "freeloader," or "patsy." The students did not see the teacher ratings.

The quiz scores were not collected for this study, but provided context and focus for the group processing. Only the unit test scores were collected, examined and analyzed. The CLI was administered twice: once at the beginning of the second quarter and again the week after the unit test had been taken. Table 7 summarizes how these variables were measured.

To address issues of pacing and treatment diffusion, the researcher and the second AL trainer observed the groups weekly. As fulltime teachers themselves, they were not able to visit both treatment and both control groups every week for the 50-minute period and visited each for only half the period. The researcher and the two teachers met weekly to discuss the observations.

Table 7
Measurements Obtained to Answer the Research Questions

Research Question	Pre-Test	Post-Test
1. To what extent is the freeloader and sucker effects present in an Ignatian pre-calculus classroom prior to and after a cooperative learning experience?	1. CLI factors of Freeloader and Sucker Effects. 2. CLI factors on peer support.	1. CLI factors of Freeloader and Sucker Effects 2. Peer Evaluation 3. Teacher Evaluation
2. To what extent does attitude and openness to group work change after extended exposure to a cooperative learning experience designed according to the research of Johnson and Johnson?	1. CLI factors of Cooperation, Individualism and Competition.	1. CLI factors of Cooperation, Individualism and Competition.
3. To what extent do the perceptions of students change with regard to the Ignatian concepts of *cura personalis* and to their relationships with teachers and other students as a result of cooperative learning?	1. CLI factors of Fairness, Teacher Support and Peer Support. 2. Ignatian Factor questions.	1. CLI factors of Fairness, Teacher Support and Peer Support. 2. Ignatian Factor questions.
4. To what extent does the use of cooperative learning in introductory Calculus topics affect the achievement of students in a pre-calculus class?	1. PSAT/PLAN scores. 2. Fall Midterm Exam Grade. 3. Cumulative Math GPA	1. Introductory Calculus Unit Test.

Data Analysis

The data were analyzed using SPSS software. Independent sample t-tests were run to establish comparability of the control and treatment groups. Linear regressions

were performed to determine which (if any) of the demographic data might predict the attitudes defined by the CLI. Pretest and posttest changes were analyzed by use of paired t-tests. A linear regression was also performed to determine if any particular demographic or academic data should be used as a covariate on the achievement data. The achievement data was subject to both an independent t-test and an ANCOVA.

Background of the Researcher

This researcher was born and raised in San Francisco. He attended a Catholic elementary school and the high school that is the site of this study. While in college, he began coaching football and designing sets and lights for the theatre program at this site. He coached for 26 years and has been the theatre's Technical Director for 25 years, during which time he has done the sets and lights for over 50 shows.

He graduated from San Francisco State University (SFSU) in January, 1984, and became a long-term substitute teacher at the site that fall. The following fall, he became a fulltime math teacher there and has remained for 21 years. He received his Master of Arts degree from SFSU in 1988 and his California Cleared Teaching Credential in 1992.

In 1992, this researcher implemented the first alumni math survey, which polled alums after one year of college to determine their level of preparedness. As a result, he revised the PreCalculus curriculum and wrote the two textbooks presently in use. He added AP Calculus BC to the course offerings and designed a summer class called Advanced Algebra that allowed students to move up from the regular track to the Calculus track. In 2006, he wrote the text for the Advanced Algebra course, as well, and has begun writing a text for AP Calculus. In 1998, be began a six-year term as Math Department Chairman, during which time he presided over an explosive growth in the

number of students taking Calculus. The percentage changed from under 30% of the senior class in Calculus to over 60% and the percentage of the senior class to pass an AP Calculus test rose from 12% to over 30%. When the Archdiocese mandated Algebra 1 in the 8th grade, he designed a workshop to retrain the 7th and 8th grade teachers.

In 2005-2006, this researcher served on the leadership team at the research site for the Western Association of Schools and Colleges (WASC) accreditation process. He handled all community census data and surveys. As a result, he has been appointed as the site's Educational Data Analyst. He will be responsible for compiling and interpreting all quantitative data, which comes through the academics office and has been tasked with designing alumni surveys for all the academic departments.

The researcher's long history at this site is both an advantage and a limitation. He has, essentially, not left the site since his freshman year of 30 years ago. He has developed an intimate knowledge of Ignatian education from both sides of the desk and outside the classroom. He also knows this school inside and out and has direct knowledge and experience of its history and recent developments. On the other hand, he has limited experience outside this school and his views of Jesuit education may be colored by his experience.

This research study has been part of the researcher's professional development plan. The findings explored in the next chapter have helped him to question his assumptions about Ignatian education and have led him to a further expansion of his horizons.

CHAPTER V

FINDINGS

Introduction

This chapter presents the research findings of the effects of cooperative learning pedagogies on the attitudes and achievement in pre-calculus classes at an Ignatian secondary school. The attitudes were measured by the *Classroom Life Inventory* (CLI) and the achievement was measured by the Introductory Calculus Unit test (ICU). The effects of cooperative learning and traditional teaching on these attitudes and achievement were compared. Prior to presenting the findings relevant to the research questions, comparability of the treatment and control groups must be established.

Descriptive Data

In order to make comparisons between the experiment data on these preexisting groups, several descriptive data were gathered. The descriptive data fell into three categories: (a) demographic data, (b) academic data, and (c) attitudinal data. The demographic and academic data were gathered from the school site database, with the help of the Director for Scheduling. The attitudinal data was from the CLI pre-test.

Demographic Data

The control and treatment groups were almost identical in all the demographic areas. Table 8 summarizes these data. The groups were of similar size, with the treatment group having 56 students and the control group having 54. The ability groupings were equally represented in each group. The treatment group had 25 PreCalculus B students and 31 PreCalculus A students, while the control group had 26 PreCalculus B and 28

PreCalculus A students. The gender of the treatment group was four more females than males, while the control group had two more males than females.

Table 8
Summary of the Demographic Data of the Sample

	Treatment Total n = 56	Control Total n = 54	Treatment Group B n = 25	Control Group B n = 26	Treatment Group A n = 31	Control Group A n = 28
Gender						
Male	26	28	11	14	15	14
(%)	(46)	(52)	(44)	(54)	(48)	(50)
Female	30	26	14	12	16	14
(%)	(54)	(48)	(56)	(46)	(52)	(50)
Grade						
9th	0	0	0	0	0	0
10th	2	2	2	2	0	0
11th	51	50	23	24	28	26
12th	3	2	0	0	3	2
Freshman Course						
ALG 2H	27	25	24	24	3	1
ALG 1A	20	20	1	1	19	19
ALG 1	9	9	0	1	9	8
Ethnicity						
White	28	32	12	15	16	17
(%)	(50)	(59)				
Asian	10	6	5	2	5	4
(%)	(18)	(11)				
Latino	7	6	1	4	6	2
(%)	(12)	(11)				
African Amer	2	2	0	2	2	0
(%)	(4)	(4)				
Filipino	5	5	3	2	2	3
(%)	(9)	(9)				
Other	4	3	4	1	0	2
(%)	(7)	(6)				

Grade levels and freshman Algebra experiences of the groups were equivalent. The treatment group was comprised of 51 juniors, two sophomores and three seniors. The control group was comprised of 50 juniors, two sophomores and two seniors. The

treatment group's freshman experience was that 27 had been in Algebra 2 Honors, 20 in Algebra 1 Accelerated, and nine in Algebra 1. The control group had 25 students who came from Algebra 2 Honors, 20 from Algebra 1 Accelerated, and nine from Algebra 1.

The ethnic compositions of the two groups were similar in terms of raw numbers, though the small sample size caused the percentages to appear to be more divergent. The treatment group had 28 Caucasians and the control group had 32. This resulted in the treatment group being 50% white while the control group was 59% white. The treatment group had ten Asian students (18%), while the control group only had six (11%). The treatment and control groups had seven and six Latino students respectively. There were equal numbers of Filipino and African American students in each group (nine and two, respectively). Four treatment group members and three control group members were officially listed as "other" in the school database.

Academic Data

A variety of data were gathered to compare the academic levels of the sample, including: (a) midterm exam scores, (b) sophomore PLAN scores, (c) junior PSAT scores, (d) math GPA, (e) overall GPA, and (f) motivation ratings of each student by previous teachers. Comparisons between the control and treatment groups in each of these categories were made via an independent sample t-test. All t-tests were run at a .05 level of statistical significance. Table 9 summarizes the results of these tests.

The midterm exam means were equivalent with $M_C = 78.03$ ($SD_C = 11.92$) and $M_T = 80.88$ ($SD_T = 11.49$). While usable as a comparative measure within each level, the midterm scores could not be used as a measure of ability or aptitude. The two ability groupings did not use the same midterm exam.

Table 9
Independent t-Tests of the Academic Data of the Sample

	n	means	SD	t	p	*df*
Midterm				-1.29	0.20	108
Control	54	78.03	11.92			
Treatment	56	80.88	11.49			
PLAN				-2.9	0.00*	108
Control	54	23.35	3.98			
Treatment	56	25.31	3.13			
PSAT**				0.03	0.98	104
Control	52	58.15	7.40			
Treatment	54	58.11	8.94			
Math GPA				-1.05	0.29	108
Control	54	3.39	0.59			
Treatment	56	3.49	0.40			
Overall GPA				-0.47	0.64	108
Control	54	3.41	0.30			
Treatment	56	3.44	0.37			
Motivation				-0.15	0.88	108
Control	54	8.24	1.22			
Treatment	56	8.25	1.38			

*Note: * Significant at $p < .01$.*
***PSAT scores are not available for 10^{th} graders.*

The PLAN scores appear equivalent between groups, with $M_C = 23.35$ ($SD_C = 3.98$) and $M_T = 25.31$ ($SD_T = 3.13$). The t-test, however, determined that there was a significant difference at the .01 level. This test is a national exam given to sophomores and testing Algebra 1 and arithmetic. As it does not cover any geometry or Algebra 2 topics, it may or may not be a pertinent measure for pre-calculus students.

The means for the PSAT, math GPA, overall GPA, and motivation were almost identical in each case. The PSAT means for control and treatments groups were 58.15 ($SD_C = 7.40$) and 58.11 ($SD_T = 8.94$), respectively. The math GPAs were 3.39 ($SD_C = 0.59$) and 3.49 ($SD_T = 0.40$)., and the overall GPAs were 3.41 ($SD_C = 0.30$) and 3.44 ($SD_T = 0.37$). The motivation ratings were 8.24 ($SD_C = 1.22$) and 8.25 ($SD_T = 1.38$).

The t-tests on these data revealed no significant difference statistically at the $p < .05$ level.

Table 10 summarizes the disaggregated academic data for the four classes. As would be expected of the nature of the courses, the two PreCalculus B classes had significantly higher GPAs, PLAN Scores, PSAT scores and motivation ratings than the PreCalculus A classes. The PSAT means were six to ten points higher for the PreCalculus B classes.

Table 10
Summary of the Disaggregated Academic Data

	Treatment Group A n = 31	Control Group A n = 28	Treatment Group B n = 25	Control Group B n = 26	PreCalc A Totals	PreCalc B Totals
PLAN						
Mean	24.79	21.41	25.92	25.44	23.16	25.68
SD	3.35	3.74	2.78	3.12	2.94	3.91
PSAT						
Mean	53.40	55.50	63.90*	61.30*	54.43	62.60
SD	8.19	6.88	5.95	6.88	7.43	6.51
Math GPA						
Mean	3.40	3.28	3.60	3.51	3.34	3.56
SD	0.37	0.73	0.42	0.37	0.60	0.39
Overall GPA						
Mean	3.31	3.37	3.59	3.46	3.32	3.52
SD	0.35	0.28	0.33	0.32	0.32	0.33
Midterm						
Mean	85.50	80.00	75.31	73.09	82.92	75.23
SD	8.53	12.87	12.21	10.63	11.10	11.12
Motivation						
Mean	7.98	7.95	8.88	8.59	7.80	8.71
SD	1.19	1.08	1.19	1.25	1.15	1.26

*Note: *PSAT scores are not available for 10th graders.*

Both math and overall GPA means of the PreCaclulus B classes were .2 higher than PreCalculus A. The motivation scores for PreCalculus B were almost a full standard deviation higher. PreCalculus A had significantly higher midterm scores, but this could

be attributed to the fact that different exams were given. The PreCalculus B midterm was more difficult and graded more stringently.

The two PreCalculus A groups were very similar to one another in most categories. There was a greater difference between the two PreCalculus A classes on the PLAN, which might have given rise to the significance noted above. The PreCalculus B treatment group had higher academic scores in all categories than the PreCalculus B control group. An independent t-test revealed that none of the differences were significant at the .05 level.

Attitudinal Data

The attitudinal data in this study, as measured by the 11 subscores of CLI, fell into three broader categories: (a) interdependence preference, (b) attitudes toward peers, and (c) attitudes regarding the student-teacher relationship. Interdependence preference was measured by the cooperation, individualism, and competition factors. The Student Academic Support, Student Personal Support, Freeloader, and Sucker factors were used to measure attitudes towards peers. The Teacher Academic Support, Teacher Personal Support, Grading Fairness, and Ignatian Factors were used to measure attitudes regarding the student-teacher relationship. The CLI used a five-point scale to measure each of these factors.

Interdependence Style Preference

Orbell and Dawes (1981), Kerr (1983), and Salomon and Globerson (1989) stated that the sucker effect resulted in a reduction in cooperation by highly competent individuals due to freeloading. If this reduction is to be measured between groups, it is

important to establish that the control and treatment groups have similar attitudes for their preferred mode of interdependence.

Among the Cooperation Factor items from the CLI, the means of the control and treatment groups were $M_C = 4.08$ ($SD_C = 0.68$) and $M_T = 3.85$ ($SD_T = 0.72$). On the Individualism Factor, the means were $M_C = 3.03$ ($SD_C = 0.62$) and $M_T = 2.92$ ($SD_T = 0.53$). Among the Competition Factor, the means were $M_C = 3.24$ ($SD_C = 0.79$) and $M_T = 3.19$ ($SD_T = 0.79$). As Table 11 shows, the results of the t-tests for these factors indicate no statistically significant differences between the groups.

