A STUDY OF THE EFFECTS OF THE IMPLEMENTATION OF SMALL PEER LED COLLABORATIVE GROUP LEARNING ON STUDENTS IN DEVELOPMENTAL MATHEMATICS COURSES AT A TRIBAL COMMUNITY COLLEGE

by

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DEDICATION

This dissertation is dedicated my family: my children Hayden, Leidy, and Kennan, who grew up while I was busy taking classes and writing; my husband Jeff, who supported me through it all and was always there when I needed him, offering advice and assistance; my parents Ken and Nancy, who never failed to ask how it was coming, encouraged me to keep working, do the best you can, and never give up; and thanks sis for being with me every time I logged on to the computer.

Leidy, mom is finally done with college.

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ABSTRACT

College students needing remediation in mathematics are a problem at nearly all colleges and universities but are immense at community colleges where large numbers of students enroll in developmental mathematics courses. This issue for Native American students at Tribal Community Colleges has an enormous effect on future opportunities in education, employment, politics and society. The overarching research question was: How does the implementation of small peer-led collaborative learning groups affect students in developmental mathematics courses at the Tribal Community College? To answer this question five sub-questions were addressed. What impact will the treatment have on: 1) completion, 2) perseverance, 3) demonstrated procedures of mathematics, 3) personal skills for success, and 4) the leaders' perceptions of the benefits associated with acting as small peer led collaborative group leader?

This research study took place at a small Tribal Community College. The quasi-experimental, mixed methods study involved collection and analysis of both quantitative and qualitative data. The treatment class consisted of having the students work together on a workshop activity designed to be engaging, challenging and relevant for one class period each week in small peer-led collaborative learning groups. Peer leaders were chosen according to predetermined criteria. The peer leaders were trained to help guide the group in the direction of a solution and to help the group learn how to collaborate to achieve the best results. The control class was given the same workshop activity to work on, but not encouraged to work together nor assisted by a peer leader.

Results of this research study show increased completion and perseverance rates. Students participating in the small peer-led collaborative groups were more likely to attempt mathematics. The attitude toward mathematics was the most drastic change; students now look forward to attending their mathematics class and spend more time out of class doing mathematics. Group leaders gained personal, academic and leadership skills. Detailed descriptions of the results are given. In conclusion, implications of the findings and how they may be used are provided for mathematics instructors, administrators and student support personnel are offered. Recommendations for further research are also suggested.

CHAPTER 1

INTRODUCTION TO THE STUDY

Introduction

Colleges and universities are struggling to find ways to accommodate the need for remediation in mathematics and English for entering students (Achieve, 2005; Curtis, 2000; Jones, 2002). Community colleges often find that over 60 percent of their students are required to take at least one developmental course and the most commonly taken developmental course is mathematics (Adelman, 2004; Schuetz, 2002; Winograd, 2007). Native American students entering tribal colleges have about a 20 percent chance of being prepared for college level material in all subject areas, and a lower chance in mathematics (Freeman & Fox, 2005).

According to a study by Freeman and Fox (2005), less than 15 percent of American Indian/Alaska Natives scored at or above the proficient level in mathematics in the 8th grade; this number most likely decreases in the four subsequent years of high school (Freeman & Fox, 2005). In Montana, only 23% of the students at the two high school districts closest to the tribal college used in the present study -test at or above proficiency (Montana Office of Public Instruction, 2009). In such settings, many students rise above the level of their teachers by the fifth or sixth grade and have no one to teach them “higher” level mathematics (Moses, 2001). Students at this age also perceive mathematics as important and not too hard to learn. But more fifth and sixth grade Native American students also think of mathematics as useless and they have very few role models to demonstrate to them why or how it is useful (Mather, 1997).

Many Native American students are not motivated to learn mathematics (Cardona & Artiles, 1998). Although the high school graduation rate of American Indians is estimated to be 54 percent, the college readiness rate is estimated to be 14 percent, thus indicating that the number of American Indian students entering higher education with remediation needs is about 86 percent (Burley, 1994; Green & Forester, 2003; Ashburn, 2007). The American College Testing Program (ACT), estimates that only 40 percent of all U.S. students are ready for college level algebra. This number drops to 23 percent for the Native American population (ACT, 2005). In addition to the large number of students who need remediation, completion and retention rates among these students are very low (Boughan, 1995). It is not unusual for course completion rates to be under 50 percent. Retention rates from one semester to the next are similarly low, implying that less than one-half of the students who begin a developmental course do not progress to the next level. In an effort to improve student understanding and success, this study examines how small peer led collaborative study groups affect student learning in developmental mathematics courses at a Tribal Community College.

National Data on Developmental Mathematics

Student outcome and achievement data from public colleges and universities across the nation reveal that approximately 40 percent of all students are enrolled in developmental classes, and approximately 30 percent are enrolled in developmental mathematics classes their first year of college (Conley, 2006; Curtis, 2000; Green and Forster, 2003; Greene & Winters, 2005; Keller, 2000; National Center of Educational Statistics; 2004; Ohio Board of Regents, 2005; Olson, 2006; Illinois Community College Board, 1997; Illinois Community College Board, 1998; Remedial/Developmental Education in the Kansas Community College System, 1988; Waycaster, 2001; Winograd, 2007; Young, 2002). The students at the historically black colleges and universities represent the largest proportion of students needing remediation. Students attending community colleges account for over half the minority enrollment in higher education institutions and, of the minorities in the community college, nearly 90 percent are enrolled in developmental programs (Burley, 1994; Littleton, 1998; Roderick et.al., 2009; Kline & Williams, 2007; Ashburn, 2007).

The number of developmental courses a student takes limits the students' ability to achieve a baccalaureate degree by exhausting their available PELL grants on developmental courses. This is especially affects many minority college students. Completion of developmental classes and retention to the next semester present additional challenges to students and schools. A typical success rate for students in a developmental mathematics classes, earning a grade of C or better, ranges from 24 percent to 50 percent, with about 40 percent being the most common completion number (Guthrie, 1992; Maack, 2002). Once a student passes their first developmental mathematics class completion rates for subsequent mathematics classes rises to over 60 percent (Maack, 2002). The strongest predictor for student performance in the first year of college is the student's performance in his or her mathematics course. This also affects drop out rates. College freshmen who take no mathematics class during the first year are five times as likely to not return to the college for a second year (Herzog, 2005).

Community College Data on Developmental Mathematics

Using data from the US Department of Education, Clifford Adelman found that over the past 30 years the proportion of all students taking at least one developmental course at community colleges has remained virtually constant at 61-63 percent (Adelman, 2004). From the same study it is also interesting to note that out of the top 20 undergraduate classes with the highest proportions of withdraws or no-credit repeats, the top four are all developmental mathematics classes. There are five developmental mathematics courses in the top nine and a total of ten developmental mathematics courses in the top twenty undergraduate classes with the highest proportions of withdraw or no-credit repeats.

The states of Florida, Illinois and Maryland reported that approximately 90 percent of all remediation occurs at their two year institutions, where the percentage of students needing remediation in mathematics hovers between 42 and 70 percent (Florida State House of Representatives, 1996; Illinois Community College Board, 1998; Keller, 2000; Roderick, et.al., 2009; McClenney, 2009; Viadero, 2005 They also reported that there was very little difference in the need for developmental mathematics between men and women. Minorities appeared to have the highest need for remediation, based on college readiness rates and graduation rates. (Florida State House of Representatives, 1996; Green and Forster, 2003; Keller, 2000).

Time to Degree Completion

The percentage of four-year degrees has remained fairly constant in the past decade, but it now takes an average of six years to earn the four-year college degree, with 30-60 percent of college students needing some sort of developmental courses (Conley, 2006). Similar information from the state of Ohio reports that students took an average of 3.8 calendar years to complete an associate degree and 4.3 calendar years to complete a bachelor's degree (Neutzling, 2003). The National Center for Educational Statistics reports that the average time for a student to complete an associates degree is 3.5 years, while the time to complete a "one year" certificate is 2.5 years (Hoachlander, 2003; Horn 2009). An unpublished study at the Tribal Community College where this study took place concluded that the average time to completion of an associate's degree in the fields of science, mathematics, and technology was 3.6 years

Tribal Community Colleges

Tribal community colleges were created in the late 1960's and 1970's across the United States to increase postsecondary education opportunities for Native Americans by locating the colleges on the reservations. Many Tribal community colleges are located in the rural west. The role of the Tribal community college is twofold: to meet the instructional needs of the community and to help preserve and perpetuate traditional culture in the community (Tribal College catalog, 2007-2009). The Tribal community college is often seen as the only means for professional, vocational, and personal development of individual students and for their advancement into higher education or the workplace. The Tribal community college is the place where Native American students feel they have a safe learning environment and can succeed.

Tribal Community College Data on Developmental Mathematics

Tribal community colleges experience the same need for remediation as other community colleges and universities, but at higher percentages. Over 98 percent of the students at the Tribal community colleges are residents of the local counties and most grow up and received their entire education in those counties (IPEDS report 2006-2007). Montana has seven Tribal community colleges and, according to the Montana Office of Public Instruction (OPI), the results of the 2006-2007 statewide Criterion-Reference Test (CRT) indicate that less than 27 percent of all Native Americans at high schools on or near the reservations where the state's Tribal community colleges are located test at or above proficiency in mathematics at the 10th grade level (Montana Office of Public Instruction, 2009. p. 10-13). This proficiency rate is less than ten percent at two out of the four high schools on or near the reservation where the Tribal Community College in this study is located. One of the four high schools did not have sufficient numbers to report the results (Montana OPI, 2009, p. 10-13). To further amplify the problem, many of the students do not take any mathematics classes the last two years of high school. Many of these students choose to enter the Tribal community college and thus have a large mathematics deficiency to overcome.