Table 11
Independent t-Tests of the Pre-test Means for Attitudes towards Cooperation, Individualism and Competition between Control and Treatment Groups

Factor	n	means	SD	t	p	*df*
Cooperation				1.72	0.09	108
Control	54	4.08	0.68			
Treatment	56	3.85	0.72			
Individualism				1.00	0.32	108
Control	54	3.03	0.62			
Treatment	56	2.92	0.53			
Competition				0.74	0.33	108
Control	54	3.24	0.79			
Treatment	56	3.19	0.79			

One might assume that higher achieving students would be more competitive or individual rather than cooperative. Table 12 summarizes the t-tests between the ability groups on these factors. PreCalculus A, the lower ability group, had a cooperation mean ($M_A = 4.07$, $SD_A = 0.66$) that was 0.19 higher than PreCalculus B ($M_B = 3.78$, $SD_B = 0.86$), significant at the .05 level. PreCalculus B, the higher ability group, had a significantly higher individualism mean by 1.28 points ($M_B = 4.29$, $SD_B = 0.64$) than PreCalculus A ($M_A = 3.01$, $SD_A = 0.61$). PreCalculus B had a barely higher competitive

mean ($M_B = 3.39$, $SD_B = 1.11$) than PreCalculus A ($M_A = 3.14$, $SD_A = 0.85$), which was not statistically significant.

Table 12
Independent t-Tests of the Pre-test Means for Attitudes towards Cooperation, Individualism and Competition between PreCalculus A and PreCalculus B Classes

Factor	n	means	SD	t	p	*df*
Cooperation				2.00	0.05*	108
PreCalculus A	59	4.07	0.66			
PreCalculus B	51	3.78	0.86			
Individualism				-7.89	0.00*	108
PreCalculus A	59	3.01	0.61			
PreCalculus B	51	4.29	1.06			
Competition				-1.34	0.18	108
PreCalculus A	59	3.14	0.85			
PreCalculus B	51	3.39	1.11			

*Note: *Significant at $p < .05$.*

Peer Relationships

There were four peer relationship factors measured by the CLI: (a) peer academic support, (b) peer personal support, (c) the freeloader effect, and (d) the sucker effect. The t-tests for the differences between the groups on these factors are summarized in Table 13.

The means of the peer support factors were all above three, indicating a positive sense of support. The mean values of the peer academic support factor were $M_C = 3.46$ ($SD_C = 0.81$) and $M_T = 3.29$ ($SD_T = 0.73$). The control group perceived a slightly more positive sense of academic support from their peers than the treatment group, but it was not significant, with $t = 1.11$ ($p = 0.23$). The control group also had a marginally more positive sense of personal support ($M_C = 3.48$ and $SD_C = 0.75$, $M_T = 3.44$ and $SD_T = 0.67$), though the difference was not significant. Both groups agreed that they had

experienced the feelings associated with the sucker effect in the past ($M_C = 3.59$ and $SD_C = 0.64$, $M_T = 3.42$ and $SD_T = 0.59$).

Table 13
Independent t-Tests of the Peer Support Data

	n	means	SD	t	p	*df*
Student Academic Support				1.11	0.23	108
Control	54	3.46	0.81			
Treatment	56	3.29	0.73			
Student Personal Support				0.29	0.76	108
Control	54	3.48	0.75			
Treatment	56	3.44	0.66			
Sucker				1.45	0.15	108
Control	54	3.59	0.64			
Treatment	56	3.42	0.59			
Freeloader				-1.27	0.21	108
Control	54	2.41	0.61			
Treatment	56	2.56	0.63			

Both groups disagreed with statements about the freeloader effect, as the means were both below 3.00. This indicated they did not consider themselves freeloaders. On this factor, $M_C = 2.41$ ($SD_C = 0.61$) and $M_T = 2.56$ ($SD_T = 0.64$). There was no statistical significance in the difference.

Teacher-Student Relationships

A unique feature of this study was the Ignatian context of the sample and one stated limitation was the potential disparity between how the different teachers interacted with their different classes. There were four peer relationship factors measured by the CLI: (a) teacher academic support, (b) teacher personal support, (c) grading fairness, and (d) the Ignatian factor. Table 14 summarizes the pre-test factors that relate to *cura*

personalis, that is, the factors that attempt to measure the students' perceptions of their teacher's personal care for them.

Table 14
Independent t-Tests of the Teacher Support Data

	n	means	SD	t	p	*df*
Teacher Academic Support				2.44	0.02*	108
Control	54	4.48	0.57			
Treatment	56	4.12	0.92			
Teacher Personal Support				1.23	0.22	108
Control	54	4.14	0.72			
Treatment	56	3.96	0.81			
Grading Fairness				1.76	0.08	108
Control	54	4.23	0.70			
Treatment	56	3.97	0.82			
Ignatian				2.08	0.04*	108
Control	54	3.91	0.73			
Treatment	56	3.61	0.78			

*Note: *Significant at p < .05.*

Both groups experienced a very strong sense of support and fairness from their teachers, with means near or above 4.00. There is no significant differences between the control and treatment group means on fairness of grading and teacher personal support. The control group perceived a higher sense of personal support from their teachers than the treatment group ($M_C = 4.14$ and $SD_C = 0.72$, $M_T = 3.96$ and $SD_T = 0.81$), but the difference was not significant with $t = 1.23$ ($p = 0.22$). On fairness of grading, the means were $M_C = 4.23$ ($SD_C = 0.70$) and $M_T = 3.97$ ($SD_T = 0.82$), and the mean difference was not significant at the .05 level ($t = 1.76$, $p = .08$).

There were significant differences on teacher academic support and the Ignatian factor. The mean values of the teacher academic support factor were $M_C = 4.48$ ($SD_C = 0.57$) and $M_T = 4.12$ ($SD_T = 0.92$). The control group mean on this factor was significantly higher than the treatment group mean, with $t = 2.44$ ($p = .02$).

There was a significant difference between the means of the Ignatian factor. Breaking out the individual items showed that the means on Question 49 ("I understand *cura personalis*") were somewhat close at $M_C = 3.75$ and $M_T = 3.88$. The mean differences on the other three questions ranged from .55 to .71, with the control group feeling more strongly that *cura personalis* was important despite their answers to question 49 indicating they understood it less.

A linear regression of all the pretest factors onto each other revealed that the PreCalculus level of a subject was a predictor on the teacher academic support factor. When the data were disaggregated among the four classes, the PreCalculus A classes showed a stronger affinity for their teacher than did the PreCalculus B classes. Treatment Group A, in particular, had an extremely strong sense of teacher academic support with $M_T = 4.75$ ($SD_T = 0.55$).

In three of the four areas, the students have a significantly more positive attitude toward Teacher A than Teacher B. The Teacher Academic Support means of the PreCalculus A and PreCalculus B classes were $M_A = 4.49$ ($SD_A = 0.56$) and $M_B = 3.55$ ($SD_B = 0.97$). The Teacher Personal Support means were $M_A = 4.16$ ($SD_A = 0.70$) and $M_B = 3.28$ ($SD_B = 0.95$). The Grading Fairness Factor means for the control and treatment groups were $M_C = 4.23$ ($SD_C = 0.70$) and $M_T = 3.51$ ($SD_T = 0.92$). The Ignatian Factor was the only place where PreCalculus B rated higher (with $M_B = 4.04$, $SD_B = 1.13$) than PreCalculus A (means of $M_A = 3.91$, $SD_A = 0.70$). Table 15 summarizes the pre-test factors that related to the student-teacher relationships.

Differences between the two ability groups were significant (at the p<.01 level) in the area of academic support, personal support, and grading fairness. The difference on the Ignatian Factor was not statistically significant. Teacher A, the male

Table 15
Independent t-Tests of the Pre-test Means of Student-Teacher Relationship Items between PreCalculus A and PreCalculus B Classes

Factor	n	means	SD	t	p	*df*
Teacher Academic Support				6.33	0.00*	108
PreCalculus A	59	4.49	0.56			
PreCalculus B	51	3.55	0.97			
Teacher Personal Support				4.20	0.00*	108
PreCalculus A	59	4.16	0.70			
PreCalculus B	51	3.28	0.95			
Fairness				4.66	0.00*	108
PreCalculus A	59	4.23	0.70			
PreCalculus B	51	3.51	0.92			
Ignatian				-0.73	0.46	108
PreCalculus A	59	3.91	0.70			
PreCalculus B	51	4.04	1.13			

*Note: *Significant at p < .01.*

veteran, was perceived to be more supportive, both personally and academically, as well as more fair than the younger female Teacher B. Further research would be needed to determine if gender, experience, age or some other factor was a source of this disparity.

Linear Regressions

Before addressing the research questions, a series of stepwise linear regressions were performed to determine which, if any, of the demographic and academic variables might serve as predictors for each of the attitudinal variables. Which level of pre-calculus was also considered, in order to determine the necessity for disaggregating the data. Four of the eleven attitudinal variables had predictors among the demographic and academic data.

Of the three interdependence factors (cooperation, competition, and individualism), only cooperation had a predictor. The lone predictor was the PSAT score. Among the four peer relationship factors, there were no predictors, and one of the four teacher-student relationship factors (teacher personal support) had no predictors. Teacher academic support was predicted primarily by PreCalculus level and secondarily by overall GPA. Fairness of grading was predicted by PreCalculus level. The Ignatian factor was predicted by PSAT score. Students with higher PSAT scores tended to rate their teacher higher on the items related to *cura personalis*.

Summary of the Descriptive data

The descriptive data attempt to delineate the comparability between the control and treatment groups in this study. The data fall into three general categories: (a) demographic, (b) academic and (c) attitudinal. There were four demographic variables: (a) gender, (b) graded level, (c) freshman course, and (d) ethnicity. There were not significant differences between the control and treatment groups on any of the demographic variables.

There were six academic variables: (a) midterm exam scores, (b) sophomore PLAN scores, (c) junior PSAT scores, (d) math GPA, (e) overall GPA, and (f) motivation ratings. Only the PLAN test scores showed a statistically significant difference. Due to inconsistencies between the tests used by the two ability groupings and how those tests were graded, the midterm exam variable was determined to be unusable.

There were eleven attitudinal variables. Statistically significant differences between control and treatment groups were found in two of the eleven: (a) teacher

academic support, and (b) the Ignatian factor. The control group means were higher in both cases.

Some significant differences existed between ability groups, as should be expected, especially among the academic variables. One class had a particularly strong affinity for their teacher. One PreCalculus level was more cooperative, while the other level was more individualistic. Overall, since the control and treatments groups contained equivalent numbers of subjects from both ability groups, the control and treatments groups appear to be comparable for this study.

Three of the demographic and academic variables were uncovered by linear regression as predictors of four of the attitudinal variables. PreCalculus level was a primary predictor of teacher academic support, while overall GPA was the secondary predictor for that factor. PreCalculus level was the primary predictor of fairness of grading. The PSAT was the lone predictor of both cooperation and the Ignatian factor.

Problems with the Post Treatment Analysis

PreCalculus B finished the study three weeks ahead of PreCalculus A. When the Introductory Calculus Unit Test results came in, the means of the two groups were almost identical. This raised a major concern in the researcher's mind. An earlier red flag had been raised by a parent complaint. Teacher B had been giving group members an average of their group's score as a quiz grade, contrary to the individual accountability element of AL. Clearly, she had not understood the concept of individual accountability, nor its necessity in the process. As a result of the parent complaint, the researcher had to intervene in Teacher B's grading policy. The researcher thought the problem had been corrected, but apparently it had not.

When the final data from PreCalculus A came in, a linear regression of the post-treatment CLI data revealed which teacher the students had was a strong predictor of attitude change. This caused the researcher to further investigate the manner in which cooperative learning practices had been implemented in the PreCalculus B class. Observations of Teacher B's classes seemed to show cooperative learning occurring, though the teacher's monitoring and intervening was limited. Later discussions between the researcher and Teacher B revealed that she had not, in fact, actually implemented all the techniques required by the study.

Closer inspection of Teacher B's treatment class revealed that it exhibited the characteristics of traditional group work rather than true cooperative groups. Groups had been formed with less concern for academic diversity within the groups than recommended. Group identity building had not been encouraged, though nor was it discouraged. Boardwork tended to be done by one student copying the homework of another and students were not assigned to explain the work, let alone randomly assigned to do so. Review sheets were done individually, and the process of shared note-taking described in the methodology was not routinely followed. Most importantly to the Ignatian nature of this study, the weekend group processing reflections were not assigned.

By contrast, Teacher A very carefully crafted his groups for balance of ability. He asked the researcher almost daily for input on how to implement the various techniques required. Observations showed a teacher who was very active in the groups and showed few students off task.

At this point, the study took on an unanticipated dimension. Instead of remaining a two-group quasi-experimental study investigating cooperative learning vs. traditional

teaching, it became more like a four-group study of the effects of cooperative learning, traditional group work, and two levels of traditional non-group teaching. One lower ability pre-calculus class was traditionally individualistic, while the other was cooperative. One higher ability pre-calculus class was traditionally individualistic, while the other exhibited the trappings of cooperation but was in fact as individualistic as the other class. This required further disaggregation of the data for analysis. The smaller sample sizes made conclusions more suspect and less generalizable. The data gathered to address each research question needed careful consideration in light of this unanticipated situation.

Research Question One

The first research question asked to what extent the freeloader and sucker effects were present in an Ignatian pre-calculus classroom prior to and after a cooperative learning experience. Evidence was gathered from three sources: (a) the freeloader and sucker effect factors of the CLI, (b) a peer evaluation, and (c) a teacher evaluation.

The CLI pretest results seem to indicate that, if the freeloader effect occurred, the subjects did not think it was not due to them. Both groups' means were below 3.00 (M_C = 2.41 and SD_C = 0.61, M_T = 2.56 and SD_T = 0.64). In fact, only ten of the 110 subjects scored above 3.00 and two above 4.00 on the freeloader factor. Eight of the ten and one of the two were in the treatment group. While the students seemed to not believe they themselves might be freeloading, the sucker effect questions indicated that freeloading by others was a concern. The means of both control and treatment groups were above 3.00 past (M_C = 3.59 and SD_C = 0.64, M_T = 3.42 and SD_T = 0.59).

When the CLI was re-administered to the treatment group, they were told to answer considering their experiences of the past three months. The CLI post-test mean of the treatment group showed no appreciable change in their opinion about the sucker and freeloader effects. Table 16 presents the frequencies of the pretest and posttest freeloader factor results.

Table 16.
Frequencies of Responses on the Pre-test and Post-test Freeloader Factor.

Group	n	2.00 or below	Between 2.00 and 3.00	3.00	Between 3.00 and 4.00	4.00 or above
Pretest						
Control	54	20	20	9	4	1
Treatment	56	14	24	8	9	1
Total	110	34	44	17	13	2
Posttest						
Control	54	9	21	9	12	3
Treatment	56	15	19	7	13	2
Total	110	24	40	16	25	5

Fourteen of the 56 treatment subjects now rated themselves above 3.00 (one above 4.00) meaning they considered themselves to freeload to a certain extent. Interestingly, eleven of the 54 control group subjects now considered themselves freeloaders. This represented an overall rise from 11% to 22%. As was noted in Chapter IV the reliability of freeloader factor posttest was suspect at alpha = .63.