At one Tribal community college, "the average student entering the Tribal community college scores at the eighth-grade level in mathematics and science" (Rousey & Longie, 2001, page 1493). This is very typical of Tribal community college students in general. Remediation is necessary to bring students up to a college level. Successful completion of the developmental courses increases the students' persistence to complete a degree; failure often leads to the students stopping out for a period of time. "Stopping out" is a term used frequently at Tribal community colleges for students who take a number of semesters off but eventually return to the college. Either way, the need for developmental courses increases the time-to-degree for the student. In an area of low socio-economic status, this time delay has an impact on the financial resources and hence degree completion.

Completion rate is an issue at most Tribal community colleges. An average of less than 40 percent of the developmental mathematics students complete their mathematics class. Data from the past five years, summarized by TSET-2005 (Tribal Colleges Undergraduate Program Self Evaluation Template), indicate completion rates at Montana Tribal colleges in developmental mathematics classes generally range from 29 percent to 40 percent. The completion rates across all Tribal colleges are very similar (TSET-2005) and match the numbers given in several national studies, i.e. between 20 and 45% (Guthrie, 1992; Maack, 2002). This has lasting educational, social, and financial implications. If a class must be repeated, it affects the plan of study and may cause course conflicts that make it difficult to take other classes necessary for the degree. Student self esteem and academic confidence is often fragile and needing to withdraw from or failing classes only accentuates that problem. Over 60 percent of the students at one Tribal Community College rely fully on government funded PELL grants to pay for higher education costs. So each extra semester used at the two-year Tribal college means one more semester without funding when they transfer to a four-year institution (Tribal College AKIS Report, 2007). It is imperative that tribal colleges find a way to increase completion and retention in their developmental mathematics courses.

The Problem

The lack of success of Native American students in developmental entry-level mathematics courses at the Tribal community college has an enormous effect on future opportunities in education, employment, and socio-economic advancement. (Greene & Forester, 2003).

Purpose of the Study

This study focused on how the implementation of mandatory small, peer-led, collaborative-group-learning workshops affected developmental mathematics students at a small Tribal Community College. The study sought to determine if the use of such workshops had a measurable impact on completion, perseverance, and demonstrated use of mathematical procedures for Native American students enrolled in developmental mathematics classes at the College. The study also looked at how the peer leaders changed as they led the groups through the workshop exercises.

Focus Questions

The following questions were addressed in this study:

1) What impact did the implementation of small, peer-led, collaborative-group-learning workshops have on completion rates of Native American students in developmental mathematics classes at a two-year Tribal Community College?
2) What impact did these workshops have on perseverance rates of Native American students in developmental mathematics classes at a two-year Tribal Community College?
3) Did the implementation of the workshops improve the demonstrated mathematical procedural skills of Native American students at a two year Tribal Community College?
4) What other skills connected to the success of Native American students at a two-year Tribal Community College can be attributed to the use of small, peer-led collaborative-learning-group workshops?
5) What were the peer leader's perceptions of the benefits or deficits associated with their role in the workshops?

Teaching and Learning Strategies Identified as Effective for Native Americans

Several groups that address education for Native Americans including the American Indian Science & Engineering Society (AISES) , the National Indian Education Association (NIEA), and the Center for Research in Education Diversity and Excellent

(CREDE) have proposed teaching strategies that help Native students learn mathematics (AISES, 1994; Hilberg, et. al., 2002, Tharp & Yamauchi, 1994). However, it must be recognized that there is great variation among Native American tribal populations and what may work well for one group does not always work well with others. There is some agreement that Native American students learn best with hands-on, inquiry-based and cooperative-learning methods. The students need to be recognized as important contributing members of the class or group. Group work allows students to take responsibility for their own learning and understanding by contributing to discussions and activities (AISES, 1994).

Pewewardy (2002) proposed seven common dimensions of the learning styles of American Indian students. This research suggests that American Indian students tend to be holistic\visual learners who are reflective, prefer cooperative learning to competition and benefit from culturally relevant examples for learning. Relationships between the student, instructor, and other students are important bonds for learning and classroom activities. Traditionally, family, elders, and Tribal members played a large part in education. Finding a means to continue these relationships in classrooms improves the learning environment (Pewewardy, 2002).

> "Cooperative learning is an excellent way to lessen competition and help students develop a sense of teamwork and pride in one's groups. Allowing students to work in groups or pairs to tutor peers or to tutor younger children is also an excellent teaching strategy. American Indian /Alaska Native students enjoy sitting in groups or circles using group problem-solving techniques" (Pewewardy, 2002, page 30).

The idea of building on the student's background experiences, using holistic and community-centered approaches that emphasize high expectations, cooperative learning, and self-esteem building are common in summaries of effective Indian Education (Gilliland's 1999; Radda, Iwamoto, & Patrick, 1998; Reyhner, 1992; Rhodes, 1994).

Native Culture and Ways of Learning

Teaching must include culturally relevant examples and be applicable to everyday experiences (AISES, 1994; Reyes, 1991; Reyhner & Davidson, 1992). One of the themes that emerges in the AISES review of the literature was the "disregard for cultural relevancy" in education (AISES, 1994). When this occurs a barrier develops that makes it very difficult to learn the subject matter. Topics that are taught without connecting them to everyday life experiences are often difficult to understand. This is a fairly common occurrence with mathematics and science topics. Other barriers develop in the classroom as a result of class rules and expectations. Western education often uses competition to rank participants with each other. Rewards are given for getting finished first and receiving the best scores (Reyes, 1991; Swisher, 1990). In most Native communities these qualities are not valued as much as cooperation and teamwork. Bragging about oneself is considered improper and too much public praise could put a student at risk of being made fun of by his or her peers, although praise is important to encourage effort (Radda, Iwamoto, Patrick, 1998).

Family and community also contribute to the teaching methodologies recommended for Native Americans. Familial relationships are very supportive and extensive. Tribal elders and older family members are teachers and respected as such. They teach by doing and letting younger members watch, observe and then attempt on their own timeline when they feel ready (Nelson-Barber & Estrin, 1995; Pease, 2000; Swisher 1991, Swisher & Deyhle, 1989). This pattern is disrupted in many schools where everything operates on a strict schedule. Furthermore, students are very concerned about how they are perceived by their peers (Swisher, 1990). Most Native American children are taught to cooperate and help everyone to succeed. They have worked together for the good of everyone and our current education system often discourages working for the group and encourages individuality and doing the best for oneself. These inconsistencies are very confusing to the students whose circumstances and culture may require them to spend more time trying to navigate the social differences of class and life than learning the concepts the teacher is putting forth (Barta, 1999; Bradley, 1984; Cajete, 1994; Cheek, 1984; Nelson-Barber & Estrin, 1995; Pease, 2000; Reyes, 1991; Reyhner & Davison, 1992; Swisher, 1990; Swisher & Deyhle, 1989).

Collaborative and Cooperative Learning

Collaborative learning has been suggested as an excellent method for helping American Indian students learn. The experience gives the students the opportunity to work together to develop a sense of teamwork and pride (Pewewardy, 2002; Reyes, 1991; Swisher, 1990). It allows the students to try out new ideas in a safe, non-threatening, non-competitive setting. Although competition among individuals is discouraged, competition among clan or team groups is very acceptable. This means everyone in the group is working toward the common goal and any reward or praise is shared as well. The collaboration provides a venue for each individual to try out or test his or her abilities without fear of failure or criticism. Others offer suggestions and encouragement for improved performance without judgment.

Peer Learning

Peer learning has benefits for all parties. Traditionally this was done in groups of similar-age children, often among siblings and cousins who had a special bond or relationship (Pease, 2000). The peers would learn from each other and help each other to do better. There were challenges between peers to encourage each to further develop their abilities (Pease, 2000; Nelson-Barber & Estrin, 1995; Swisher, 1990). “Among boys the peer teaching would especially happen in the field of competition. The young boys would contest one another in running, riding, shooting arrows, hunting…” (Pease 2000, p. 8). The peers would constantly be learning from each other and sharing their accomplishments with each other. All were motivated to contribute.

Small Group Work

Small groups work to provide opportunity for each group member to be included. One complaint many Native students had about their teachers was that “they don’t know anything about me” (Barta, 1999; Cajete, 1994; Nelson-Barber & Estrin, 1995; Reyhner & Davison, 1992). Small groups give everyone the chance to get to know everyone else. So, if the connection is missing with the instructor, the group has a special bond that is shared and helps to hold the group together (Bradley, 1984; Pease, 2000). They share similar experiences, frustrations and accomplishments. They share rewards and disappointments (Reyes, 1991; Swisher, 1990).

Small groups make it hard to get lost or forgotten. It may be easy to hide in a room of thirty students, but it is not possible in a group of six or eight. When each group member is held accountable, peer pressure takes over and group members become more responsible (Soleste & Tharp, 2002; Reyhner & Davison, 1992; Reyhner & Davidson, 1992; Wauters et. al. 1989). Attendance improves and with improved attendance usually comes additional self esteem, motivation, interest and learning (AISES, 1994; Aragon, 2002; Radda, Iwamoto, & Partick, 1998; Reyes, 1991; Reyhner & Davidson, 1992; Swisher, 1991; Tinto & Goodsell-Love, 1993).

A model that combines the aspects of small group learning, collaboration and peer learning is the Peer-Led Team Leader model. A detailed description follows.

Peer-Led Team Leader (PLTL) Model

The Peer-Led Team Leader (PLTL) model is a collaborative learning model that has its roots in the area of chemistry but has been expanded to a workshop model for teaching sciences, mathematics and other subjects. “The theoretical basis for PLTL is the recognition that learning occurs best when the students are actively engaged with the material and with each other” (Sarquis, Dixon, Gosser, Kampmeier, Roth, Storzak, Varma-Nelson, 2001, p.1). The PLTL workshop model combines traditional lecture classes with two-hour workshop sessions each week to allow a unique blend of teaching and learning methods. The workshop sessions give the students a chance to actively participate in discussion, problem solving and debate. The workshops are carefully designed by the course instructor to engage the students using concepts and content recently covered in class to solve challenging problems. The workshops are mandatory and are not simply question-and-answer sessions. They involve groups of six to eight students working together to achieve a better understanding of a concept or set of concepts. “The workshop is an integrated and fundamental part of the course structure, constructed by the course instructor for all students in the course” (Tien, Roth, & Kampmeier, 2002, page 609).

Gosser et. al. (2001) describe the following six “critical components” of the workshop model:

1. The peer-led, team-learning workshop sessions are integral to the course and are coordinated with other elements.
2. The faculty teaching the courses are closely involved with the PLTL workshops and with the peer leaders.
3. The peer leaders are students who have successfully completed the course. They are well trained and closely supervised, possessing understanding of the workshop problems, teaching/learning strategies, and leadership skills for small groups.
4. The workshop materials are challenging at an appropriate level, integrated with the other course components, and designed to encourage active learning in collaborative groups.
5. The organizational features of the workshops, including the size of the groups, space, time, noise level, and teaching resources, promote learning.
6. The institution, at the highest levels of administration as well as at the department levels, encourages innovative teaching and provides sufficient logistical and financial support.

(Gosser, et.al., 2001, p.4).

The workshop is a built-in component of the course and all students must attend. Workshop leaders are chosen from students who have recently taken and passed the class. They must learn how to do their job through training sessions and weekly meetings with the course instructors and other faculty members. As the leader of the workshop group, it is his or her responsibility to make the group function effectively by clarifying the purpose and goals of workshop activities, ensuring full participation of the group members, building commitment and self-confidence, strengthening the team members' skills and approaches to problem solving and creating special opportunities for team members (Gosser, Cracolice, et.al., 2001). The workshop is designed as a set of challenging problems or activities that are consistent with the course content and pitched at an appropriate level for deepen understanding of the concepts. The workshops are designed so that group members must work together and help each other to solve the problems.

Several Models of Peer-Led Team Learning

Miami University, Ohio

In 1998 the PLTL model was adopted for use at Miami University, Oxford Ohio, in one chemistry class. The PLTL method was used in the class for students who had never had high school chemistry and were not confident in their ability to do chemistry. A comparison of end-of-semester grades indicated that although the students in the PLTL Class began the course with a significantly lower SAT score, they performed at a level equal to the more experienced and confident students in the traditional course (Sarquis &

Detchon, 2004). A second research study at Miami University in 2003, by Hoffelder & Hoffelder, looked for a gender difference in success rates as a result of the PLTL approach to instruction a general chemistry course. Students enrolling in the general chemistry course, either the PLTL-based class or the non-PLTL-based classes were used for this study. Background data was collected from the admissions office on each student and used in the analysis. A comparison of the gender groups indicates high similarity in background preparation. Results indicated the use of the PLTL approach did not appear to have a measurable effect on the success of the males in the general chemistry class, but the females enrolled in the PLTL -based class did appear to have a “better-than-expected” success rate (Hoffelder & Hoffelder, 2003).

Borough of Manhattan Community College, New York

A research study at Borough of Manhattan Community College, BMCC, in 1999, used the PLTL method in the *Fundamentals of Mathematics I* course, MAT 100. This course traditionally had a high number of liberal arts students. The community college has a large student population with and about 90 percent minority students of Black, Hispanic, Asian, and other ethnic origin. The college offers various associate degrees. The results of the study showed that the students in the PLTL program were about five percent more likely to earn grades of A, B or C and approximately four percent less likely to withdraw from class than non- PLTL students.

<u>Pilot Study of Peer-Led Team Learning</u>

A pilot test of PLTL was carried out in a first semester organic chemistry class in a small Eastern research university in the United States in 1995. The course had a history of being very competitive and challenging. Students who chose the PLTL workshop sections showed significantly higher course grades than students who registered for the traditional chemistry sections. The following year, PLTL was introduced into all sections of organic chemistry. Results showed that PLTL participants earned significantly higher scores on exams translating to higher overall course grades, approximately three tenths of one point on a four point scale, which was an increase of about 11 percent receiving a grade of C- or better. Significantly better retention rates also resulted when the scale-up of PLTL occurred (Tien, Roth, & Kampmeier, 2002). The PLTL students reported through interviews that they thought the PLTL experience helped them learn chemistry, found the workshops “socially engaging, intellectually stimulating, and above all, a productive use of their time” (Tien, Roth, & Kampleier, 2002, page 613). Students who attended more PLTL workshops (10 or more workshops out of 13) earned higher grades than students who attended less than ten workshops (Tien, Roth, & Kampmeier, 2002). Students felt that the PLTL experience built a community of learners and gave them the opportunity to think instead of just getting answers.

The PLTL method has been used in a variety of settings, at different institutions, and course levels, in different areas of study, and with various student clientele. Although each application is a little different, they all show a positive impact on student learning. Table 1 is a summary from a PLTL website displaying the results.

Many anecdotal remarks, but relatively few formal research studies, accompany the above statistics. The following is a typical anecdotal statement: "In its first year, PLTL had a major impact on our students – no class failures or incompletes, higher exam grades, enhanced communication and teamwork, and improvement in critical thinking and problem solving" (Berke, 2003).

Table 1: Comparisons of Percent of Students Achieving ABC Grades

Institution	Non-PLTL % ABC	PLTL % ABC
Historic Comparisons		
University of Rochester (Org)	66 (n = 1450)	79 (n = 1554)
St. Xavier, Chi (Org/Bioch)	72 (n = 95)	84 (n = 116)
City College 103.1 (G Ch 1)	38 (historic)	58 (n = 484)
City College 104.1 (G Ch 2)	52 (historic)	66 (n = 137)
University of Portland	44 (%AB, historic)	73 (%AB, n = 99)
Prince George's CC (A&P)	39 (historic)	53 (n = 34)
Prince George's CC (Gen Ch)	51 (n = 173)	66 (n = 156)
University of Miami (Int Bio)	82 (n = 1471)	85 (n = 1584)
Evergreen CC	65.3 (n = 269)	74.4 (n = 74)
Penn State Schuylkill (Gen Ch)	73 (n = 67)	86 (n = 90)
Randomly Assigned		
Univ of Pittsburgh (G Ch 2)	83 (n = 113)	90 (n = 130)
Self Selected Groups		
University of Rochester (Chem)	2.681 (Ave grade, n = 171)	3.095 (Ave grade, n = 119)
University of Kentucky (Chem)	63 (n = 1072)	84 (n = 92)
U of OH, Athens (Gen Chem)	76.5 (n = 292)	83.6 (n = 65)
Sierra College (Inorganic)	72.5 (n = 62	94 (n = 82)
Sierra College (Organic)	70.8 (n = 24)	94.8 (n = 19)
Portland State University	74 (n = 119)	89 (n = 44)
Miami of Ohio	70 (n = 236)	75 (n = 116)
Univ. of West Georgia	35 (n = 78)	49 (n = 145)
NYC Technical College (Chem)	62 (n = 433)	81 (n = 131)

http://www.sci.ccny.cuny.edu/~chemwksp/ResearchAndEvaluationComparisons.html

(Sarquis, Dixon, Gosser, Kampmeier, Roth, Storzak, Varma-Nelson, 2001)

Background

Over 95 percent of the students entering the Tribal Community College where this study took place must begin in a developmental mathematics course. Completion rates of the developmental mathematics courses are generally under 35 percent. (See Table 2.)

Table 2: Completion Rates in Developmental Mathematics Courses

Completion rates in developmental mathematics courses from Fall 2002 through Spring 2008				
Percent of students earning a grade of C or better.				
Semester	General Math	Pre-Algebra	Algebra	AVE
sp 08	16%	23%	29%	23%
f 07	32%	32%	28%	31%
sp 07	35%	38%	30%	34%
f 06	53%	45%	44%	47%
sp 06	41%	28%	32%	34%
f 05	10%	34%	39%	28%
sp 05	41%	22%	9%	24%
f 04	10%	16%	25%	17%
sp 04	28%	33%	26%	29%
f 03	36%	33%	26%	32%
sp 03	39%	21%	29%	30%
AVE	31%	30%	29%	30%

Entry level is determined by a standardized, mathematics placement test required by one of the government-funded grant programs at the college. Because the mathematics instructors recognize that the placement test is not entirely accurate, additional observation and informal assessment is done during the first few days of class and students are sometimes moved to other classes for more accurate placement. Students are required to take the placement test when they register for courses. Many students are not aware of this. Some do not have the time to put the necessary amount of effort into the test to show what they really know; some have children with them who provide distractions; and some are interrupted for other reasons.

Class sizes begin large, usually 30-40 students, then quickly fall to about half of the officially registered count and this count is usually much larger than the number of students who actually complete the class. A bad experience in college classes during the first semester is often blamed for the student dropping or stopping out of college, with the interruption in attendance sometimes lasting for a number of years. There are various plausible reasons for the poor completion rates of the students in the developmental classes. Students are not prepared for college, unreal expectations, no ownership or feeling of belonging are simply a few of them.

Many of the students who attend the Tribal Community College have not graduated from high school, but may have earned a General Equivalency Diploma (GED) or may be working toward one. Sixty percent of the College's students who have a high school diploma are from the lower half of their high school graduating class. Many lack motivation, exhibit a poor work ethic and fail to accept the rigor that college classes require. Students often have unreal expectations that if they put in a similar amount of effort in college as they did in high school they will receive similar grades. They often expect instructors to give them exceptions for deadlines, as many make up tests as necessary, and not hold them responsible for the material they might miss when they are absent.