The post-test mean on the sucker factor was $M_T = 3.51$ ($SD_T = 0.80$) as opposed to the pretest mean was $M_T = 3.42$ ($SD_T = 0.59$). The posttest mean on the freeloader factor was $M_T = 2.63$ ($SD_T = 0.72$) as opposed to the pretest mean was $M_T = 2.56$ ($SD_T = 0.64$). Table 17 summarizes the pretest and posttest results of the freeloader and sucker effect factors.

Table 17.
Paired t-Tests between the Pre-test and Post-test Treatment Group Scores of the Freeloader and Sucker Factors.

Factor	n	Mean difference	SD	Standard Error Mean	t	p	*df*
Freeloader	54	0.07	0.94	0.13	0.56	.58	55
Sucker	54	0.09	1.02	0.14	0.69	.49	55

The teachers also rated each treatment subject based on their observations of group work, boardwork and note-taking during the three months of the study. Each student was categorized as "cooperative," "dominant," "freeloader," or "pasty." Among the 31 students in his treatment group, Teacher A identified no dominators, one possible patsy, and four freeloaders. The other 25 students were considered cooperative. Among the 25 students in her treatment group, Teacher B identified no dominators, two patsies, and five freeloaders. The other 18 students were considered cooperative.

Only one of the nine identified freeloaders identified himself or herself as a freeloader, by scoring below 3.00 on the freeloader factor on the CLI pretest. The other eight were among the lowest scores in the sample. Three of these nine subjects identified themselves as freeloaders after the treatment, including the one who had the lowest score in the whole sample. Three more had increased freeloader scores, though not to above 3.00. One remained the same and two seemed to have thought they were less of a freeloader after treatment. Table 18 lists the freeloader factor scores for the nine subjects who were identified by a teacher as a freeloader.

The students were asked to rate their group-mates and themselves on a scale from one to five as to whether each member did their fair share of the work in the group. The

peer ratings were quite inconsistent with the teacher's identifications. Three of the six students identified as freeloaders by Teacher A received a four from their peers, indicating they had mostly done their fair share of the work. The sixth received a five.

Table 18.
Freeloader Factor Data for the Teacher-Identified Freeloaders

	PreCalculus Level	Freeloader Factor	
		PreTest	PostTest
Subject 1	PreCalculus A	2.00	1.75
Subject 2	PreCalculus A	2.50	3.00
Subject 3	PreCalculus A	1.75	3.50
Subject 4	PreCalculus A	2.25	2.75
Subject 5	PreCalculus B	3.50	2.25
Subject 6	PreCalculus B	2.00	2.25
Subject 7	PreCalculus B	1.50	3.50
Subject 8	PreCalculus B	2.00	3.50
Subject 9	PreCalculus B	2.50	2.50

Three students identified as freeloaders by Teacher B received fours and the other two received fives. Both students identified as suckers gave themselves a four. Only one student received a score less than four. She had been labeled "cooperative" by the teacher but received two scores of three (from two students that the teacher had identified as freeloaders). In general, few scores below five were given and there was a tendency among the non-freeloaders to score themselves lower than their group-mates scored them.

Research Question Two

The second question asked to what extent did attitude and openness to group work change after extended exposure to a cooperative learning experience designed according

to the research of Johnson and Johnson. Table 19 summarizes the pretest and posttest paired t-tests of the interdependence preferences.

Table 19.
Paired t-Tests between the Pre-test and Post-test Means of the Control and Treatment Groups for Attitudes towards Cooperation, Individualism and Competition.

Factor	n	Mean difference	SD	Standard Error Mean	t	p	*df*
Cooperation							
Control	54	0.02	0.92	0.13	0.17	0.87	52
Treatment	56	-0.28	0.98	0.13	-2.18	0.91	54
Individualism							
Control	54	0.15	0.81	0.11	1.37	0.18	52
Treatment	56	0.27	0.76	0.10	2.70	0.01*	54
Competition							
Control	54	0.03	1.19	0.16	0.19	0.85	52
Treatment	56	-0.06	1.09	0.15	-0.44	0.66	54

*Note: *Significant at p < .01.*

The control group showed no significant changes in interdependence preferences. The mean differences were: (a) $MD_C = 0.02$ ($SD_C = 0.92$) for cooperation, (b) for $MD_C = 0.15$ ($SD_C = 0.81$) for individualism, and (c) $MD_C = 0.03$ ($SD_C = 1.19$) for competition. The treatment group showed no significant changes in attitudes toward cooperation or competition, with mean differences of $MD_T = -0.28$ ($SD_T = 0.98$) for cooperation and $MD_T = -0.06$ ($SD_T = 1.09$) for competition. But there was a significant difference (at the .01 level) toward individualism, with a mean difference of $MD_T = 0.27$ ($SD_T = 0.76$).

This mean difference on individualism seems to indicate that the treatment group's attitude became more individualistic during the study. Given that the group work in the PreCalculus B class appeared to have been traditional rather than cooperative, it was important to disaggregate the pre- and post-test data on these factors and reapply the paired t-test. Surprisingly, it was the PreCalculus A class which had the significant

mean difference of 0.31 (SD = 0.82), leading to a p = 0.04. Table 20 summarizes this break out.

Table 20.
Paired t-Tests of the Pre-test and Post-test Means for Attitude towards Individualism between PreCalculus A and PreCalculus B Treatment Classes

Factor	n	Mean difference	SD	Standard Error Mean	t	p	*df*
PreCalculus A	31	0.31	0.82	0.15	0.61	0.04*	30
PreCalculus B	25	0.22	0.89	0.18	1.25	0.22	24

*Note: *Significant at p < .05.*

Research Question Three

The third research question asked to what extent the perceptions of students changed with regard to the Ignatian concepts of *cura personalis* and to their relationships with teachers and other students as a result of cooperative learning. None of the pretest-posttest mean differences of the control group were statistically significant. Whatever level of *cura personalis* that had been established in the first quarter seemed to have remain unchanged.

On the other hand, the treatment group did exhibit some significant differences in attitude between the pretest and posttest. There were no significant differences between means on the factors that related to student-teacher relationships. Both peer support factors showed a significant negative change, indicating that they felt less supported by their peers than before the treatment. Peer academic support showed a mean difference of -0.36 (SD = 1.03) and peer personal support dropped -0.28 (SD = 0.93). Table 21 summarizes the paired t-test results for these six factors.

Table 21.
Paired t-Tests between the Pre-test and Post-test Means of the Control and Treatment Groups on the Relationship Factors of the CLI

Factor	n	Mean Differences	SD	Standard Error Mean	t	p	*df*
Teacher Academic Support							
Control	54	0.07	1.11	0.15	0.46	0.64	52
Treatment	56	-0.02	1.37	0.18	-0.11	0.91	55
Teacher Personal Support							
Control	54	0.23	1.07	0.15	1.58	0.12	52
Treatment	56	0.12	1.40	0.19	0.63	0.53	55
Fairness							
Control	54	0.07	0.97	0.13	0.51	0.61	52
Treatment	56	0.11	0.13	0.15	0.70	0.49	55
Ignatian							
Control	54	-0.22	1.05	0.14	-1.56	0.13	52
Treatment	56	-0.03	1.07	0.14	-0.02	0.98	55
Student Academic Support							
Control	54	-0.18	1.14	0.16	-1.12	0.27	52
Treatment	56	-0.36	1.03	0.14	-2.63	0.01*	55
Student Personal Support							
Control	54	-0.09	1.12	0.15	-0.65	0.51	52
Treatment	56	-0.28	0.97	0.12	-2.31	0.02*	55

*Note: *Significant at $p < .05$.*

Research Question Four

Finally, the last question asked to what extent did the use of cooperative learning in introductory Calculus topics affect the achievement of students in these pre-calculus classes. The original design of the research study was that of a two-group quasi-experiment. As such, an independent sample t-test was deemed an appropriate analysis of the group means. The results showed no significant difference between the group means on the Introductory Calculus Unit Test ($M_C = 76.8$, $SD_C = 24.95$ and $M_T = 79.1$, $SD_T = 25.25$) with $t = -.48$, $p = 0.63$. Table 22 summarizes these results.

Table 22.
Independent Sample t-Tests of the Means of the Introductory Calculus Unit

Factor	n	means	SD	t	p	*df*
Overall				-0.48	0.63	108
Control	54	76.8	24.95			
Treatment	56	79.1	25.25			

The differences between teacher implementation of the cooperative learning seems to indicate this quasi-experimental study should be considered a four-group, rather than two-group, study. This, in turn, implied that an alternative analysis should be viewed.

Three possible alternative analyses were considered. First, a 2x2 ANOVA analysis could have been applied with control/treatment as one factor and PreCalculus level as the other. The differences between the lower course means and that of the upper level were 15 to 20 points. Any significance based on the treatment that might be revealed by the ANOVA, though, would be overshadowed by the significance based on pre-calculus level. Second, an ANCOVA could be used with a covariate that controlled for ability. The covariate would have adjusted the means by approximately a point. The comparatively large mean difference between the levels would still far outweigh that adjustment and the level significance would still obscure the control/treatment difference. Third, the two PreCalculus groups could be considered independently. This third option was chosen.

The PreCalculus B mean scores on the Introductory Calculus Unit test (ICU) were almost identical. The control group mean was $M_C = 88.7$ ($SD_C = 22.38$) and the treatment group mean was $M_T = 87.9$ ($SD_T = 22.79$). There was no significance here.

The PreCalculus A results revealed a greater mean difference in the ICU scores. The means scores were $M_C = 65.0$ ($SD_C = 21.81$) and $M_T = 74.5$ ($SD_T = 25.73$). A stepwise linear regression determined that, of the academic and demographic variables, math GPA was the primary predictor of success on the ICU, followed by PSAT and midterm scores. The math GPA correlated to the ICU scores at $r = 0.50$, which was significant at the $p = .01$ level, but homogeneity of regression could not be established because of significant interaction between the math GPA and the group. Therefore, an independent t-test was performed. The results determined that, though the raw numbers showed what appeared to be a large mean difference, it was, in fact, not statistically significant at the .05 level because of the large standard deviations. Table 23 summarizes the t-test results.

Table 23.
Independent Sample t-Tests of the PreCalculus A Means of the Introductory Calculus Unit Test

Factor	n	means	SD	t	p	*df*
PreCalculus A				-1.78	0.08	57
Control	28	65.0	21.81			
Treatment	31	74.5	25.73			

Summary of the Findings

Over a period of four months, two pre-calculus classes were taught trigonometry and introductory Calculus material using primarily traditional lecture and seatwork pedagogy. Two other pre-calculus classes were instructed using cooperative learning techniques. One of those classes adhered to the protocol more strictly than the other.

Comparability between the control and treatments groups for this study was established through a variety of descriptive data. The data fell into three general

categories: (a) four demographic data, (b) six academic data from the school site's database, and (c) eleven attitudinal measured by the *Classroom Life Inventory*. Some differences existed between ability groups, as should be expected, especially among the academic variables. One class had a particularly strong affinity for their teacher. One PreCalculus level was more cooperative, while the other level was more individualistic. Overall, the groups were comparable. At the end of the coverage of the Introductory Calculus Unit, a unit test was administered and the *Classroom Life Instrument* was re-administered.

The findings fell into four topics which were dictated by the research questions: (a) existence of freeloading and of the sucker effect, (b) changes in preference for specific social interdependence styles, (c) changes in teacher-student and peer relationships, and (d) achievement on the unit test.

According to the findings, freeloading appeared to have occurred in these Ignatian classes, but to what extent and by whom is unclear. Twelve subjects (11% of the sample) thought of themselves as having freeloaded in the past on the pretest and 25 (22%) thought so on the posttest. The teachers identified nine students as freeloaders, only three of whom had identified themselves as such via the CLI. The students' ratings of each other were inconsistent with the teachers' identifications.

There was no significant change found in interdependence preference in the realm of cooperation or competition. There was a significant change in the treatment group's attitude toward individualism. Unexpectedly, the treatment group more strongly preferred individualism after the treatment, especially in the class that had more success.

There were no significant changes in attitude toward the student-teacher relationship during the research study. This is important in an Ignatian context and demonstrates that cooperative learning and Ignatian pedagogy can coexist. There were significant changes in peer relationships, though. It is important to note that the treatment group had negative mean differences between pretest and posttest results on the student personal and academic support factors. When using a quasi-experimental design, it is difficult to attribute causality to treatment, but these negative changes are discomforting.

Finally, the findings revealed no statistically significant differences in performance on the unit test. PreCalculus A seemed to have benefited more from the treatment, but whether that was due to the teacher, the implementation of the treatment, the ability level, or some interaction effect is unknown.

In the Ignatian fashion, the "experience" that is represented by these findings needs further reflection to determine future action and evaluation. What follows in Chapter VI is that reflection.

CHAPTER VI

CONCLUSIONS AND IMPLICATIONS

Restatement of the Problem

The problem that originally led to this study was that calculus has been a class that restricted access to certain majors and, hence, to some fields of endeavor beyond college. Research by Triesman (1986), Johnson and Johnson (1989), and others indicated that cooperative learning might help solve this problem. There are four interrelated problems with using cooperative learning as a solution to the calculus-access problem in a Jesuit college preparatory school. First, cooperative learning, when not implemented properly, can lead to freeloading. Second, poor implementation can lead to resentment on the part of the harder-working student, which has come to be called the sucker effect. Third, while there is a vast amount of research in cooperative learning, the amount that pertains to pre-calculus is limited and none is in an Ignatian context. Finally, cooperative learning is student centered where Ignatian pedagogy is centered on the relationship between the student and teacher.

This study sought to address these problems. It attempted to measure the amount and sources of freeloading in an Ignatian classroom, tried to measure the changes in attitude toward cooperative learning, expanded the research literature in this field, and attempted to determine if cooperative learning and Ignatian pedagogy occur in an interrelated manner.

Summary of Methodology

This study initially set out to employ a two-group quasi-experimental design, with pre-test and post-test on eleven variables and a posttest on a twelfth variable. The sample

was comprised of 110 students from four pre-calculus classes at a coeducational Jesuit college preparatory in California. Two of the classes were honors classes and two were accelerated classes. The honors classes were taught by one teacher and the accelerated classes were taught by a different teacher. The sections were combined into one treatment and one control group of comparable size, with an honors class and an accelerated class in each group. Subsequent analysis of the data determined that, to answer certain research questions, the classes should also be considered as four separate groups.

Prior to treatment, a modified form of the *Classroom Life Inventory* was administered to all four classes. This instrument measured attitudes in eleven areas and the data served for between group comparisons. In addition, data on ten demographic and academic variables were gathered to determine comparability of the groups. Independent sample t-tests were calculated on the means of the demographic, academic, and pretest attitudinal data for between-group comparisons. Linear regressions were performed on all the preliminary data to determine covariates for later use.

Between October and February, one honors and one accelerated class served as the control group and were taught using a traditional lecture-and-seatwork pedagogy. The other two classes formed the treatment group and used cooperative learning techniques based on the five elements of Johnson, Johnson, and Smith's (1998) Active Learning.

The eleven attitude factors measured by the modified *Classroom Life Inventory* included attitudes toward interdependence, peer interaction, and teacher-student interaction. Of particular interest were measurements of the freeloader and sucker effects

and of Ignatian teacher-student interaction. Achievement was measured on a unit of introductory calculus material. Three other units of material were covered using the different pedagogies during the course of this quasi-experimental study, but achievement data on those units were not gathered.

Summary of the Findings

The findings addressed in this research addressed concerns with regard to attitudes and achievement of the participants. First, freeloading appeared to have occurred in these Ignatian classes, but to what extent and by whom was unclear. Few students considered themselves freeloaders either before or after the treatment. The teachers identified nine students as freeloaders, only three of whom were self-identified as such. The students' ratings of each other were inconsistent with the teachers' identifications and often with other group members. Most students generally rated themselves lower than the members of their cooperative group did.

There was no significant change found in interdependence preference in the realm of cooperation or competition, but the positive attitude toward individualism increased significantly. There were no significant changes in attitude toward the student-teacher relationship during the research study. There were significant negative changes in peer relationships.

Further, the findings revealed no statistically significant differences in performance on the unit test. PreCalculus A seems to have benefited more from the treatment, though not significantly. PreCalculus B appeared not to have benefited at all from the treatment, but this part of the treatment group did not follow all cooperative learning protocols set forth in the research design.

Discussion and Conclusions

This research study sought to address four research questions. These questions centered around the existence of freeloading, how students' preferences for the three kinds of interdependence are influenced by cooperative learning, students perceptions of teacher and peer support within a cooperative learning situation, and cooperative learning's effect on achievement.

Freeloading did occur, even in these Ignatian classroom. As noted above, to what extent freeloading was present is unclear. The teachers' perceptions of who was freeloading and who was not did not seem to match the students' perceptions. The students' perceptions of their own level of freeloading was inconsistent with their peers and teachers. Some teacher-identified freeloaders acknowledged that they had freeloaded, while others became more adamant that they had not. Those considered cooperative rated themselves all along the gamut. The extended CLI needed more questions to improve the reliability of this factor. It also probably needed questions on a separate factor that identified and measured the extent of freeloading by peers, rather than self. Those kinds of questions could have replaced the fairness of grading questions, if the length of the CLI was an issue.

The Ignatian sense of these classrooms was not diminished by the use of cooperative learning in this study, in terms of the student-teacher relationship, which is at the core of Ignatian pedagogy. Cooperative learning is clearly not at odds with this aspect of *cura personalis*.

One of the limitations of this study was the lack of direct training of the teachers involved. Neither teacher was available for cooperative learning workshops that had

been offered at this school site and elsewhere in the area during the summer prior to this research study. Reading and second-hand instruction in this pedagogy clearly were not enough in this situation. The group identity building and the sense of celebration so strongly emphasized by R. Johnson (2004) in his workshops was not translated into these classrooms. The importance of each essential element and how it was brought to bear on the students was not clearly understood, leading to inconsistent implementation and disappointing results.

The fact that the PreCalculus A treatment group had a significant increase in its preference for individualism was very interesting. The level of preference for cooperation did not drop, so it would be difficult to conclude that the experience resulted in a dislike for group activities. The PreCalculus A treatment group preferred to be more individual afterwards, despite the fact that there was an increase in achievement, albeit not a significant one, for this group over its control counterpart. One could conclude that the experience was such that, in spite of the benefits, the subjects would not be enthusiastic about study groups and collaborative work in the future.

The flip side of this is also interesting. Despite no superior achievement by the PreCalculus B treatment group and the presence of more freeloaders (teacher-, student- and self-identified) in a smaller class, this class did not show a change in its interdependence preference. Is this because the students are unclear about the differences between traditional group work and cooperative learning? Does this mean that honors students have come to expect a certain level of freeloading and assume it is normal?

Though achievement was not the primary topic being researched in this study, the initial problem investigation grew out of the need for students to be able to be more successful in the gatehouse class that is Calculus. Though the results of the PreCalculus A unit test were tantalizing, they were not significant. They were enough to motivate Teacher A to continue the use of cooperative learning on his own and try to improve on his implementation.

It is difficult to attribute the lack of significance in this study to the treatment alone. The teachers and the relative respect their students had for them may have affected the results. The treatment was not consistently implemented. A ceiling effect may have come into play due to the ability level of the pre-calculus classes involved. It is possible that the PreCalculus B classes, having all the most able students, could not have enough variance for significance to arise.

The review of the literature demonstrated the wealth and diversity of cooperative learning approaches and its impact on teaching and learning. From cooperative to collaborative, from conceptual to structured, from teacher-centered to student-centered, there is a vast panoply of views and attitudes about cooperative learning. However, three things were apparent. First, a certain common theme kept arising. The discussion that arose around the differences between Dubinsky (1986) and Davidson' (1971) views regarding the fundamental point of the discovery approach (the discovery of the math vs. the development of the higher-order thinking skills) parallels the conceptual to structured continuum of the various cooperative learning methods, and both parallel the coverage versus depth issue. Though both views have similar goals, there are different priorities as

to process and product. Though this duality, of course, is part of human nature, Ignatian education calls for us to concentrate on the process and trust the spirit for the product.

Second, whether one feels most comfortable with Slavin (1985), Johnson, Johnson, and Smith (1998), or Kagan (1992), small group work is effective if designed and implemented cooperatively. Problems with the freeloader and sucker effects, unequal participation, and other anticipated problems may be overcome with pre-implementation design and teacher engagement in the process. This design and engagement is far less likely to occur without proper teacher training, though.

Third, there is resistance to change in spite of the evidence of the positive effects. Cooperative learning is a difficult and exhausting practice for the teacher, and achieving a pedagogical status quo where the teacher may relax is not possible. Lecture and direct dissemination of material, be it traditionally or by the use of technology, is much easier on the teacher, especially in math. However, that just may not be in the best interests of the students and their learning needs.

Implications for Practice

Cooperative and collaborative processes at the instructor level were found to be the major difference between American and Japanese math instruction in the Third Annual Math and Science Survey (TIMSS) as reported by Stigler and Hiebert (1999). Japan has a national math curriculum rather than standards, as the United States has. There is a national databank of lesson plans for any particular piece of that curriculum and the expectation of cooperation and common observation among the faculty helps new teachers improve and veteran teachers stay on track and up-to-date (Stigler & Hiebert, 1999).

One implication of this research study that aligns with the TIMMS report is the need for direct and thorough teacher training. Marzano, Pickering, and Pollock (2001) reiterated the warning of Anderson, Reder, and Simon (1997) that cooperative learning can be misused and overused. They defined "misused" as giving tasks to the groups that were not well structured and "overused" as implementation that did not allow sufficient time for the student to practice independently. Proper teacher training is necessary for misuse and overuse to be avoided. Cooperative learning is not an add-on methodology that any teacher can employ effectively at will. One-day workshops or a brief introduction to the topic are less than helpful.

The results of this study did not show a detrimental effect of poor implementation, although the design did not specifically inspect for that. The increase in preference for individualism might be construed as a negative in light of supposition by Levy and Murnane (2004) that jobs in the near future will require collaborative work based on complex communication skills.

Another implication of this study is that *cura personalis* must extend beyond the student-teacher relationship. The student-peer relationships need to be a considerable part of an Ignatian classroom. Teacher methodology affects this student-to-student form of *cura personalis* as much as it affects the teacher-student relationship that is at the core of Ignatian education. As much care must be taken to nurture the peer relationships as is taken to achieve the learning of the material. Intellectual competence is only one of six aspects of the graduate of a Jesuit school. The others are seeded in the interpersonal relationships of community.

Finally, despite the lack of statistical significance in the achievement data, Teacher A was very encouraged by the results. A major implication of this study was that an experienced veteran teacher can be re-energized in his or her teaching by researching a different pedagogy. Ignatian educators are flexible by definition. Ignatian classrooms should lend themselves well to research and research can invigorate Ignatian teachers.

Recommendations for Future Study

While the same dramatic results as found in the literature were not found in this study, it does raise questions that lead to several recommendations for further study. First of all, this study needs to be replicated without the design and implementation flaws that color the conclusions. The questions added to the CLI to measure the freeloader and sucker effects need to be revised and expanded and made more reliable. Other questions should be added to help measure the subjects' perceptions of the freeloading of their peers. With a better identification of freeloaders, the differing perceptions of freeloaders and non-freeloaders could be investigated.

Gender was not investigated in this study other than demonstrating that it was not a predictor of any of the gathered data. As the study site is unique in that it is the only coed Jesuit school in the California province, two recommendations for further study seem to be indicated. As more than half of the Jesuit schools in the country are all male, this study should be replicated in an all-male school to see if attitudes differ in that environment. Coed Jesuit institutions should investigate the research questions in this study so as to arrive at findings that are more generalizable. All the schools of the Ohio

Province, in particular, are coed and would provide a sample that is geo-socially and gender-wise more representative of a larger population.

All the research in the meta-analyses reviewed in Chapter III considered the effects of cooperative learning on the students. It is clear that teachers and school culture have a tremendous impact on cooperative learning. A study of the effect of teacher training and implementation on the cooperative learning results might be valuable. Did the gender of the teacher affect the results? Did the experience play a greater role in the teacher's ability to successfully implement the treatment? The fact that one teacher was an alumnus of a Jesuit high school and a Jesuit college, while the other had no religious upbringing, went to public schools, and had only working in a Catholic schools for a limited time did not give rise to significant differences in the *cura personalis* data. Could it have affected how they used cooperative learning, though?

Johnson and Johnson (1989) disaggregated some studies in their meta-analysis to look at the effect sizes of those that were considered high quality, but they did not look at the frequency of occurrence of lower quality studies nor did they differentiate between possible types of low quality. A random sample of classes in a particular district, province, or even school who claim that they are doing cooperative learning could be studied to investigate how well the cooperative learning is really being implemented and how much training the teachers received, possibly correlating that data with the data from Johnson, Johnson, and Stanne (2000) to determine which cooperative learning methods are most effective with differing levels of training.

Another interesting meta-analysis would be one that distinguished between studies in Catholic, private, and public school sites. The research might tease out if the

Catholic character and culture of a school (or even of a particular charism) affects the outcomes.

It was distressing to observe among the findings of this study the significant drop in the students' sense of peer support, both academically and personally. It is questionable whether this can be attributed to the treatment itself, the implementation of the treatment, or to the grade and ability levels of students. Are more able math students less supportive by nature when placed in cooperative situations? Does incorrectly structured or implemented cooperative learning tasks cause students to be more self-centered and less supportive? Do freeloader and sucker effects, which were originally investigated in the adult workplace, manifest as personal issues among teenagers? Does cooperative learning set personal support expectations higher than teenagers can fulfill? These questions were not designed for observation or control within this study and could be a source for future research.

Finally, both cooperative learning and Ignatian pedagogy are challenged at their core by the recent rise of distance learning. One of cooperative learning's five essential elements is face-to-face promotive interaction. The core of Ignatian pedagogy is the student–teacher relationship. Distance learning limits the direct personal contact that is the basis for both. Can the highly personal nature of these learning experiences be maintained through technology?

Summary

For the past 150 years, cooperative learning has been researched and shown to be effective in a diversity of subjects and situations. The last 35 years, in particular, have seen an explosion in the field. Cooperative learning has been touted as a cure-all for

everything from learning differences to racial and socio-economic inequalities. The evidence, which is mostly from middle school classrooms, is overwhelming in its support of this pedagogy. It has been demonstrated to have a significant positive effect on individual achievement and retention, group and organizational productivity, higher-level reasoning, moral reasoning, motivation, job satisfaction, interpersonal affection and love, prejudice, self-esteem, effort, and psychological health.

The realm of Ignatian education has overlapped the same time-space continuum, though its heyday was somewhat earlier. Much less formal research has been done on the effects of Ignatian education on those dependent variables analyzed by the cooperative learning research. The historical power and influence of the Jesuits continue today and points to an effective system of education that is valued by many. It was founded on a sense of community interdependence similar to that described by Lewin (1935) and Deustch (1949).

This research study sought to draw out the parallels between cooperative learning and Ignatian pedagogy, as well as to investigate their combined effect in college preparatory math classrooms. The study showed that cooperative learning and Ignatian pedagogy can go hand-in-hand. The student-teacher relationship and the *cura personalis* exhibited by Ignatian educators are valued by the students and not diminished by the cooperative learning experience. More work needs to be done to determine how these two approaches can be more fruitfully intertwined.

The world we prepare our students for is not the world for which we were prepared. The Information Age has placed complex communication and problem solving in higher demand than ever before. For many, collaboration has become the new

watchword, but working and living in community has always been the way of the Catholic Church. The Society of Jesus has been on the forefront of bringing that life-in-community to the secular world ever since they formed themselves as the Companions. It is a tradition that is regaining popular value and acclaim. We owe it to our students to maximize their opportunities for success, to provide them with the best learning experience available, and to prepare them for the world to which they belong.

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APPENDIXES

APPENDIX A:

DOCUMENTS ON IGNATIAN EDUCATION

Table 24
Documents Foundational to Jesuit Education

Title	Published	Authors
The Preamble	1970	Bailey, et al.
The Jesuit High School of the Future	1972	The Commission on Research and Development
Apostolic Consciousness	1973	Robert J. Starratt, SJ
Men for Others	1974	Pedro Arrupe, SJ
Instrument for Self-Evaluation of Jesuit High Schools	1975	
Faith and Justice	1976	Edwin J. McDermott, SJ
Reflections on the Educational Principles of the Spiritual Exercises	1977	Robert R. Newton, SJ
Profile of the Graduate at Graduation	1981	The Commission on Research and Development
Sowing Seeds of Faith and Justice	1980	Robert J. Starratt, SJ
Go Forth and Teach: The Characteristics of Jesuit Education	1987	Day, et al.
Teaching for the Kingdom	1987	Day, et al.
Send our Roots Rain	1991	Charles P. Costello, SJ
Four Hallmarks of Ignatian Pedagogy	1991	Ralph E. Metz, SJ
Ignatian Pedagogy: A Practical Approach	1993	Duminuco, et al.