Socializing is a big part of the college environment and attending classes interferes with time for socializing (Tribal Community College catalog, 2007).

Instructors have more interaction with the students than any of the non-student employees at the college. The bond between an instructor and a student is one important aspect of retaining the student in class. Teaching methods, class sizes, faculty teaching loads, cultural variation, the unfamiliarity of college settings even when located close to home, and the situations outside of school that affect community college students' lives all influence whether or not the student is retained in a given class.

Only two of the eight instructors at the Tribal Community College in the STEM (science, technology, engineering and mathematics) fields are Native American, and these two instructors both teach biological science classes. Of the instructors outside the STEM fields, four out of the seven are Native American. Ninety-eight percent of the students registered at this Tribal Community College are Native American. Each of the faculty members teach an average of 15 credits each semester leaving little time for interactions outside of class. The majority of the classes, including all developmental classes taught at the Tribal Community College, are taught using traditional methods of instruction - for example, lecture and "cookbook" labs.

Definitions

Several descriptions and definitions are useful for purpose of reporting this study. First some of the common terms that are used throughout this research will be defined.

Developmental Courses are post-secondary courses that teach the academically underprepared students the skills necessary to be successful learners (Lucas, 1993). They have also been defined as "….any program, course or other activity for students lacking necessary skills to perform college level work required by the institution" (Cahalan, 1986).

Completion rate is the percentage of students enrolled in a course who complete the course earning a grade of A, B or C. A final grade of D in a course does not meet the prerequisites for the subsequent course and is accordingly not considered a successful grade for completion.

Perseverance rate is the percentage of students who do not withdraw or quit attending the course during the semester of enrollment. Turning in a withdrawal card is often a formality that many of the students do not know about or take time to bother with. Therefore, instructor attendance records are the most accurate way to find out who completed the course.

Significance of the Study

There is research on how effective different teaching methods are for particular Native American groups. It is recognized that there are many related learning characteristics that can be generalized to all Native Americans, but there are also distinct differences. The intervention chosen for this study has not been reported in the literature as implemented or researched within any developmental mathematics courses, or in any courses offered for Native American students attending a Tribal community college.

CHAPTER 2

LITERATURE REVIEW

Literature Review Introduction

In the introduction to this study in Chapter 1, I reviewed the need for developmental mathematics in postsecondary institutions in the United States and the PLTL model for collaborative learning. The literature review will first provide an introduction to the role and purpose of the Tribal Community College, including an overview of the Tribal Community College environment in terms of both learning and socialization, followed by how this affects retention and absenteeism and typical teaching methods used by community colleges. Then I will look at effective learning styles for Native American students. This will be followed by examination of learning communities and teaching methods that appear to be successful for Native American learning communities. And finally, I will address how collaborative workgroups fit into the framework of learning and teaching developmental mathematics at a Tribal Community College.

Tribal Community Colleges

The Tribal Community College is not only a place of education; it is a place of socialization (Tribal Community College catalog, 2007). All Tribal colleges play a dual role in their communities: education and perpetuation of Tribal customs and culture. Students come to the college to interact with each other and be part of the Tribal community. It is the cultural center of the reservation. The mission statement of the Tribal Community College in this study proclaims that "The College is committed to the preservation, perpetuation and protection of culture and language, and respects the distinct bilingual and bicultural aspects of the community. The College is committed to the advancement of the Indian Family and community building" (Tribal Community College, 2007, p.1). Historic Tribal papers are housed in the college's archives. Tribal activities are preserved with both video and audio records at the college. Cultural activities and events often originate or conclude at the college. The college offers the service of being a collection point and a distribution hub used by individuals or organizations throughout the reservation. People come to the college for many reasons: to find other people, to find information, to share information, etc. It is important that the college supports and maintains Native culture and performs the task of education as well. The Tribal college gives students the opportunity for post-secondary education in a traditional setting based on their principles and values. In the process, Tribal colleges promote students' self-esteem and cultural identity (American Indian College Fund, 2005). To do this the Tribal Community College must find a way to unite culture with education so they both can flourish.

Learning Environment and Interpersonal Relationships at Tribal Colleges

The Tribal Community College campus provides a place for socialization, which is ideally integrated with the learning that is expected to be happening at the college. The learner must feel safe and comfortable in order to learn at his or her best. Even if the teacher is not an expert in Native culture, they can still provide a warm style of teaching conducive to student learning (Pewewardy & Hammer, 2003; Reyes, 1991). The learner must have respect for and trust the teacher, and the teacher must earn respect and trust from the student. This atmosphere of respect for each other and cultural difference combined with a safe demanding environment can help engage and challenge Native American students' intellectual abilities (AISES, 1994; Cheek, 1984; Pewewardy & Hammer, 2003). It has been found that using group or cooperative learning approaches is more inclusive and less competitive, thus providing a more positive atmosphere for learning (AISES, 1994; Pewewardy & Hammer, 2003). Research shows that Native American students who initiate interactions with the teachers or work in student-led groups are more talkative than those who participate in large group scenarios (AISES, 1994; Swisher, 1991). The interpersonal relationships a student makes are important aspects of the student's learning environment.

Retention and Absenteeism: Tribal Community College

Native American students give many reasons for dropping out of school. A lot of their reasons can be directly related to teaching methods. If the students do not see the school as relevant to their lives and do not encounter teachers that care they will drop out (AISES, 1994; Reyhner & Davison, 1992). Of those who drop out of college, only eight percent say they drop out because of academic failure. Thirty seven percent indicate they were bored and another 24% say they were not interested in school. Many students express the feelings that the teachers were not interested in helping them succeed

(Reyhner & Davison, 1992). Both groups, teachers and students, must overcome their cultural differences in order to succeed.

A factor directly related to student success in developmental mathematics courses is attendance (Illinois Community College Board, 1997). A typical developmental mathematics class at this college begins with about 25-30 students at registration. The class size drops to about half the original number in the first two or three weeks and by midterm the number of students still attending class on a regular basis is roughly half of the original enrollment, 12-15 students. During the second half of the academic term, about a third to a half of the students who were present at midterms quit attending on a regular basis, leaving approximately 6-10 students to complete the course. Nearly everyone who attends on a regular basis throughout the term and participates in class completes the class with a grade of C or better and is allowed to progress to the next level mathematics course. Students are much more inclined to continue attending classes when they consider the material in the class relevant to their lives and when the instructor shows an interest in them as individuals and makes special efforts to learn about them through personal information about their family and life goals (Fast, 1980).

Teaching Methods: Community Colleges

In 1995 the American Mathematical Association of Two Year Colleges (AMATYC) developed standards for promoting and improving mathematics education in two year colleges (AMATYC, 1995). These standards encourage creating a learning environment that responds to changing technologies and offers students the opportunity to obtain mathematical knowledge and to use it (AMATYC, 2006). The standards addressed intellectual development, content and pedagogy. The area of pedagogy is the most challenging, especially designing a learning environment that promotes understanding, not just getting the right answers.

There are large numbers of students requiring developmental mathematics entering all colleges and universities. This is a problem for all colleges and universities and the problem is very prominent among two year colleges with open enrollment policies. At campuses with areas of ethnic diversity and open enrollment, more than 80 percent of all students are in need of remediation (Epper & Baker, 2009; Garcia, 2003; Schmitz, 2006; St. Phillips College, 1992; Waycaster 2001). In larger institutions, teaching assistants can be used for instructors in developmental classes, but smaller institutions often do not have the resources available for this. Class sizes are often very large and impersonal in nature. There is usually a long track record of low student success in college arithmetic (Epper & Baker, 2009; Garcia, 2003; Hardiman & Williams, 1990; Noel-Levitz, 2006; Schmitz, 2006). Classes have a wide range of student abilities and skills.

> "Some require only a quick review of skills that they have learned well in secondary school. Other students, never having successfully mastered those skills at the high school level, only now attempt to make up their deficiency in mathematics. Students who have been unsuccessful in mathematics in the past may fear mathematics now. Students who have deficiencies in their mathematical background often have associated difficulties in reading and writing, thereby making it difficult for them to learn from text books" (Hardiman & Williams, 1990, p. 2).

The students who enroll in the developmental mathematics courses often fall into one of two categories: 1) students who once knew the content but now need a review of it and 2) students who have never had the opportunity to learn the content. Students needing only a review of the content are much faster at learning it and do not require as much practice as is necessary for students who are learning the material for the first time.

Teaching Methods: Tribal Community Colleges

Teaching styles used in community college developmental mathematics classes play a role in the success of the students. Research has shown that the reasons many Native American students give up on school are because they do not perceive their teachers as caring and they do not see how what they are learning is relevant to their lives (Barta, et al. 2001; Cajete, 1994; Davison, 2002; Lipka, et al., 2005; Nelson-Barber & Estrin, 1995; Pewewardy, 2002; Reyhner & Davison, 1992; Trumbull et al., 2002). One successful Native American scholar stated that “she feels she struggled with mathematical ideas because they (her instructors) could not help her see the relevance of what they were teaching” (Barta, 1999, p.37). Other reasons for avoiding studying high level mathematics in high school included poor or no counseling, poor or unskilled teachers, negative images of mathematics and science, no role models, fear of failure, poor preparation in basic skills, low priority from the family and community, conflict between cultures and poor study habits (Bradley, 1984).

Native American Student Learning Styles

There is no single teaching method or distinct learning style that works for all people; there are methods that do work better than others for various groups of learners. Research shows that many students in the over 500 different Native American groups in the United States have similarities in preferred learning styles even though they come from very diverse backgrounds and cultures (Bush 2003; Cheek, 1984; Soleste & Tharp, 2002; Swisher, 1990; Pewewardy & Hammer, 2003;). Although we cannot be assured that one method is best for everyone there are common themes that appear. These can be characterized as:

1) holistic or global learning style.