Note: Adapted from Melrose (1994)

APPENDIX B:

THE 28 CHARACTERISTICS OF JESUIT EDUCATION

Table 25
The 28 Characteristics of Jesuit Education

Ref	Characteristic
1.1	Jesuit Education is world-affirming
1.2	Jesuit Education assists in the total formation of each individual within the human community
1.3	Jesuit Education includes a religious dimension permeates the entire education
1.4	Jesuit Education is an apostolic instrument
1.5	Jesuit Education promotes the dialogue between faith and culture
2.1	Jesuit Education insists on individual care and concern for each person
2.2	Jesuit Education emphasizes activity of students in the learning process
2.3	Jesuit Education encourages life-long openness to growth
3.1	Jesuit Education is value-oriented
3.2	Jesuit Education encourages a realistic knowledge, love and acceptance of self
3.2	Jesuit Education provides a realistic knowledge of the world in which we live
4.1	Jesuit Education proposes Christ as the model for human life
4.2	Jesuit Education provides adequate pastoral care
4.3	Jesuit Education celebrates faith in personal and community prayer, worship and service
5.1	Jesuit Education prepares for an active life commitment
5.2	Jesuit Education services the faith that does justice
5.3	Jesuit Education seeks to form men and women for others
5.4	Jesuit Education manifests a particular concern for the poor
6.1	Jesuit Education is an apostolic instrument, in service of the church as it serves human society
6.2	Jesuit Education prepares students for active participation in the Church and local community, for the service of others
7.1	Jesuit Education pursues excellence in its work of formation
7.2	Jesuit Education witness to excellence
8.1	Jesuit Education stresses lay-Jesuit collaboration
8.2	Jesuit Education relies on a spirit of community among: Teaching Staff and Administrators The Jesuit Community Governing Boards Parents Students Former Students Benefactors

Table 7 (continued)
The 28 Characteristics of Jesuit Education

Ref	Characteristic
8.3	Jesuit Education takes place within a structure that promotes community
9.1	Jesuit Education adapts means and methods in order to achieve its purposes most effectively
9.2	Jesuit Education is a "system" of schools with a common vision and common goals
9.3	Jesuit Education assists in providing the professional training and ongoing formation that is needed, especially for teacher

Adapted from Day, et al, 1987

APPENDIX C:

PERSONAL COMMUNICATIONS

Subject: Re: Doctoral Request
Date: Sat, 03 Sep 2005 09:50:51 -0700
From: Kevin Quattrin <kquattrin@earthlink.net>
To: Roger Johnson <johns009@maroon.tc.umn.edu>
References:
1 , 2

Dear Dr. Johnson--

Thank you for your support. I would definitely like to see the Classroom Life instrument. I was a little worried about creating my own survey and trying to prove validity and reliability for it and am glad to know there is already a tool to use.

Thanks again.

Kevin Quattrin

Roger Johnson wrote:

>
>
> Kevin,
> I do remember you. I think we may have talked briefly about this project. It sounds like fun. > Keep in mind the more carefully you structure the cooperative learning and encourage
> cooperative behaviors, the more likely you are are to see the gains reported in previous > research. You are certainly welcome to use our work to build your rationale. If you look at the > web site (www.co-operation.org) you will find more research support material, but the review > in the text is pretty good. There is a meta-analysis done by a group at the University of
> Wisconsin that summarizes research on coop lng and math/science/tech studies at the College > level. The reference escapes me at the moment but is probably in the bibliography at the end > of the book. We also have an instrument for measuring student perceptions (called Classroom > Life) that could be useful. It has about 20 factors (clusters of questions) and is too long but if > you chose 3 or 4 factors it is short enough to give. Let me know if you want to look at it.
> Good luck with your work and keep me informed.
>
> Roger T. Johnson

Subject: Re: Doctoral Research
Date: Wed, 08 Mar 2006 15:13:32 -0600
From: Roger Johnson <johns009@umn.edu>
To: Kevin Quattrin <kquattrin@earthlink.net>

Kevin,
We are updating the meta-analysis but it won't be ready for awhile. We will send you the Classroom Life instrument and background for the instrument. It is not intended that you use all the questions (factors) so pick and chose the factors you want. Good luck with your work and keep me informed.

Roger

On 2/28/06 9:27 AM, "Kevin Quattrin" <kquattrin@earthlink.net> wrote:

> Dear Dr. Johnson--
>
> We exchanged emails a while back. I am the Calculus teacher at St
> Ignatius iwho is going a Doctoral study at University of San Francisco.
> I am in the middle of the dissertation proposal process and hope to
> defend in the Fall. Thank you of your past help. The meta-analysis
> from Wisconsin was very useful and, along with both your 2000 and 1989
> meta-studies, forms the core of my lit review. I was wondering if there
> was any more recent study you might recommend I look at as well. Also,
> if you could let me know where I can obtain a copy of the Classroom Life
> instrument you mentioned, it would be great.
>
> Thank you again for all you past help to me individually and to
> education in general.
>
> Kevin Quattrin
> St. Ignatius College Prep
> 2001 - 37th Avenue
> San Francisco, CA 94116
>

Kevin, first my apologies for not responding earlier to your request. Second, I'm not sure there has been much written on Cooperative Learning and IPP. I cannot say that I know of much of anything written, which does a comparison/contrast or interconnects the two. I'm sorry. Thanks for the inquiry though.

Peter A. Musso

Jesuit Secondary Education Association

1616 P Street NW, Suite 400

Washington, D.C. 20036

tel:202.667.3888 fax: 202.387.6305 email: mussop@jsea.org

-----Original Message-----
From: Mr. Kevin Quattrin [mailto:kquattrin@siprep.org]
Sent: Monday, April 10, 2006 9:14 PM
To: Mussop@jsea.org
Subject: IPP and Cooperative Learning

Hello Mr. Musso--

Paul Molinelli gave me your email and said you might be able to help. I am a math teacher at SI (San Francisco) and a doctoral student at USF. My dissertation topic is Cooperative Learning (CL) in the math classroom with a view toward changing Honors students attitudes about group work. It seems to me that the IPP and CL are fairly well aligned and CL might be a way to do spiritual formation in a math classroom. I was hoping you might point me toward some journal articles or other literature about the conjunction of CL and IPP. Thanks for you help.

Kevin Quattrin
Calculus Teacher
St. Ignatius College Prep
San Francisco, CA

APPENDIX D:

INSTRUMENTATION

CLASSROOM LIFE INSTRUMENT

Directions: On the answer sheet, fill in the circle which tells you how true each of these statements is for you.

If the statement is:	fill in the circle under number
Completely False	1
False much of the time	2
Sometimes true and sometimes false	3
True much of the time	4
Completely true	5

1. Other students in this class want me to do my best schoolwork.
2. In this class, other students like to help me learn.
3. Other students in this class think it is important to be my friend.
4. In this class, it is important that we learn things by ourselves.
5. My teacher really cares about me.
6. In this class, we spend a lot of time working at our own desks.
7. My teacher thinks it is important too be my friend.
8. Everyone in this class has an equal chance to be successful if they do their best.
9. In this class, other students care about how much I learn.
10. In this class, other students like me the way I am.
11. My teacher cares about how much I learn.
12. Other students in this class want me to come to class every day.
13. In this class, we do not talk to other students when we work.
14. my teacher likes to see my work.
15. Other students in this class care about my feelings.
16. Other students in this class like me as much as they like others.
17. If a student works hard, he or she can definitely succeed in this class.

18. My teacher likes to help me learn.
19. In this class, we work by ourselves.
20. In this class, other students really care about me.
21. My teacher wants me to do my best in schoolwork.
22. My teacher likes me as much as he or she likes other students.
23. Students in this class get the scores they deserve, no more and no less.
24. My teacher cares about my feelings.
25. I deserve the scores I get in this class.
26. Sometimes I think the scoring system in this class is not fair.
27. I like to share my ideas and materials with other students.
28. It bothers me when I have to do it all myself.
29. I like my work better when I do it all myself.
30. I like the challenge of seeing who is best.
31. I do not like to be second.
32. I am happiest when I am competing with other students.
33. Competing with other students is a good way to work.
34. I do not like working with other students in school.
35. I can learn important things from other students.
36. I work to get better grades than other students do.
37. I like to help other students learn.
38. I like to compete with other students to see who can do the best work.
39. Working in small groups is better than working alone.

40. I try to share my ideas and materials with other students when I think it will help them.

41. It is a good idea for students to help each other learn.

42. I like to do better work than other students.

43. I like to cooperate with other students.

44. I like to work with other students.

45. I do better work when I work alone.

46. Students learn a lot of important things from each other.

47. I would rather work on schoolwork alone than with other students.

48. I like to be the best student in class.

49. I understand what *cura personalis* is.

50. *Cura personalis* has been an important part of my education at SI.

51. When working in groups in the past, I have had to do more than my fair share.

52. When working in groups in the past, I have let someone else do more than their fair share of the work.

53. A positive relationship with my teacher is necessary for me to learn.

54. It bothers me when, in group projects, someone else gets credit for my work.

55. When working in groups in the past, I have withheld my help or effort from the group because I considered the situation unfair.

56. A positive relationship with my peers is necessary for me to learn.

57. I should get more credit if I do more work in a group.

58. I trust that my peers will do their fair share of the work.

59. Group work means I do not have to work as hard.

60. When working in groups in the past, I have done less than my fair share.

Table 26.
Factors of the Classroom Life Instrument (Modified Version)

Factor	Question Number
Teacher Academic Support	11, 14, 18, 21
Teacher Personal Support	5, 7, 22, 24
Student Academic Support	1, 2, 9, 12
Student Personal Support	3, 10, 15, 16, 20
Cooperation	27, 35, 37, 40, 41, 43, 46
Fairness of Grading	8, 17, 23, 25, 26
Individualistic Learning	4, 6, 13, 19, 28, 29, 34, 39, 44, 45, 47
Competitive Learning	30, 31, 32, 33, 36, 37, 42, 48
Ignatian Factor	49, 50, 53, 56
Freeloader Factor	52, 58, 59, 60
Sucker Factor	51, 54, 55, 57

PreCalculus B '07 Name_____

Chapter 2 Test--PART I
CALCULTOR ALLOWED

Directions: Round at 3 decimal places.
Show all work.

1. Find the equations of the lines tangent and normal to $y = x^4 + 4x^2 - 5$ at x=-2

2. $\lim_{x \to -4} \sqrt{\frac{x^4 - 14x^2 + 3x - 20}{x^3 + 6x^2 - 2x - 40}}$

3. $D_x\left[\sqrt[3]{x^5} - \frac{6}{x^2} - \sqrt[3]{x} + \pi^2\right]$

4. The height of a ball bouncing is described by $y(t) = t^3 - 4t^2$.
When is it going down?

5. Find the extremes algebraically of $y = 2x^3 - 3x^2 - 32x + 48$

6. The strength of a wood beam with a rectangular cross-section is directly proportional to its width and the square of its height. For a log that is 12" in diameter, the equation is

$$S = kwh^2 = kw(144 - w^2)$$

where k is a constant, S = strength and
w = width.

a) What are the dimensions of the strongest beam that can be made from a 12'diameter log?

b) What is the maximum S value?

PreCalculus B '07 Name_____

Chapter 2 Test--Part II
NO CALCULTOR

Directions: Show all work.

7. $\lim_{x \to 0} \dfrac{1-\cos^2 x}{2\cos^2 x - 3\cos x + 1}$

8. $\dfrac{d}{dx}\left[6x^5 - 3x^3 + 3x + 21\right]$

9. $\lim_{x \to 5} \dfrac{5-\sqrt{30-x}}{5-x}$

10. Set up, but do not solve, the Limit Definition of the Derivative for #3.

11. Find the traits of and sketch $y(t) = t^3 - 4t^2$

Domain:

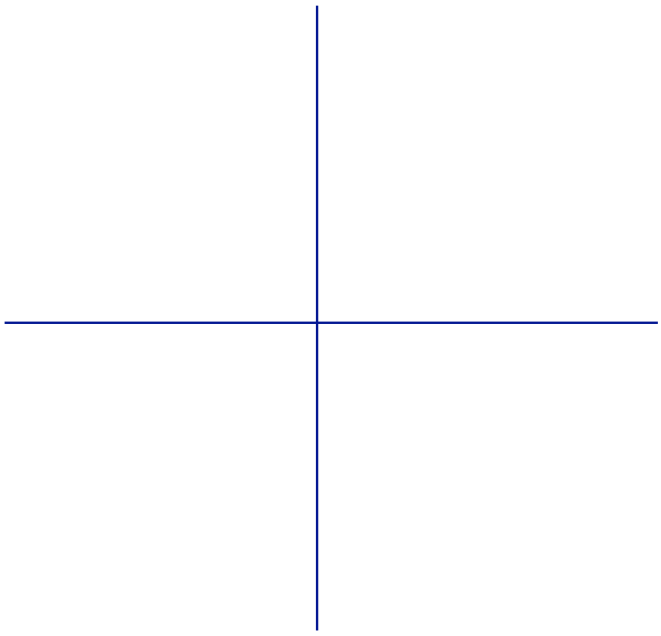
Y- Int:

Zeros:

Extremes:

End Behavior:

Range:



12. Find the traits of and sketch $y = 2x^3 - 3x^2 - 32x + 48$.

Domain:

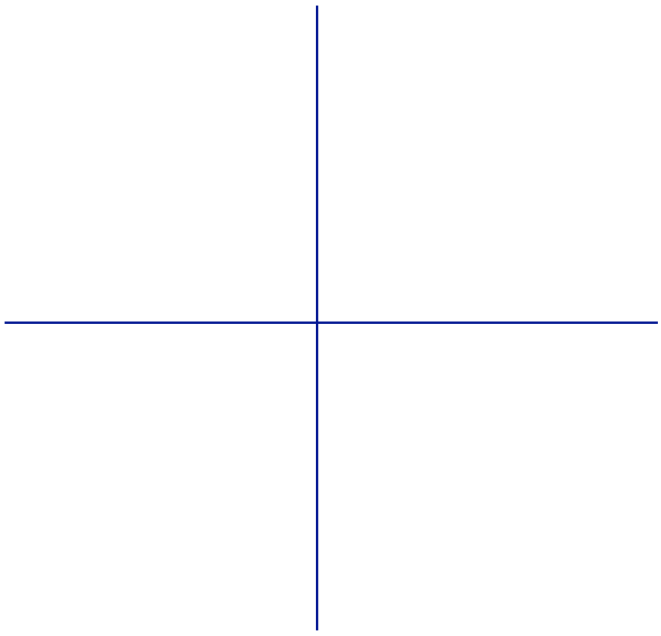
Y- Int:

Zeros:

Extremes:

End Behavior:

Range:



APPENDIX E:

VALIDITY PANEL INFORMATION

Mr. Kevin Quattrin
330 Loma Vista Terrace
Pacifica, CA 94044
650-355-8877
kquattrin@siprep.org

August 27, 2006

Dear Colleague,

Thank you for our recent conversation where you agreed to be a member of my Validity Panel. As an expert in the field of mathematics, I value your assistance as a member of the Validity Panel for my doctoral study. The purpose of this study is to determine to what extent cooperative learning effects attitude and achievement. The Validity Panel you have agreed to participate on will investigate the validity of the achievement instrument I will use.

Enclosed you will find the following: a) a brief description of the study, including a copy of the research questions, b) a list of objectives of the Introductory Calculus Unit section, c) three versions of the Introductory Calculus Unit Test, d) the scoring rubric for Form B, and e) a Validity Panel questionnaire which asks you to comment on the construct, content, and face validity of the tests and to make suggestions for any necessary revisions.

Please use the questionnaire to record your feedback. If you have any additional comments please attach a comment sheet or type them into the doc. Once you have completed your responses please return the validity questionnaire to me in one of three ways: 1) e-mail it to me as an attachment at kquattrin@siprep.org, 2) fax it to 415-731-2227, or 3) mail it to the above address.

Thank you again for your generosity in sharing your time and expertise with me and making it possible for us to improve education for all of our students. When my research is complete, if you wish, I will send you a synopsis of the results as a PDF file or in any form that you wish.

Thank you again for your help,

Kevin Quattrin

Mr. Kevin Quattrin
330 Loma Vista Terrace
Pacifica, CA 94044
650-355-8877
kquattrin@siprep.org

October 10, 2006

Dear Colleague,

Thank you for our recent conversation where you agreed to be a member of my Validity Panel. As an Ignatian educator, I value your assistance as a member of the Validity Panel for my doctoral study. The purpose of this study is to determine to what extent cooperative learning effects attitude and achievement. The Validity Panel you have agreed to participate on will investigate the validity of the Attitude instrument I will use.

Enclosed you will find the following: a) a brief description of the study, including a copy of the research questions, b) a list of definitions of the extra factors involved, and c) a Validity Panel questionnaire which asks you to comment on the construct and content validity of the tests and to make suggestions for any necessary revisions.

Please use the questionnaire to record your feedback. If you have any additional comments please attach a comment sheet or type them into the doc. Once you have completed your responses please return the validity questionnaire to me in one of three ways: 1) e-mail it to me as an attachment at kquattrin@siprep.org, 2) fax it to 415-731-2227, or 3) mail it to the above address.

Thank you again for your generosity in sharing your time and expertise with me and making it possible for us to improve education for all of our students. When my research is complete, if you wish, I will send you a synopsis of the results as a PDF file or in any form that you wish.

Thank you again for your help,

Kevin Quattrin

RESEARCH SUMMARY

Problem:

The purpose of this quasi-experimental study is two-fold. The first part is to explore the effect of CL on achievement in the context of a Jesuit college preparatory math classroom. The second part is to determine the effect of CL on the attitudes of students toward group work. Advanced students often bear the negative effects of the "freeloader effect," and this can inhibit their social learning. CL could change their perspective, so as to open them to the advantages of complex communication and heighten their sense of *cura personalis,* or care for the individual.

Rationale:

The theoretical rationale underlying CL is the social interdependence theory of Morton Deutsch (1949) and its application to CL by David and Roger Johnson (1974, 1981, 1989). Johnson and Johnson's research has defined five basic elements that differentiate CL from traditional group work and make it effective.

Educational Significance:

The majority of CL books and research are aimed at elementary and middle schools, with relatively few in higher math education. Despite the limitations, this study will expand on the body of research at this nexus of higher education and mathematics.

Another significant effect this study could have is ease the change of instructional practices. The ease with which an experienced traditional teacher can implement Johnson and Johnson's CL design and the extent of its influence on achievement could encourage other math teachers to attempt similar adaptations to their curriculum and methodology. Addition of this pedagogy to a math teacher's repertoire could make higher level math, especially Calculus, more accessible to his or her students.

Finally, a groundswell of CL use is just beginning at the college level, with math departments at universities such as Michigan, Minnesota, and Berkeley leading the way. If Jesuit secondary schools are to be truly college preparatory, they must look beyond their curriculum and examine their methodology in how they prepare the students for the university life and the job market beyond. This study will help delineate the influence of design on the Johnson and Johnson (1998) model on the attitudes of honors students. These particular students are the ones who, in traditional group work, receive the least benefits and do the most work.

Methodology

In order to accomplish these purposes, a two-group quasi-experimental design will be used. The treatment group will be taught introductory calculus topics in context of graphing polynomials in a cooperative learning setting with heterogeneous groups of

three to four students each. The control group will be taught the same material in a traditional individualistic format.

The first dependent variable is attitude toward group work. It will be measured by the part of the *Classroom Life Instrument* (CLI). Those items which are associated with the student-teacher relationship and attitudes toward competition, individualism and cooperation will be used.

The second dependent variable will be achievement, which will be measured by a unit test designed by the researcher and teachers. The questions will range from items on knowledge to synthesis and explanation on the topics of limits, basic derivatives, the Power Rule, extrema and sketching of functions. The test will have both a calculator and a non-calculator part.

Research Questions

1. To what extent does the use of cooperative learning in introductory Calculus topics affect the achievement of students in a pre-calculus class?

2. What are the separate and combined effects of gender, ability, motivation,, ethnicity and previous math coursework on attitudes toward group work in a pre-calculus?

3. To what extent do attitudes and openness to group work change after exposure to a cooperative learning experience designed according to the research of Johnson and Johnson (1998)?

4. To what extent do the perception of students change with regards to their relationships with teachers and other students?

Introductory Calculus Unit Objectives

Student will be able to:

1. define and calculate limits of functions.
2. calculate the slope of a tangent line at a point by secant slopes and limits.
3. Understand Indeterminate Numbers.
4. Develop and use the formula of a Derivative.
5. Develop and use the Power Rule.
6. Find Extremes of a Polynomial.
7. Apply the First Derivative Test.
8. Apply Derivatives to Rectilinear Motion.
9. Find Traits and sketch a Polynomial Function.

Definitions

Freeloader Effect: The situation wherein one student does most of the work while the others do little or nothing, but get the same grade.

Sucker Effect: The situation wherein one student feels resentful because shouldering an undue amount of a group's workload.

Information and Directions for Calculus Unit Test Validity Panel

The purpose of this study is to examine the effects of cooperative learning on attitude and achievement in a pre-calculus classroom. Your participation is voluntary and I appreciate your offer of your most precious gift, time, so you might share your expertise and improve this instrument. Your input will enhance the validity of this research study.

Directions:

1. If you desire, take form B of the test. This will be the one used in the experiment. Note that some of the responses in Part 1 (the Calculator part) are needed for answers in Part 2.

2. Please note how long it took you to complete all 12 questions.

3. After completing the test, review Forms A and C of the test and please complete the enclosed evaluation form. You will be asked to evaluate the content validity (how well the test covers the subject material) and face validity (the appearance of the test).

4. If you feel that an item or word needs to be modified to enhance clarity or fulfill the purpose of the study please write your improvements on the survey itself.

Thank you again for your valuable assistance in completing this survey and being part of this Validity Panel. Your time and expertise is valued and appreciated. Please return the questionnaire in the envelope provided to:

Mr. Kevin Quattrin
330 Loma Vista Terrace
Pacifica, CA 94044

Information and Directions for CLI Addendum Validity Panel

The purpose of this study is to examine the effects of cooperative learning on attitude and achievement in a pre-calculus classroom. Your participation is voluntary and I appreciate your offer of your most precious gift, time, so you might share your expertise and improve this instrument. Your input will enhance the validity of this research study.

Directions:

1. Please review the following twelve questions. Note that they fall into three categories.

Ignatian Factor	49, 50, 53, 56
Freeloader Factor	52, 58, 59, 60
Sucker Factor	51, 54, 55, 57,

2. After completing the test, review Forms A and C of the test and please complete the enclosed evaluation form. You will be asked to evaluate the content validity (how well the test covers the subject material).

3. If you feel that an item or word needs to be modified to enhance clarity or fulfill the purpose of the study please write your improvements on the survey itself.

Thank you again for your valuable assistance in completing this survey and being part of this Validity Panel. Your time and expertise is valued and appreciated. Please return the questionnaire in the envelope provided to:

Mr. Kevin Quattrin
330 Loma Vista Terrace
Pacifica, CA 94044

Validity Panel Questionnaire and Evaluation Form

CONTENT VALIDITY

1. Do the questions measure the factors defined?

   Yes _____ No _____If no, which questions do not matched? Why?

2. Should any questions be added?

   Yes _____ No _____ If yes, which items would you add to which group?

3. Should any item be deleted?

   Yes _____ No _____ If yes, which items? Why?

CONSTRUCT VALIDITY

4. Do the 12 questions when taken as a whole appear to be a valid measure of attitude for this unit of material?

   Yes _____ No _____If not, why not?

5. Do the 12 questions appear to be a relevant measures?

   Yes _____ No _____If not, why not?

FACE VALIDITY

6. Are there vocabulary words or phrases in the test that are unclear, ambiguous, or confusing?

   Yes _____ No _____ If yes, please identify the words or phrases either on the actual survey or in the space below. Please offer suggestions if you can.

7. Did you detect any inconsistencies in wording or language in this test?

   Yes _____ No _____ If yes, please identify.

8. Does the test contain any items that are extraneous to measuring the factors?

   Yes _____ No _____ If yes, which ones?

9. Are the instructions clear?

   Yes _____ No _____ If no, suggestions?

10. Is the layout conducive to participants completing the test in a reasonable time?

    Yes _____ No _____ If no, suggestions?

11. Do you have any additional suggestions for improving the test questions?

    Yes _____ No _____ If yes, suggestions?

12. Demographics:

Gender: Male_____Female_____

Position (including level):_____

Subject presently teaching:_____

Have you taught PreCalculus before? Yes _____No _____

Have you taught AP Calculus? Yes _____No _____

Highest degree earned:_____

Would you like to receive a copy of the findings of this research?

Yes _____ No _____If yes, please indicate your preferences below:

Please send via:

E-mail: e-mail address _____PDF file _____ Word _____

Direct mailing address:

_____

_____

_____

Calculus Test Validity Panel Matrix

	1	2	3	4	5	6	7	8	9
Gender	M	F	F	M	F	M	F	M	M
B.A./B.S.			X	X	X				
M.A./M.S.	X	X				X	X	X	X
Ph.D./Ed.D.									
Secondary Teacher	X	X	X	X	X	X	X	X	X
Has taught PreCalculus	X	X			X	X	X	X	X
Has taught Calculus		X	X	X			X	X	X
Ignatian Educator	X		X			X			
Coed Educator	X		X	X	X		X	X	X
Single Sex Educator (gender)		X (F)				X (M)			

CLI Addendum Validity Panel Matrix

	1	2	3	4	5	6	7
Gender	M	M	M	M	F	M	F
B.A./B.S.					X		
M.A./M.S.		X	X	X		X	X
Ph.D./Ed.D.	X						
Secondary Teacher	X	X	X	X	X	X	X
Math teacher						X	X
Psychology Teacher	X	X	X				
Religion Teacher				X	X		
Ignatian Educator	X	X	X	X	X	X	X
Coed Educator	X	X	X	X	X	X	X

APPENDIX F:

TEACHER COURSE POLICIES

Precalculus A

E-mail: Teacher A@high school **Voice mail**: 731 – 7500 x 6705
Office Hours: The teacher is available for individual help before and after school and the first half of fifth period.

Required Text: Analytic Geometry and an Intro to Calculus, Books 1 & 2, Kevin Quattrin, 2005

Course Description: This course is designed to give each student a thorough preparation for and a basic introduction to Calculus. The first semester topics include a review of algebra, the trigonometric and circular functions and their applications, identities, oblique triangles, vectors (in two dimensions) in rectangular and polar form, and complex numbers as vectors. The second semester topics include the study of polynomial, rational, irrational, exponential and logarithmic functions and their graphs. The course introduces The Calculus and covers limits, continuity and basic derivatives.

Expectations: Since this is an honors course, students are expected to do A or B level work. Students are expected to do the following:

1. Complete homework assignments on a regular basis (nightly)
2. Master each concept that is covered in class
3. Participate in classroom discussions and solutions to various problems
4. Maintain a notebook to clarify theorems, etc.

Student Preparedness: Homework is to be neatly done in pencil (name, date, page and assignment placed in the upper right hand corner) on a 8.5 x 11 paper (not torn out of a notebook).

NO LATE ASSIGNMENTS WILL BE ACCEPTED. In the event of an absence, homework is to be turned in the day the student returns to school. It is the student's responsibility to find out the assignments and tests missed while absent. Failure to make up a test will result in a zero for the exam. Weekly assignments will be posted on the homework site. Students should see the teacher in the event of any long term absence.

A student is expected to be prepared for class. This includes the following items:

1. Textbook: Analytic Geometry and an Intro to Calculus, Books 1 & 2
2. Notebook
3. Calculator (TI 83 or higher)
4. Paper, pencils and ruler
5. Graph Paper

A student will receive no credit if writing on tests or homework is illegible or incomplete. Work must be complete and well organized and all answers must be boxed. All graphing assignments must be completed using graph paper.

Retreats: Students will be given a reasonable amount of time, usually a week, to complete all homework assignments and to take tests or quizzes. It is the student's responsibility to inform the teacher of this absence prior to the retreat. Students should consult with classmates or the homework site for assignments and tests.

Grading Policy

Midterm Grade		**Final Grade**	
1. Midterm Exam	30%	1. Chapter tests/quizzes	60%
2. Chapter tests/quizzes	60%	2. Homework (5/5)	10%
3. Homework	10%	3. Midterm Exam	15%
		4. Final Exam	15%

A	100 – 93	B+	89 – 88	C+	79 – 78
A-	92 – 90	B	87 – 83	C	77 – 68
		B-	82 – 80	C-	67 - 65

2006-07 Academic Year Teacher B
Honors Precalculus B Room
3rd, 4th period
E-mail: Teacher B@high school

Honors Precalc B

Text: *Analytic Trigonometry, Analytic Geometry and an Intro to Calculus, Kevin Quattrin* (2004).

Office Hours: I will be in Room after school and at lunch. Please come and find me if you have questions on your homework.

Calculators: We will be using a TI-83(or TI-84) calculator throughout the year and it is required to have one.

Tests: Quizzes will be given approximately every week and can include questions about any reading assigned as homework. Since homework is not collected daily, the quizzes will be used as a marker to whether or not you are keeping up on your homework. If your quiz scores fall below 65%, you may be required to turn in homework. Tests will be at the end of each unit of the class. If you are not satisfied with a test (not quiz) score, you may retake it for a maximum possible score of 75% on the retake. If you are absent for an exam you will take the retake.

Notebooks: Each student must keep a neat and legible notebook. This can be done in either a spiral notebook or a binder and it will contain class notes, any problems assigned in class, and all homework. Included in the notebook should be all tests and quizzes. Notebooks will be collected and graded during the week of midterms and the week prior to the final.

Homework: I will assign homework at the end of every day. We will go over it the next class meeting. At the beginning of class place your homework questions on the board. Homework is extremely important. DO NOT FALL BEHIND IN YOUR HOMEWORK ASSIGNMENTS!!!!