2) visual learners and learning by observation and doing, reflective learning.

3) cooperative and collaborative learning.

4) culturally relevant examples and models.

(Aragon, 2002; Soleste & Tharp, 2002; Hilberg et al., 2002; Lipka, 2002; Nelson-Barber & Estrin, 1995; Pease 2000; Pewewardy, 2002).

Holistic or Global Learning Style

The holistic or global approach to learning begins by looking at the subject area from an overarching point of view or theme (Swisher & Tippeconnic, 1999; Wauters et al, 1989). Looking at how the material fits in the big picture before breaking it down into smaller individual parts using metaphors and visual organizers. Reyhner and Davison (1992, page 5) offered suggestions for teaching: "learn how to motivate minority students; this goes beyond a simple ‘grabber’ or anticipatory set, to providing students with classroom tasks that are intrinsically of interest to them (Reyner & Davison, 1992, p.5). Integrating each aspect of the curriculum with a larger concept is important so that students can see how they are connected together (Reyhner & Davidson, 1992; Soleste & Tharp, 2002). This makes it more meaningful for learners to break down the material into smaller parts and examine each one in more detail.

Visual Learners and Learning by Observation and Doing

Native American learners prefer visual learning to verbal abstract learning (Reyhner & Davidson, 1992). Reading textbooks and working from written words is more difficult than learning from seeing, touching and doing. Observation is a traditional way of learning, quietly watching, practicing in private until the skill is perfected. This is sometimes referred to as “watch, then do” (Swisher & Deyhle, 1989; Swisher & Deyhle, 1989; Soleste & Tharp, 2002; Nelson-Barber & Estrin, 1995; Bush, 2003; Butterfield, 1994). Learning by doing is a very powerful tool for many learners. They learn much better and remember much more if they do something instead of just reading or hearing about it. Students need to be able to apply what they are learning to help them learn (Reyes, 1998; Bradley, 1984). In some Tribal societies it is customary for individuals to observe tasks and practice in private before attempting any public performance. Making mistakes in public is not an acceptable way to learn (Nelson-Barber & Estrin, 1995; Swisher 1991; Swisher & Deyhle, 1989; Pease, 2000). Other groups believe in the ability of the individual to learn experientially, without constant supervision and correction (Cajete, 1994; Swisher, 1991).

Cooperative and Collaborative Learning

Another culturally relevant idea is that of group learning and cooperation. Historically, groups of age-equivalent children would learn together as they played and helped out in the community (Reyes, 1991). They would compete against other age-equivalent groups, but not against each other.

> "There is a constant fear of "standing out" in a group that has deep roots in our culture and is sanctioned even by the present generations through teasing. Yet there is also considerable competition in games outside the classroom, in sports, for example where teams are involved" (Swisher, 1990, p.1).

Teasing clans are part of the culture in the Crow Indian society. Their purpose is to provide a gentle, non-threatening way to remind individuals of their place in the group or community. Because of this, good students may choose to hide their academic talent and competence to avoid being teased or singled out. In the same light, it is not appropriate to brag about your own accomplishments; so academic achievement usually remains private. Individual humility is to be respected and preserved (Reyes, 1991). Clan members can sing praise for you, but you cannot talk about your own accomplishments. Dr. Barney Old Coyote, a much respected Crow Tribal elder, said "I am famous because of my granddaughters; they are all very bright and have honored me" (Interview, March 2004). Schools often use an atmosphere of individualism and competition for teaching and this idea conflicts with the environment of cooperation in which many Native American children are raised. Thus they cannot be expected to thrive in the school environment. "Standing out" produces embarrassment and disrupts the harmony of the community. An extension of this includes any type of immodest behavior or showing off one's individual abilities, such as giving speeches, talking about one's own accomplishments, or being recognized for earning a spot on the honor role (Reyes, 1991; Swisher, 1990). High expectations and a warm caring atmosphere are also very necessary aspects of a successful learning environment (Swisher, 1991; Pewewardy & Hammer, 2003).

Culturally Relevant Examples and Models

Presenting mathematics topics in a culturally relevant manner involves applying mathematics topics to objects or things that are present in the everyday lives of the students. Choosing meaningful content material itself is a task necessary for learning (Reyhner & Davison, 1992). Motivation based on test scores and class grades does not work for most students; the motivation must be based on something more relevant to their interests. Some other ideas that help with learning are first and foremost convincing the students that mathematics is relevant and important in their lives and their home culture (AISES, 1994; Reyhner & Davidson, 1992; Reyes, 1991). The material that is being taught must be relevant to the learner. Effort must be made to tie concepts into real life experiences and observations. This will change from area to area even within a specific group of people, as they have shared and common experiences, but each individual also has unique experiences that they can bring to the discussion and understanding of a topic. If the material is presented in a relevant way, the students will have more interest and be familiar with the concepts (Reyhner & Davidson, 1992; INTIME, 2001; Cheek, 1984; Barta, 1999). It has been shown that when the teachers and learners share culture, learning is enhanced (Pewewardy & Hammer, 2003; Lipka, 2002). Using culturally relevant examples provides a seamless connection of the concepts and life experiences and helps with success in the classroom. This also improves self esteem and positive attitudes toward mathematics (Strutchens, 1995). The use and acknowledgment of culture is an important tool for showing the why the content is relevant.

From the Native American perspective, mathematics is used for specific purposes, not all interesting or relevant to the dominant western culture. These are the ideas that need to be brought into the classroom to help teachers relate to their students. An example of this might be the way ratios and proportions are explained, by having Native American students construct a miniature bow and arrow for a young child, an activity that connects ideas that they are familiar with and the idea of hands-on visual learning to the mathematics concepts and real life skills (Pease, 2000). This is not just cultural relevance. It also builds the mathematics concept around cultural understanding and interest (Davidson, 1990). Having students calculate the area or perimeter of a garden is meaningless if no one has a garden and finding the price of a taxi is pointless when you live in a rural area with no taxi service. These same topics can be modeled using culturally relevant examples such as the area inside or perimeter of the tipi and the cost of having a delivery man drive from the nearest town to bring necessities of water or propane.

Regardless of the reasons Native American students give for avoiding mathematics or doing poorly at the primary and secondary level, if they plan to complete a college degree they must be able to do mathematics. The instructors at Tribal colleges must find a way to help these students learn mathematics. Dr. Janine Pease (2000), a nationally prominent Crow educator and MacArthur award recipient, presented a paper at the Crow Education Summit, Fall 2000, in which she specified over twenty ways of Crow Indian knowing and learning (Pease, 2000). Although many of the ways are not familiar school methods, some ideas could easily be incorporated more heavily into the classroom: intensive listening and observation, age grade societies, lessons by analogy, observations of nature, discovery learning, knowledge gifts (mentor type relationships), role models for the people, peer teaching, master/apprentice relationships, tools of scale, and clan relationships (Juneau, 2001; Pease 2000; Nelson-Barber & Estrin, 1995). Age-grade societies are groups of children of similar ages who are brought together to learn from elders or experts on a topic. These children often belong to a specific clan and are often related as brothers, sisters, or cousins (Pease, 2000). Keeping in mind most instructors are not familiar with Native cultures, the most accessible ways of including this information in instruction at first would be to try the practices that are also present in schools in the dominant white culture: intensive listening and observation, discovery learning, peer teaching, and master/apprentice relationships. Over time, as instructors become familiar with ways of learning practiced and valued in the Native culture(s) of their students, who often represent more than one tribe, they may begin introducing additional strategies.

Successful Teaching and Learning Methods for Native American Communities

Learning communities are an important part of an educational system. A vital element of the learning community is collaborative effort put forth by members of the community. In order for a learning community to be successful, members of the community must each be responsible for their own learning and they must value the contributions made by fellow members of the community. The following section discusses learning communities and then introduces a collaborative learning example. Definitions of cooperative and collaborative learning will come next with a chart to compare and contrast the two. This section ends with the five necessary components of either cooperative or collaborative learning.

A learning community is defined by Astin (1985) as a small subgroup of students with a common sense of purpose that can build a sense of group identity, cohesiveness, and uniqueness (Astin, 1985; Mutusav et al. 2005; Freire, 1970; Tinto 2003; Rao, 2005; Wenger 1998). Combining the use of a learning community and the ideas proposed by research as appropriate cultural learning pedagogies, four promising strategies for improving learning success emerge: 1) small group learning, 2) peer led interventions, 3) culturally based content, and 4) challenging, relevant and engaging problems. Each of these has been studied for effects on the learning of developmental mathematics. Although none affect the placement of students into a class, they directly affect teaching methods and retention and help students form their own support network.

A learning community exists when teachers and students work together to help each other learn (Klein, 2005; Rao, 2005; Wenger, 1998). Learning communities are used as an approach to learning in many colleges and universities. They often take the form of linked courses or block scheduling that allows the students to be enrolled in several courses together. "The more students are involved in the social and academic life of an institution, the more likely they are to learn and persist" (Tinto, 1998, p. 2). By putting students together in several classes they have a better chance at getting to know one another and interact both socially and academically. Students who are enrolled in the same classes together get to know each other better and then they also share the experience of learning together. This helps bond the students even more. Helping the students to get to know each other by having them work together in small groups encourages this connection. Student success can be linked in part to these learning communities that they have been brought into. Tinto (1998) summarizes the learning communities as involving three major components. 1) *Building Supportive Peer Groups* involves practices such as block scheduling, linked courses and collaborative groups, 2) *Shared Learning-Studying Together* includes approaches such as small collaborative learning groups, 3) *Involvement, Learning, and Persistence* may entail students getting to know each other better resulting in being more actively involved in learning even after class and spending more time on the academic work (Tinto, 1998). The Supportive Peer Groups help students make the transition into college and provides a group of peers who are going through the same types of experiences as themselves. In Tinto's examples, it was found that Shared Learning-Studying Together served a double purpose; it helped students become better friends and also took the competition out of learning and socializing because they were done together. Shared learning promotes an appreciation for collaboration. It helps with academic understanding but also promotes important social norms of respect and consideration which are often lacking in college classrooms (Tinto 1998). A big dilemma for many college students is deciding what time they need to devote to studying and what time they need for socializing. Involvement, learning, and persistence were higher among students who had been part of a learning community; they had higher rates of involvement, higher rates of passing their courses and higher rates of staying in school. The more positive interactions the student has both academically and socially the more likely they will learn and persist (Rao, 2005; Tinto, 1998). This is perhaps more important when students find themselves placed in developmental courses. The learning community helps the student fit into the college atmosphere (Tinto, 1998). This is most important during the very beginning of the student's college career when they are making the connections that they will carry with them throughout their college career. "In smaller environments, students seem to gain a feeling of belonging from the personal relationships they are able to develop with teachers, administrators and their cohort of students" (Jones, in Rao, 2005, p. 1).

Teachers must also be willing to work with students to help each other learn. The teachers must be flexible to reorganize the way courses are currently being taught to utilize methods that promote shared, connected, and collaborative learning across curricula boundaries (Tinto, 1998). "The best learning communities are classrooms where students are connected through meaningful conversations in cooperative groups with each other and their teachers" (Hess and Mason, in Rao, 2005, p. 1)

A study of collaborative learning at Glendale Community College showed remarkable increases in student success rates in several areas of study. The completion rates in college algebra were much higher with the use of collaborative learning groups. The results in precalculus went from about 50% completion to 80%. The results in the calculus class were almost double that of classes not using the collaborative methods, 38% versus 70%. Students' comments about the collaborative learning groups were nearly all positive, wishing that there were organized collaborative learning groups for other challenging classes as well. The groups were modeled after Uri Triesman's successful program at UC Berkeley (Freemyer et. al., 1995).

The Glendale Community College research study involved a five week summer course for students who were in need of developmental mathematics training at a technical college. The students were placed in the developmental mathematics courses based on scores achieved on a general proficiency test covering arithmetic and beginning algebra. The students spent three hours a day, four days a week in the summer program. They were taught using a common problem solving technique. They worked on problems alone and in small groups. The design included working in small groups for an hour twice a week in tutoring sessions. The final part of the program included half-hour meetings with the instructor twice a week. This provided the students direct contact with the instructor. A higher percentage of students participating in this summer program passed the mathematics proficiency test and did so with a higher test score than students who did not participate (Hanlon & Schneider, 1999).

Cooperative and Collaborative Learning

Cooperative and collaborative learning are methods of learning whereby small groups of learners work together to achieve a common goal such as solving a problem, learning a task or searching for understanding (Strijbos, 2000; Matthew, Cooper, Davidson & Hawkes, 1995). The two terms are often used interchangeably. . They have only in the past 15 years been distinguished in research reports (Strijbos, 2000). The difference is sometimes the amount of structure applied to the learning environment or possibly the age of the participants, unclear distinctions at best. Cooperative learning is used to describe small group learning involving greater structure (e.g. specific tasks and roles assigned to group members), and younger learners, whereas collaborative learning is often used to describe situations with less structure and older learners. Still, at the present date, the terms are used interchangeably by some authors (Bruffee, 1993; Illini, 2004; Brown & Lara, 2007). Several definitions suggest that the difference between cooperative and collaborative learning is the sophistication of interaction; beginning with cooperative learning on the most elementary levels and gradually transitioning to collaborative learning as level of complexity increases. *Cooperative learning* requires more elementary social skills and cognitive skills because it involves relatively structured interactions, defined by the teachers (Panitz, 1997; Palmer, Peters, Streetman, 2003).

In 1996, Ted Panitz, offered a definition to point out the similarities and differences between collaborative and cooperative learning. "*Collaborative learning* is a philosophy of interaction and a personal lifestyle whereas cooperation is a structure of interaction designed to facilitate the accomplishment of an end product or goal" (Panitz, 1996, p.1). Collaborative learning is a personal philosophy, where the way a person interacts with others is governed by respect and the abilities and/or contributions of all people are valued by the group. Everyone in a collaborative group shares the responsibility for the group actions. This type of learning is centered on the individual; it is a process of learning by working together (Myers, 1991). Collaborative learning offers students less structure, less organized formats, so they can take more responsibility to form friendships and direct their own learning. Collaborative learning is well aligned with the social constructivist perspectives of Vygotsky and other scholars who focus on sociocultural influences of learning. And, using the Zone of Proximal Development (ZPD) construct, collaborative learning empowers students.

"*Cooperative Learning* is defined by a set of processes which help people interact together in order to accomplish a specific goal or develop an end product which is usually content specific" (Panitz, 1996, p.1). Teachers often use cooperative learning methods with younger children to help them develop collaborative learning skills. Cooperative learning stresses the product of the learning (Myers, 1991). This is a more formally structured process. The way cooperative learning is defined by Smith and MacGregor is "cooperative learning represents the most structured end of the collaborative learning continuum" (Smith & MacGregor, 1992.) The teacher assigns what the role of the learner is and the exact outcome of the interaction (Panitz, 1997; Smith & MacGregor, 1992). The US Department of Education, Office of Research defines Cooperative Learning as:

> A successful teaching strategy in which small teams, each with students of different levels of ability, use a variety of learning activities to improve

> their understanding of a subject. Each member of a team is responsible not only for learning what is taught, but also for helping teammates learn, thus creating an atmosphere of achievement (U.S. Department of Ed. Office of Research, 1992, p. 1).

As a learner moves from cooperative to collaborative learning the social interactions become more sophisticated, there is more discussion, negotiation, questioning and exploring. The learners truly work together to solve the problem. It becomes imperative for everyone to work together to achieve a solution. During the process, many other issues may arise. The central idea behind both types of learning is that when learners are actively taking part in their own learning they learn more and they are able to construct knowledge. The learners are talking and questioning each other, moving above their "comfort zone", tearing down and restructuring the concepts in their minds. The teacher adopts the role of facilitator. Teachers and learners are learning from each other, sharing experiences. All learners are part of the small group, share in discussions, learn team-building, responsibility and gain a sense of support by the community, which increases success and retention. This may also lead to improved attitudes toward the subject (Matthew, Cooper, Davidson & Hawkes, 1995; Garfield, 1993; Hilberg et al. 2002; Smith & MacGregor, 1992; Davidson, 1985; Davidson & O'Leary, 1990; Pewewardy, 2002; Rao, 2005; Slusser & Erickson, 2006; Tinto, 1998;).

The definitions given above are certainly not black and white. There are suggestions that the use of the approaches associated with each definition changes with the grade level. K-12 classrooms use cooperative learning and postsecondary classrooms use collaborative learning, different levels of sophistication in a continuum (Matthews, et. al., 1995; Brown & Lara, 2007; Brufee, 1995). There are also suggestions that the level of material determines the type of learning, foundational material is learned with cooperation while more abstract material lends itself to collaborative learning (Panitz, 1996; Panitz, 1997). A comparison of the characteristics of cooperative and collaborative learning is given in Table 3.

There are five necessary components of cooperative/collaborative learning: 1) small groups usually composed of two to six individuals and the accompanying interpersonal and small groups' skills; 2) "positive interdependence" whereby everyone in the group needs everyone else in the group in order to be successful; 3) a task requiring all members to help accomplish it, a task that promotes face-to-face interactions; 4) individual accountability, where each individual is responsible for some aspect of the group's process or performance; and 5) student-centered work where the role of the teacher is shifted to that of coach (Johnson & Johnson, 1994; Strijbos, 2000; Panitz & Panitz, 2004).

Through discussions of their own ideas and experiences, learners are able to adjust their misconceptions and build on their own existing knowledge. When the experiences come from a common background this assimilation process is sped up. Learners who share a common language also have an advantage by being able to converse more freely. Learners who take on the role of leader or teacher find they benefit greatly by explaining the concepts to the others. By finding ways to communicate the concepts to other members of the group, peer leaders construct better connections for themselves and find they understand the concepts much more thoroughly.

Table 3: Characteristics of Cooperative and Collaborative Learning.

Characteristics	**Cooperative learning**	**Collaborative learning**
Teacher involvement	High. Facilitator provides specific objectives and content, and explains tasks and goals.	Low. Students organize themselves and monitor. Tasks are open ended.
Relationships: Teacher/Student	Teacher observes, listens, intervenes as needed, Student/Student interactions high, Teacher/Student interactions high, teacher provides assistance as needed and evaluates student achievement.	Student/Student interactions high, Teacher/Student interactions low and only when absolutely necessary. Students evaluate assignments, rarely evaluated by the teacher.
Training in working together	Extensive training in how to interact, listen, show respect, carry out assigned roles, and other social skills.	Little needed. Participants already know how to work together. What they don't have they will create.
How knowledge is constructed	Student/Student discussion and interactions, Teacher/Student discussion and interaction.	Student/Student: testing, questioning, explaining, presenting and defending ideas, exchanging beliefs, being actively engaged.
Purpose of groups	Facts, master foundational knowledge.	Higher connections, constructivist, higher order thinking.
Importance of aspects of student growth personal, social, cognitive	Teacher, and occasionally students, assess individual and group performance. Necessary to teach collaborative skills.	Students assess individual and group performance.
Implementation, concerns, group formations, task construction, accountability, equitable work distribution.	Very structured, specific roles for each learner identified by the teacher, task and product evaluation by the teacher.	Loose structure, group decides what roles each member should have, group evaluates the overall performance and final result. Group decides individual responsibility and liability.