Participation: It is expected that each student will come to class with his own notebook, paper, pencils, textbook, calculator and completed homework. While homework will not be collected and graded daily, repeated lack of preparation and/or lower quiz scores will cause a student to be required to turn in completed assignments. Each student is also expected to be mentally prepared to discuss and present logical solutions to the homework both orally and on the board. Students will put homework solutions to requested homework problems on the board at the beginning of each class.

Daily Notes Binder: We will have a daily notes binder for our class. If you are absent, you need to come to my office and look at the daily notes binder. It will contain the notes for every day of class and the worksheets that were passed out each day. Each day a different student will be assigned to take notes. He/She is responsible for taking clear notes for the day and collecting all worksheets passed out that day for whoever is absent. He/She will then need to place the notes and the worksheets in the Daily Notes Binder located on the desk of my office. This will be a graded project. If the student assigned to take notes is absent that day, I will offer the day up for extra credit.

Grades: The course grade will be determined by counting homework scores, quiz scores, test scores, and your final score, with the following weight factors.

Notes	**10%**
Participation	**15%**
Quizzes	**20%**
Midterm	**10%**
Tests	**30%**
Final	**15%**
Total	**100%**

100 – 91.5 = A **91 – 87.5 = A-**
87 – 84.5 = B+ **84 – 79.5 = B** **79 – 74.5 = B-**
74 – 71.5 = C+ **72 – 67.5 = C** **67 – 64.5 = C-**
64 – 59.5 = D+ **59 – 54.5 = D** **54 – 50 = D**

Classroom Policies: Here are the rules of my classroom….

♦ No food or drinks are allowed in the classroom. As long as I do not hear gum I do not mind if you chew it. Water bottles are OK.

♦If you are absent you will have until the next time the class meets to make up the work. Consult the Daily Notes Binder to see what you missed. IT IS YOUR RESPONSIBILTY TO MAKE UP THE WORK YOU MISS. This means I will not track you down so you can make up a test. You will receive a zero for work that is not made up in time. Students that miss class due to a retreat have one week to make up any work, including tests.

♦I do not accept late work, unless there is an excused absence.

♦Use academic integrity at all times. If you are found cheating in a test or quiz I will give a zero to all parties involved and I will report it to the dean.

APPENDIX G:

SHARED NOTE-TAKING SHEETS

Taking Summary Notes

These are some practical suggestions for taking notes for someone else, as well as strategies to help you improve your own note-taking abilities.

Format:

- Record the date, your name, course and period.
- List absent students' names.
- Take an extra copy of any handouts.
- Number your pages.
- Write neatly or type. If you write, use dark ink and write on one side of the page.
- If you use shorthand ('Fe' for iron, '=' for equals, '@' for at, etc.) and abbreviations, please put a key at the bottom of the page so your notes can be understood.
- Highlight important items with asterisks(*) or draw circles or boxes around critical info. Mark important ideas, terms, concepts with different colors, underlines, or asterisks. Indentation, underscoring and starring are also effective for indicating relative importance of items. Show uncertainty with a circled question mark.

Listening:

- Listen carefully to what is being said.
- Pay attention to qualifying words(sometimes, usually, rarely, etc.)
- Notice signals indicating that a change of direction is coming (but, however, on the other hand)
- Look for meaning and implications; be an active listener.

What to write:

- Definitely include:

* Anything written on the board or presented on an overhead.
* Any info that is repeated or emphasized. Ways to emphasize include: tone or gesture, repetition, illustration on board, reference to text, and use of cue words such as: finally, remember, most important, another cause, etc.
* All numbered or listed items.
* All terms and definitions.
* Examples.
* New words and ideas.

- If the instructor refers to the text, mark the page number in notes to refer.

Additionally:

- Ask questions.
- Ask the teacher to pause on occasion so you can catch up.
- Soon after the presentation, review your notes to rewrite skimpy or incomplete parts and to fill in gaps you remember but didn't record.
- Check with another student to help fill in gaps. Give credit to that student (verifier) at the bottom of your notes.
- Attach a copy of the completed and corrected homework that was due that day.

APPENDIX H:

WORKSHEETS

PreCalculus
Trig Identities
Worksheet #1

Goal: Use the Pythagorean Theorem to derive the Pythagorean Identities for the trigonometric functions.

We have been using the Pythagorean Theorem in the context of the Cartesian Coordinate Plane; this means that

$$x^2 + y^2 = r^2$$

You will also need to recall the definitions for the sine, cosine, tangent, secant, cosecant, and cotangent of an angle for this exercise.

1) Divide both sides of the Pythagorean Theorem by r^2. Translate this equation into trigonometric functions by substituting where you can.

2) Divide both sides of the Pythagorean Theorem by y^2. Translate this equation into trigonometric functions by substituting where you can.

3) Divide both sides of the Pythagorean Theorem by x^2. Translate this equation into trigonometric functions by substituting where you can.

Hint for 1) – 3): Is $\left(\frac{a}{b}\right)^2 = \frac{a^2}{b^2}$?

4) You have discovered three of the nine Pythagorean Identities. List them here. You can come up with six more that are based on the three that you have listed here. Write out the three that you have discovered and isolate for each term in those identities.

PreCalculus
Trig Identities
Worksheet #2

Goal: Use the definitions of the trigonometric functions to find the quotient and reciprocal identities.

You will need to recall the definitions for the sine, cosine, tangent, secant, cosecant, and cotangent of an angle for this exercise.

5) Multiply $\sin\theta$ by $\csc\theta$. What should the result be? Prove it algebraically, and then repeat the process for $\cos\theta$ and $\sec\theta$, then for $\tan\theta$ and $\cot\theta$.

6) You just came up with the basis for the reciprocal identities. List them here, and then come up with two additional versions of each identity. You should have nine total reciprocal identities. Use algebraic manipulations to move the trig functions in the equations to come up with the other identities. Refer to page 93 in your book for a hint.

7) Divide $\sin\theta$ by $\cos\theta$. What are the results? You will need to substitute the definitions of sine and cosine of an angle to see these results. See if you can come up with any similar patterns using $\sec\theta$ and $\csc\theta$.

8) Divide $\cos\theta$ by $\sin\theta$. What are the results? You will need to substitute the definitions of sine and cosine of an angle to see these results. See if you can come up with any similar patterns using $\csc\theta$ and $\sec\theta$.

9) In 3) and 4), you discovered the quotient identities for tangent and cotangent of an angle. List them here, along with the nine reciprocal identities. You should have a total of thirteen identities listed.

Precalculus Worksheet 3 Names_____
_____
_____
_____

A.M.D.G.

For each of the following functions, find an expression for $f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$.

Remember, $(x+h)^4 = (x+h)(x+h)(x+h)(x+h)$ This means that you should multiply the first two terms first, then multiply that result by the next term, then multiply that by the final term.

1. $f(x) = x$

2. $f(x) = x^2$

3. $f(x) = x^3$

4. $f(x) = x^4$

5. Do you notice a pattern? Predict the derivative for the functions $f(x) = x^8$ and $f(x) = x^{20}$ and $f(x) = x^{1/3}$.

For each of the following functions, find an expression for $f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$.

6. $f(x) = 4x$

7. $f(x) = 6x^2$

8. $f(x) = -2x^3$

9. Do you notice a pattern? Predict the derivative for the functions $f(x) = 12x^8$ and $f(x) = 17x^{20}$ and $f(x) = -9x^{1/3}$.

APPENDIX I:

TRIGONOMETRY IDENTITIES UNIT LESSON PLANS

Table 27
Lesson Plans for the Trigonometric Identity Unit.

WEEK 1 Day 1	Day 2	Day 3	Day 4
Group Check-in (5 min)	Group homework Check-in (5 min)	Group homework Check-in (5 min)	Group quiz-prep Check-in (5 min)
Groups break into pairs; each pair works on Worksheet 1 or 2 (15 minutes)	Board presentations (15 Min)	Board presentations (10 Min)	Individual quiz on basic trig identities (30 min)
Groups break into alternative pairs; New partners explain their worksheets (15 min)	Teacher lectures new identities and examples (15 min)	Teacher lectures Composite Identities and examples (25 min)	
Teacher lectures examples of how the identities will be used(10 min)	Informal pairs within groups work out new example and class discusses results(10 min)		
Groups begin homework together (5 min)	Scribe and corroborator check-in (5 min)	Scribe and corroborator check-in (5 min)	Group check-in on quiz (10 min)
WEEK 2 Day 5	Day 6	Day 7	Day 8
Group quiz and homework Check-in (5 min)	Group homework Check-in (5 min)	Group homework Check-in (5 min)	Group quiz-prep Check-in (10 min)
Board presentations (15 Min)	Board presentations (15 Min)	Board presentations (15 Min)	
Teacher lectures Double-Angle formulas and examples (15 min)	Teacher lectures Half-Angle formulas and examples (15 min)	Teacher lectures Sum and Product formulas and examples (15 min)	
Informal pairs within groups work out new example and class discusses results (10 min)	Informal pairs within groups work out new example and class discusses results (10 min)	Informal pairs within groups work out new example and class discusses results (10 min)	Individual quiz on Double-Angle, Half-Angle and Sum/Product identities (35 min)

Table 6 (cont.)
Lesson Plans for the Trigonometric Identity Unit.

WEEK 3 Day 9	Day 10	Day 11	Day 12
Group quiz Check-in (5 min)	Group homework Check-in (5 min)	Group homework Check-in on chapter summaries (5 min)	Individual test on trig identities unit (50 min)
Teacher mini-lectures on quiz issues (5 Min)	Board presentations (10 Min)	Practice test (45 Min)	
Teacher lectures Linear Combination (15 min)	Teacher lectures Double-Angle formulas (25 min)		
Informal pairs within groups work out new example and class discusses results (10 min)	Informal pairs within groups work out new example and class discusses results (10 min)	Review group posts answers to practice test and fields questions (10 min)	
Scribe and corroborator check-in and group begins homework (10 min)	Scribe and corroborator check-in (5 min)	Scribe and corroborator check-in on way out	

APPENDIX J:

PERMISSION REQUEST LETTERS

October 15, 2006

Dear Parent or Guardian:

I am a doctoral student in the Institute for Catholic Educational Leadership at the University of San Francisco and a veteran teacher at St. Ignatius. Increasingly, I have found that our students are required to work in groups in college and beyond. Unfortunately, our better students have had the experience of doing more than their fair share of the work in these situations. As part of my doctoral studies, I am investigating ways to design cooperative learning in such a way that this does not happen and such that the better students have a more positive experience of academic team work.

I am privileged to be allowed, as a member of the SI community, to gather information on this subject. In addition, Mr. --- and Ms. -- have agreed to work with me in examining the extent to which cooperative learning might increase achievement and positive attitude toward group work. For the next 12 weeks, Mr. --- , Ms. -- and I will be looking carefully at the ways that cooperative learning can be implemented in their PreCalculus classes.

I am asking you permission to administer an attitude inventory to you r child at both the beginning and again at the end of the study. In addition, I will be gathering archival demographic data, including (a) gender, (b) ethnicity, (c) algebra GPA, (d) overall GPA, (e) PSAT scores in math, (f) motivation rating by used for placement in PreCalculus, (g) previous algebra course, and (h) course test scores, to determine which factors might predict attitudes toward cooperation. As you will read in the enclosed permission slip, this instrument and the gathered archival data should not pose any risk to your child and will not affect his or her grade in any way. On the other hand,the benefit to your child will be knowing the scores on the Classroom Life Inventory, which, in part, measures how comfortable he or she is with cooperative learning and how supported he or she feels by teacher and classmates. Those in the cooperative learning class may have their understanding of and attitude toward group work improved. In addition, your child's participation in this study will provide valuable information that may shape future methodology and curriculum design.

I hope that you and your child will consent to his or her participation in this study by signing the attached permission form and returning them to Mr. --- and Ms. --. I have included copies with my signature for your files. If you have any concerns about your child's participation, I am can respond to any questions by phone (415-731-7500x751) or, better, by email at kquattrin@siprep.org. We can also make an appointment to meet personally during regular school hours.

Thank you for your thoughtful consideration of my request. Sincerely,

Kevin Quattrin
Doctoral Student
University of San Francisco

Mr. Kevin Quattrin
330 Loma Vista Terrace
Pacifica, CA 94044
650-355-8877
kquattrin@siprep.org

October 15, 2006
Dear Colleague (name),

Thank you for our conversation today in which you agreed to support my research examining how cooperative learning may effect attitude and achievement in a college preparatory pre-calculus class. As you know, I am a math teacher at St. Ignatius College Preparatory in San Francisco and a doctoral candidate in the University of San Francisco's Institute of Catholic Educational Leadership.

You are being asked to participate in this research study because you are a pre-calculus teacher at a Jesuit college preparatory. If you agree to be in this study, you will complete the undergo training in cooperative learning and will adjust your teaching methodologies for the duration of the study.

It is possible that adjusting you r methodologies may make you feel uncomfortable, but you are free to decline to participation at any time. Participation in research will not mean a loss of confidentiality. Records will be kept as confidential. No individual identities will be used in any reports or publications resulting from the study. Study information will be coded and kept in locked files at all times and computer files will only include pseudonyms. Only study personnel will have access to the files. Individual results will not be shared.

I appreciate the multiple pressures of your job, and am grateful for *your* help. In the next day or two you will receive an instrumentation packet complete with instructions on their use and distribution and a sample set of lesson plans for the duration of the study. Other support materials will distributed as they become available.

The results of this study will help us provide the learning opportunities our faculties need to meet the needs of students who will live their entire adult lives. For you particularly, the expansion and deepening of your pedagogical repertoire is of great value to both you and your school. If you have any questions please do not hesitate to contact me at 415-731-7500 # 751, or at kquattrin@siprep.org.

Thank you again for your generosity in making it possible to improve education for all of our children. I will pray that God bless you and your work, and grant you peace, love, and grace.

Sincerely,

Kevin Quattrin

APPENDIX K:

CONSENT FORMS

11 July 2006

Institutional Review Board for the Protection of Human Subjects
University of San Francisco
2130 Fulton Street
San Francisco, CA 94117

Dear Members of the Committee:

On behalf of College Preparatory, I am writing to formally indicate our awareness of the research proposed by Mr. Kevin Quattrin, a student at USF. We are aware that Mr. Quattrin intends to conduct his research by conducting a quasi-experiment on cooperative learning in four of our PreCalculus A and PreCalculus B classes.

I am the principal of St. Ignatius. I give Mr. Quattrin permission to conduct his research in our school. I also acknowledge that Mr. Quattrin, as our school Statistician, has access to archival data and has permission to use it in his research.

If you have any questions or concerns, please feel free to contact my office at (415)731-7500.