(Payton, 2004; Panitz, 1996; Panitz, 1997; Panitz, 1999; Smith & MacGregor, 1992; Matthew, Cooper, Davidson & Hawkes, 1995; Strijbos, 2000; Brufee, 1995).

The "positive interdependence," where learners within the group rely on each other to encourage and help each other, benefits all learners in the group. They learn because other members of the group want them and help them to learn. The group members learn individually because it is necessary that for one to succeed they all must succeed (Cuseo, 2009; Johnson & Johnson, 1994; Johnson, Johnson, & Holubec, 1998; Golden, 2008). The necessary opportunity for all members to practice using correct vocabulary in communicating concepts improves everyone's ability to correctly use the right terminology (Johnson, Johnson, & Stanne, 2000; Kellogg, 1999; Falk & Harrison, 1998; Davidson & O'Leary, 1990; Brufee, 1995).

Certain traditional approaches to education have every student working individually. In contrast, working together collaboratively or cooperatively in groups allows students to tutor and learn from each other and to take advantage of practicing their skills with each other (Reyhner & Davidson, 1992; Vaughn et. al, 2006; Soleste & Tharp, 2002; Wauters et al 1989; Johnson & Johnson, 1994). A study of collaborative education in higher education by Tinto and Goodsell-Love looked at two different collaborative learning experiences. The first was using freshman interest groups on a large university campus and the second study was from a relatively large community college. Both studies found it was an excellent way for students to meet other students and build a network for academic and social support with their peers. The benefits were that students skipped fewer classes, had a higher persistence rate, higher grade point averages and became more involved in university life (Tinto & Goodsell-Love, 1993). Students working together create a strong learning community where each individual is supported by the rest of the group. This interdependency strengthens the learning of the group by allowing each to share his or her strengths and to improve on weaknesses. In many Native cultures it is unacceptable to fail in public, hence new concepts are observed, practiced in private, and put on public display only when mastered. Working together gives the learner an opportunity to practice in private with a group of peers to master a new concept. Then the group can publicly display the achievements of its members without singling out anyone individually (Swisher, 1991; Radda, Iwamoto, & Partick, 1998; Aragon, 2002).

A research study by Thomas and Higbee of college algebra students in 1994 showed that students involved in collaborative learning activities designed to "enhance critical and logical thinking, creative problem solving and visual and spatial skills while combating negative attitudes toward word problems" were less likely to withdraw from class and earned significantly higher grades. Fifty-three percent of the students who participated in the collaborative activities earned grades of C or higher whereas only 33 percent of the students in the control group earned grades of C or better. These students also learned to enjoy mathematics, pushed themselves harder and longer to try to solve problems, and gained new insights and confidence in their own mathematical abilities (Thomas & Higbee, 1996).

Another recurring theme in discussions of cooperative and collaborative learning is *cooperation versus competition***.** In most learning situations students learn better using cooperation instead of competition. Students interact more if they are encouraged to cooperate to learn instead of compete against each other (Radda, Iwamoto, & Patrick, 1998). Cooperative student-to-student interaction provides the learners a chance to share understanding and experiences and helps to correct misconceptions. Humility helps keep relations in check, competition between groups is allowed, but competition between individuals is not (Swisher, 1990; Aragon 2002).

Cooperative learning has been suggested as a compatible learning approach for some Native American children. One general strategy that appears to be successful is to put students into learning teams in which the team or group is supported and helped to learn by the peer members (Swisher, 1990; Pewewardy, 2002; Demmert & Towner, 2003). More cooperation and less competition is the accepted norm in the classroom (Swisher & Deyhle, 1989).

Small Group Learning

Group learning has been described as "when all members perceive themselves as having contributed to a group outcome, and all members of the group can individually describe what the group as a system knows" (Kasl & Marsick, 1997, as cited in Buss, Redburn & Gau, 2006, p.57). The idea of group or community learning organization "is one in which people at all levels, individually and collectively, are continually increasing their capacity to produce results they really care about" (Karash, 1994-2002, p. 1) There are many examples of using small group learning as a tool for better understanding a subject. A common theme of both cooperative and collaborative learning is the use of small groups. Research has shown that small group learning is beneficial to most students, specifically minorities and females. The small groups often foster increased academic achievement, better attitudes toward learning, motivation, and persistence (Campbell, Jolly, Hoey, Perlman, 2002; Overmeyer, 2005). In the meta-analysis done by Overmeyer in 2005, the overall trend, when small group cooperative or collaborative learning was voluntary, students working in small groups showed a statistically significant academic improvement over the students who did not choose to participate. Improved academic achievement was noted when the grades in the class were better or when more students completed the class with a passing grade. When participation was not voluntary there were mixed results and the results were very similar or only slightly different from students working individually. When the results for African American and Hispanic were disaggregated, there was still significant improvement (Overmeyer, 2005). This study gave additional support to the findings of Springer, Stanne and Donovan (1999) who also found positive results for students in cooperative learning environments in undergraduate mathematics courses (Springer, Stanne, & Donovan, 1999).

At the University of Idaho, Carolyn Keeler and Mary Voxman conducted a study on the effect of cooperative learning in developmental mathematics. The study investigated how students in a pre-college algebra class taught using a cooperative learning section compared on final grades with students in the same class taught by traditional lecture methods. Both classes used the same textbook, assignments and exams, and both were given equal access to a mathematics assistance center. The cooperative class differed from the traditional class in the teaching methods. While the traditional class was taught using the lecture format, the cooperative class formed student-selected pairs and groups of four assigned by the instructor on the basis of pretest scores. The first five to seven minutes of each class were spent with the groups of four working on challenging and engaging problems, then the next 15 minutes was spent having groups present their results using an overhead. Over the course of the term, each member of each group was given the opportunity to present. The rest of the class was taught in a fairly traditional mode, covering new material with lecture and using the same examples as in the lecture class. Interaction in the groups was encouraged and group members were expected to help and support each other. Analysis of the final exam scores showed that the cooperative section scored over five points higher and the final course average was nearly five points better as well. A much more pronounced result was visible in the grade distribution. The cooperative class had 93% overall pass rate with 43% earning A’s or B’s, where the traditional class only had 69% overall pass rate with 28% earning A’s or B’s. In the cooperative class, 85% of the students completed the class compared to 79% completion for the traditional class. Students in the class reported they liked the group format and asked for more time and projects in groups (Keeler & Voxman, 1994).

In the Keeler and Voxman study, the researchers attempted to enhance a class without making drastic changes in the curriculum. The freshman students in their study were very close to the developmental level in mathematics of those in the present study. Students were placed into the treatment or control section based on their course schedule and availability. They were grouped by the researchers into three categories: 1) returning students who had been out of college for a number of years, were highly motivated, but had some math anxiety; 2) students who had recently graduated from high school but needed review, and were generally capable of completing the course; and 3) students who had never had the material before, were learning it for the first time, and very afraid of mathematics had high levels of math anxiety.

Mathematics instructors at the small rural Tribal college in this study have grouped their students into similar categories: 1) students who are in need of review only, they knew it once but it has been too long and need a refresher course; 2) Students who have never had the material, and need to learn it for the first time. The second type of student is much more fragile than the first. They need much more attention and individual support to get through the courses. They require a great deal of time to grasp the new concepts and to practice them. These students get frustrated easily, but when they succeed they become unstoppable. The first type of student is much more inclined to skip class because they think they know the material already and this gets them into trouble. Mathematics instructors at the Tribal college have passively encouraged working together and using mathematics tutors if necessary. It is very encouraging to see how subtle but strategically chosen changes in classroom teaching might make a huge difference in success.

Another study done by Keeler and Steinhorst at the University of Idaho showed that including group activities in introductory statistics classes increased the overall class performance and conceptual understanding of the students. The study had students in one class taught by traditional lecture methods, while the other two classes were organized in student pairs and groups of four that worked cooperatively for three to five minutes on group problems given every 10 to 15 minutes. The responses were handed in at the end of each class. These groups were also encouraged to work together outside of class.

Results showed that students were very enthusiastic about the group work and wanted more of it. The class averages for the cooperative classes were from five to eight percentage points higher than the traditionally taught class. Pass rates were 67% for the traditional class and 86% and 88% for the cooperative classes with fewer students opting to quit or withdraw (Keeler & Steinhorst, 1994). These results were consistent with Keeler and Voxman's results in their study with cooperative learning in remedial freshman mathematics courses (Keeler & Voxman, 1994). Both studies show that by incorporating cooperative learning activities in the mathematics classes the overall class performance and retention was improved.

In 1992 Gateway U classes were implemented at San Jose City College in California to assist under-prepared students about to enter college mathematics, reading and writing courses at the developmental level. These courses included basic college survival skills such as understanding assignments, talking to instructors and staff, block scheduling of courses and forming study groups. Success in classes and retention rates were studied and results showed students enrolled in the Gateway U classes had significantly higher success in their classes. Students in the Gateway U program had a 64% success rate in earning a grade of A, B or C compared to a 45% success rate for those who were not in the program. Class retention rates were 72% for those students in the Gateway U program versus 53% for those students not in the program (Kangas, 1992).

Kristine Young (2002) studied ways to retain underprepared students in remedial courses at the community college. One key feature of retention is the approach to teaching and learning. One of the most successful methods for retention is creating a "community of learning" in the program, where students regularly participate in small group work, study groups and independent study. A second key feature is that of mandatory assessment and placement. This stems from the fact that many students who are underprepared for college level work will not self-identify nor sign up for the appropriate classes without proper advising. Proper advising cannot be done without knowledge of the students' abilities. The advising must be done in a caring supportive environment. The third feature of successful developmental education programs with high retention rates is institutional outreach programs. High schools, businesses, community organizations, and colleges and universities must work together to help students attain their educational goals. Students who have completed developmental programs perform as well or better than college-ready students in college level courses (Young, 2002). Young's study also offered advice to enhance creating a community of learners by including good advising and outreach programs.