Sincerely,

Principal

University of San Francisco

Consent to Allow My Child to be a Research Subject

Purpose and Background

Mr. Kevin Quattrin, a graduate student in the Catholic Educational Leadership Program at the University of San Francisco, is doing a study on the effect of cooperative learning on attitude and achievement. Because advanced students are more likely to develop a dislike of group work due to having to more than their fair share of the work, the researcher is interested in learning whether these children's attitude about group work can be changed and whether their achievement will increase, as compared with children in a traditional individualistic/lecture setting. My child is being asked to participate.

Procedures

If I agree to allow my child to be in this study, the following will happen:

1. He or she will be asked to complete the Classroom Life Inventory, a questionnaire by Roger Johnson, PhD, at the beginning and ending of the study.
2. He or she will participate in a PreCalculus class as usual for the duration of the study.
3. He or she will take the Trigonometric Identity Unit Test and the Introductory Calculus Unit Test, as a usual part of the PreCalculus class.
4. Mr. Quattrin will have access to and use of the school's archive data, in particular, my child's (a) gender, (b) ethnicity, (c) algebra GPA, (d) overall GPA, (e) PSAT scores in math, (f) motivation rating by used for placement in PreCalculus, (g) previous algebra course and (h) course test scores.

Risks and/or Discomforts

1. There are no risks or discomforts anticipated from the attitude portion of the study. I understand that scores on the Classroom Life Inventory will not count in any way toward my child's grade in PreCalculus and are being conducted for educational research purposes.
2. Some students may be uncomfortable with aspects of the achievement part of the study. Students in either the cooperative learning class or the traditional class may feel the other class has an advantage. Both methodologies are widely accepted standard practices outside this study and their use is normally at the discretion of the teacher. Students will be individually accountable for all test scores and grades in both classes. There will be no group grades on any project or test.
3. Participation in research may mean a loss of confidentiality. Student records will be kept as confidential as possible and pseudonyms will be used on all data gathered. No individual identities will be used in any reports or publications resulting from the study. Study information will be coded and kept in locked files at all times. Only study personnel will have access to the files.

Benefits
My child will benefit by knowing the scores on the Classroom Life Inventory, which, in part, measures how comfortable he or she is with cooperative learning and how supported he or she feels by teacher and classmates. Those in the cooperative learning class may have their understanding of and attitude toward group work improved.

The anticipated benefit of this study is three-fold. This study will increase the body of knowledge regarding cooperative learning in the field of mathematics. It will expand and deepen the teachers' repertoire of skills and methodologies. It will expand the literature on the interplay between cooperative learning and Ignatian Pedagogy.

Alternative

I am free to choose not to allow my child to participate in the study. This would not require a schedule change. My child would participate in class as usual, but data will not be gathered n him or her.

Costs/Financial Considerations
There will be no costs to me or to my child as a result of taking part in this study.

Payment/Reimbursement
Neither my child nor I will be reimbursed for participation in this study.

Questions
I have talked to Mr. Quattrin or my child's teacher about this study and have had my questions answered. If I have further questions about the study, I may call him at (415) 731-7500 x 751 or email him at kquattrin@siprep.org.

If I have any questions or comments about participation in this study, I should first talk with the researchers. If for some reason I do not wish to do this, I may contact the IRBPHS, which is concerned with protection of volunteers in research projects. I may reach the IRBPHS office by calling (415) 422-6091 and leaving a voicemail message, by FAX at (415) 422-5528, by e-mailing IRBPHS@usfca.edu, or by writing to the:

IRBPHS, Department of Counseling Psychology
Education Building, University of San
Francisco, 2130 Fulton
Street, San Francisco, CA 94117-1080.

Consent
I have been given a copy of the "Research Subject's Bill of Rights" and "The Family Education Rights and Privacy Act (FERPA) Statement," and I have been given a copy of this consent form to keep. PARTICIPATION IN RESEARCH IS VOLUNTARY. I am free to decline to have my child be in this study, or to withdraw my child from it at any point. My decision as to whether or not to have my child participate in this study will

have no influence on my child's present or future status in PreCalculus or as a student at St. Ignatius College Preparatory.

My signature below indicates that I agree to allow my child to participate in this study.

_____	_____
Signature of Subject's Parent/Guardian	Date of Signature
_____	_____
Signature of Person Obtaining Consent	Date of Signature

RESEARCH SUBJECTS' BILL OF RIGHTS

The rights below are the rights of every person who is asked to be in a research study. As a research subject, I have the following rights:

(1) To be told what the study is trying to find out;

(2) To be told what will happen to me and whether any of the procedures, drugs, or devices are different from what would be used in standard practice;

(3) To be told about the frequent and/or important risks, side effects, or discomforts of the things that will happen to me for research purposes;

(4) To be told if I can expect any benefit from participating, and, if so, what the benefit might be;

(5) To be told of the other choices I have and how they may be better or worse than being in the study;

(6) To be allowed to ask any questions concerning the study both before agreeing to be involved and during the course of the study;

(7) To be told what sort of medical or psychological treatment is available if any complications arise;

(8) To refuse to participate at all or to change my mind about participation after the study is started; if I were to make such a decision, it will not affect my right to receive the care or privileges I would receive if I were not in the study;

(9) To receive a copy of the signed and dated consent form; and

(10) To be free of pressure when considering whether I wish to agree to be in the study.

If I have other questions, I should ask the researcher or the research assistant. In addition, I may contact the Institutional Review Board for the Protection of Human Subjects (IRBPHS), which is concerned with protection of volunteers in research projects. I may reach the IRBPHS by calling (415) 422-6091, by electronic mail at IRBPHS@usfca.edu, or by writing to

USF IRBPHS, Department of Counseling Psychology, Education Building
2130 Fulton Street
San Francisco, CA 94117-1080.

USF FERPA STATEMENT

Notification of Rights Under FERPA

The Family Education Rights and Privacy Act (FERPA) affords students certain rights with respect to their education records. These rights include:

1 If the records are not maintained by the University official to whom the request was submitted, that official shall advise the student of the correct official to whom the request should be addressed.

2 Additional information regarding the hearing procedures will be provided to the student when notified of the right to a hearing.

3. A school official has a legitimate educational interest if the official needs to review an educational record in order to fulfill his or her professional responsibility. Directory information at the University of San Francisco includes: Student's name, school of enrollment, credit hour load (full-time, part-time), periods of enrollment, degree(s) awarded and date(s) of conferral, honors, participation in athletic activities, weight and height of athletic participants, major and minor fields, and dean's list.

The name and address of the office that administers FERPA is:
Family Policy Compliance Office
U.S. Department of Education
400 Maryland Avenue SW
Washington, D.C. 20202-4605

University of San Francisco

Assent to be a Research Subject

Purpose and Background

Mr. Kevin Quattrin, a graduate student at the University of San Francisco, is doing a study on the effect of cooperative learning on attitude and achievement. Because advanced students are more likely to develop a dislike of group work due to having to more than their fair share of the work, the researcher is interested in learning whether these children's attitude about group work can be changed and whether their achievement will increase, as compared with children in a traditional individualistic/lecture setting. My child is being asked to participate.

Procedures

If I agree to participate in this study, the following will happen:

1. I will be asked to complete the Classroom Life Inventory, a questionnaire by Roger Johnson, PhD, at the beginning and ending of the study.
2. I will participate in a PreCalculus class as usual for the duration of the study.
3. I will take the Trigonometric Identity Unit Test and the Introductory Calculus Unit Test, as a usual part of the PreCalculus class.
4. Mr. Quattrin will have access to and use of the school's archive data, in particular, my (a) gender, (b) ethnicity, (c) algebra GPA, (d) overall GPA, (e) PSAT scores in math, (f) motivation rating by used for placement in PreCalculus, (g) previous algebra course and (h) course test scores.

Risks and/or Discomforts

1. There are no risks or discomforts anticipated from the attitude portion of the study. I understand that scores on the Classroom Life Inventory will not count in any way toward my grade in PreCalculus and are being conducted for educational research purposes.
2. I may be uncomfortable with aspects of the achievement part of the study. Whether in the cooperative learning class or the traditional class, I may feel the other class has an advantage. Both methodologies are widely accepted standard practices outside this study and their use is normally at the discretion of the teacher. Students will be individually accountable for all test scores and grades in both classes. There will be no group grades on any project or test.
3. Participation in research may mean a loss of confidentiality. My records will be kept as confidential as possible and pseudonyms will be used on all data gathered. No individual identities will be used in any reports or publications resulting from the study. Study information will be coded and kept in locked files at all times. Only study personnel will have access to the files.

Benefits

I will benefit by knowing the scores on the Classroom Life Inventory, which, in part, measures how comfortable he or she is with cooperative learning and how supported he or she feels by teacher and classmates. Those in the cooperative learning class may have their understanding of and attitude toward group work improved.

The anticipated benefit of this study is three-fold. This study will increase the body of knowledge regarding cooperative learning in the field of mathematics. It will expand and deepen the teachers' repertoire of skills and methodologies. It will expand the literature on the interplay between cooperative learning and Ignatian Pedagogy.

Alternative

I am free to choose not participate in the study. This would not require a schedule change. I would participate in class as usual, but data will not be gathered n him or her.

Costs/Financial Considerations
There will be no costs to me as a result of taking part in this study.

Payment/Reimbursement
I will be reimbursed for participation in this study.

Questions
I have talked to Mr. Quattrin or my teacher about this study and have had my questions answered. If I have further questions about the study, I may call him at (415) 731-7500 x 751 or email him at kquattrin@siprep.org.

If I have any questions or comments about participation in this study, I should first talk with the researcher. If for some reason I do not wish to do this, I may contact the IRBPHS, which is concerned with protection of volunteers in research projects. I may reach the IRBPHS office by calling (415) 422-6091 and leaving a voicemail message, by FAX at (415) 422-5528, by e-mailing IRBPHS@usfca.edu, or by writing to the:

IRBPHS, Department of Counseling Psychology
Education Building, University of San
Francisco, 2130 Fulton
Street, San Francisco, CA 94117-1080.

Consent
I have been given a copy of the "Research Subject's Bill of Rights," and I have been given a copy of this consent form to keep. PARTICIPATION IN RESEARCH IS VOLUNTARY. I am free to decline to have my child be in this study, or to withdraw my child from it at any point. My decision as to whether or not to have my child participate in this study will have no influence on my present or future status as in PreCalculus or as a student at St. Ignatius College Preparatory.

My signature below indicates that I agree to participate in this study.

_____ _____
Signature of Subject Date of Signature

_____ _____
Signature of Person Obtaining Consent Date of Signature

University of San Francisco

Teacher Consent to Be a Research Subject

Purpose and Background

Mr. Kevin Quattrin, a graduate student at the University of San Francisco, is doing a study on the effect of cooperative learning on attitude and achievement. Because advanced students are more likely to develop a dislike of group work due to having to more than their fair share of the work, the researcher is interested in learning whether these children's attitude about group work can be changed and whether their achievement will increase, as compared with children in a traditional individualistic/lecture setting. I am being asked to participate because I am a pre-calculus teacher at a Jesuit college preparatory school.

Procedures

If I agree to be a participant in this study, the following will happen:

1. I will administer the Classroom Life Inventory to two of my classes.

2. I will teach my regular schedule of classes as per my contract with St. Ignatius College Preparatory. I will adjust my teaching methodologies to allow for treatment and control groups as defined by the study.

3. I will meet with the researcher regularly to evaluate the progress of the study and to plan to future classes.

4. I will submit my lesson plans to the researcher for validation of consistency in content and differences in teaching methodologies between treatment and control groups.

Risks and/or Discomforts

1. There are no serious risks or discomforts anticipated in the study. The inconveniences of meeting with the researcher on a regular basis and the extra time required for lesson planning are the only anticipated risks/discomforts.

2. Confidentiality: All records will be kept as confidential and pseudonyms will be used on all data gathered. No individual identities will be used in any reports or publications resulting from the study. Study information will be coded and kept in locked files at all times. Only study personnel will have access to the files.

3. Because the time required for my participation, I may become tired or bored.

Benefits

The direct benefit from participating in this study is the expansion of my teaching

repertoire and my increased understanding of my students perceptions regarding cooperative learning and my classroom's social support system. In addition, I study will increase the body of knowledge regarding cooperative learning in the field of mathematics and expand the literature on the interplay between cooperative learning and Ignatian Pedagogy.

Costs/Financial Considerations

There will be no financial costs to me as a result of taking part in this study.

Payment/Reimbursement

I will be reimbursed for participation in this study.

Questions

I have talked to Mr. Quattrin about this study and have had my questions answered. If I have further questions about the study, I may call him at (415) 731-7500 x 751 or email him at kquattrin@siprep.org.

If I have any questions or comments about participation in this study, I should first talk with the researcher. If for some reason I do not wish to do this, I may contact the IRBPHS, which is concerned with protection of volunteers in research projects. I may reach the IRBPHS office by calling (415) 422-6091 and leaving a voicemail message, by e-mailing IRBPHS@usfca.edu, or by writing to the IRBPHS, Department of Psychology, University of San Francisco, 2130 Fulton Street, San Francisco, CA 94117-1080.

Consent

I have been given a copy of the "Research Subject's Bill of Rights" and I have been given a copy of this consent form to keep. PARTICIPATION IN RESEARCH IS VOLUNTARY. I am free to decline to be in this study, or to withdraw from it at any point. My decision as to whether or not to participate in this study will have no influence on my present or future status as a student or employee at USF.

My signature below indicates that I agree to participate in this study.

_____

Subject's Signature Date of Signature

_____

Signature of Person Obtaining Consent Date of Signature

APPENDIX L:

INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS (IRBPHS) APPROVAL

August 23, 2006

Dear Mr. Quattrin:

The Institutional Review Board for the Protection of Human Subjects (IRBPHS) at the University of San Francisco (USF) has reviewed your request for human subjects approval regarding your study.

Your application has been approved by the committee (IRBPHS #06-064). Please note the following:

1. Approval expires twelve (12) months from the dated noted above. At that time, if you are still in collecting data from human subjects, you must file a renewal application.

2. Any modifications to the research protocol or changes in instrumentation (including wording of items) must be communicated to the IRBPHS. Re-submission of an application may be required at that time.

3. Any adverse reactions or complications on the part of participants must be reported (in writing) to the IRBPHS within ten (10) working days.

If you have any questions, please contact the IRBPHS at (415) 422-6091.

On behalf of the IRBPHS committee, I wish you much success in your research.

Sincerely,

Terence Patterson, EdD, ABPP
Chair, Institutional Review Board for the Protection of Human Subjects
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IRBPHS - University of San Francisco
Counseling Psychology Department
Education Building - 017
2130 Fulton Street
San Francisco, CA 94117-1080
(415) 422-6091 (Message)
(415) 422-5528 (Fax)
irbphs@usfca.edu
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http://www.usfca.edu/humansubjects/