Peer-Led Interventions

There are many types of peer-led interventions. Peer learning is a two–way sharing of knowledge where all participants receive mutual benefits from working together (Anderson & Boud, 1996). Some are led by tutors, teachers, designated leaders or simply other students. By having peers lead students through a thought process, they help assist in keeping the other student or students on track and headed in the right direction, while giving the others a chance to try out ideas through discussion and experimentation. This opportunity helps the students build new connections or strengthen existing ones with concepts that are already understood. Immediate response and feedback are vital components of this type of interaction. It gives the students a chance to test new language and challenge their own ideas in a safe and friendly environment. They can make mistakes and joke about them as they discover the reasons why they were wrong. The peers are at a fairly close level of understanding so they can remember why they made the same associations or why they had the same misunderstandings. It is easier for a peer to explain concepts in terms their peers understand. According to Anderson and Boud, “the key to peer learning lies in the mutually supportive climate which the learners themselves construct and in which they feel free to express opinions, test ideas and request and offer help as needed” (Anderson & Boud, 1996, p 5).

A meta-analysis was carried out by Baker, Gersten, and Lee (2002) to synthesize the effect of various interventions to improve the mathematics achievement of students who are low achieving or at risk for failure. Four interventions were used: “a) providing teachers and students with data on student performance; b) using peers as tutors or instructional guides; c) providing clear and specific feedback to parents on their child’s mathematical success; and d) using principles of explicit instruction in teaching mathematics concepts and procedures” (Baker, Gersten, & Lee, 2002, p.1). Articles dating from 1971 through 1999 were reviewed in this study. Criteria for inclusion in the meta-analysis were: 1) studies related to mathematics content; 2) instruction that lasted for 90 minutes or more; 3) experimental or quasi-experimental studies with control groups; 4) quasi-experimental studies with justifications; 5) inclusion of at least one mathematical achievement measure; and 6) reporting of means and standard deviations.

Results showed that providing teachers and students with data on student performance did show moderate effect sizes (0.57) and gave teachers the ability to individualize instruction and concentrate on where the students needed help. Peer assisted learning had a 0.62 effect size and was the largest in the study. This intervention led to positive learning but warned that students need to be carefully trained and taught to interact appropriately. The peer assisted learning consisted of small groups of students working together. The importance of training was to ensure that everyone was getting the opportunity to learn. It is very easy for a group of students to let one student do all the work and the others just copy. In this case the desired learning is not occurring. The intervention needs to lead to sharing, and each participant taking responsibility for his or her own learning. If they need extra help they must seek it out through other members of the group.

The meta-analysis found that the "explicit instruction in teaching mathematical concepts" approach was inconclusive. Research studies in this area were split into two categories, explicit instruction in mathematics or contextualized instruction. The studies using explicit instruction, described as teaching rules, concepts, principles and problem solving skills, showed an effect size of .58. The studies using contextualized instruction, teaching mathematics using real world applications had effect sizes that ranged between -.59 and .18. The positive effect sizes being realized when the students were first taught the underlying mathematical concepts then were taught how to apply them. Providing parents with information about student successes produced an effect size of 0.42, a moderate effect, which may have educational significance, yet is not statistically significant. The parent support intervention involved regular home contacts, messages, and support from home. All four interventions seem to have a positive effect on student success. It was also concluded that having teachers that know how to teach mathematics is more important than having mathematics teachers who only have a strong mathematical back ground (Baker, Gersten, & Lee, 2002; Davis, 1999).

Research shows that low achievers in mathematics can be encouraged to do better and will persist more often when peer tutoring is used (Baker, Gersten, & Lee, 2002). Instructors can reach out, but not to the extent in which help is needed. Instructors at the Tribal college in this study have fifteen or more instructional hours per week in addition to other duties and commitments. They simply do not have the time to give all the students the extra time and attention that they need to be successful. By implementing a peer leader intervention in the developmental mathematics courses instructors can provide more time and assistance to the individual student. Using existing class time, but developing challenging and relevant projects that can be directed by peer leaders toward a collaborative solution will help form learning communities. By interacting in peer-led groups students will be able to get the help they won’t ask for individually. They will not have to self identify and say they need help, and everyone will be included as part of the classroom organization.

A research study was done at University of Texas at El Paso on the effectiveness of a mathematics review during freshman orientation before the students took the placement test to determine their entering mathematics course. Over the course of three summers, 2000-2002, students were given mathematics reviews during the freshman orientation session at the college. The goal of the intervention was to increase the number of students who are able to begin higher education in college level mathematics courses. The orientation incorporates the Circles of Learning for Entering Students (CircLES) program and used four intervention techniques: the mathematics review, a week long orientation in the summer, course clustering, and proactive counseling and scheduling. This enables the university to group students by classes into cohorts and keep them together in clusters. The mathematics review is a series of three two-hour sessions in which students are grouped in groups of 20-25 students according to their initial placement test scores (taken before attending the mandatory week long orientation). Each review group has two peer-facilitators who have had basic training in cooperative learning techniques and who helped plan the review activities. Each student in the group receives a review booklet covering material on the placement test. During the review sessions, students work on the material in the booklets in groups of 4 - 5 students. The peer facilitator checks on each group, assists if necessary, and keeps track of timely progress. A significant number of students attending the orientation and mathematics review were able to move up at least one mathematics course level. Data also shows that the successful completion by these students is lower than students who tested into the course originally, but this is improving every year. This is an area of concern (Flores, Martinez, Knaust, Darnell, Romo, Della-Pina, 2003).

Culturally Based Challenging and Relevant or Engaging Problems

Research shows that in order to learn new things connections need to be made with things we already know and ideas we are already familiar with. Using content that is part of our day-to-day experiences helps make these connections easier, and culturally based content make the material more interesting, applicable and meaningful. If there is a reason or application for the content, then it becomes relevant and it is important (Martinez & Ortiz de Montellano, 1988; Haukoos & LeBeau, 1992; Barta, 1999; Cajune, 2001, Fixico, 2003). More information on the importance of culturally relevant problems was given earlier in this chapter. Repetition is good for a short time, but quickly gets old and boring when you do something over and over again, with no challenge. We learn to walk and talk with repetition, but once we have mastered the basic skill we then move on to more complex and challenging tasks, like running, jumping, or riding a bicycle or learning new words and using them in more elaborate ways. Learning mathematics skills can be compared in much the same manner. By challenging students to use their mathematical concepts in relevant and engaging problems we strengthen the understandings and increase the usefulness of the concepts.

Models of Small Group Collaborative Learning

There are many models of small group collaborative learning. The various models include different aspects of teaching and learning. In this section I will look in detail at three more specific models that have been used in addition to the PLTL model presented in Chapter 1: 1) Emerging Scholars Program (ESP) model; 2) Math EXCEL model; and 3) Supplemental Instruction (SI). I will then go on to compare and contrast these models.

Emerging Scholars Program based on a Treisman Model

There are many examples of the Emerging Scholars Program (ESP) across the country. They are based on the model that Uri Treisman developed in the mid 1980's. The model involved the implementation of a mathematics workshop program with mostly minority, high achieving students attending a large California University. Although the students were admitted to this institution because of their prior success, once admitted mathematics often became an obstacle (Fullilove & Treisman, 1990). The workshops operated much like a discussion section where the students were organized into small groups of 5-7 students, who worked together to solve problems twice a week for about two hours each session. The problems handed out at each session were very carefully selected difficult problems that paralleled the concepts being taught in class. The worksheets were designed to give the students three benefits:

> "1) The skills to earn a final grade of A in the first semester of calculus, 2) a foundation in mathematics that will enable the Mathematics Workshop Program graduates to continue to excel in the second semester calculus and upper division mathematics (without the assistance of the program) and 3) opportunities to identify areas in mathematics knowledge that students must strengthen to survive and excel. The worksheets are composed of problems that fall into one or more of the following groups:
>
> 1) "old Chestnuts" that appear frequently on examination but rarely on homework assignment:
>
> 2) "monkey wrenches" – problems designed to reveal deficiencies either in the students' mathematical backgrounds to find their understanding of a basic concept;

> 3) problems that introduce students to motivating examples or counterexamples that shed light on or delimit major course concepts and theorems:
> 4) problems designed to deepen the students understanding of and facility with mathematics language;
> 5) problems designed to help students master what is known, in Mathematical Workshop Program parlance, as "street Mathematics" – the computational tricks and shortcuts known to many of the best students but which are neither mentioned in the text book nor taught explicitly by the instructor." (Fullilove & Treisman, 1990, p. 468).

Students were expected to work together to solve the problems and understand the concepts behind the problems. A graduate student workshop leader would monitor each group and offer suggestions and hints as needed (Fullilove & Treisman, 1990). Faculty sponsorship is critical to the success of this program. The course leadership is responsible in working with the teaching assistants to craft problems that are difficult but related to the current lecture sessions.

The University of Texas at Austin implemented an Emerging Scholars Program (ESP) in 1988. The program was created to increase diversity among mathematics students. Although minorities are recruited, the program is open to everyone. ESP is very similar to the Treisman mathematics workshop program. The ESP uses small groups and challenging problems in each of the two hour workshops three times a week to encourage students to develop a deeper understanding the calculus concepts and to develop and expand friendships with other students with similar educational goals. Results of the research study described above showed that students enrolled in the ESP earned one letter grade higher than the student not enrolled in the ESP and they were over four times as likely to enroll in the second semester of calculus (Moreno & Muller, 1999).

University of Wisconsin-Madison implemented an Emerging Scholars Program (ESP) to help minorities in calculus in 1994. A study of this program was conducted by Baine, Burda, and Miller. The ESP was similar to the regular class, but instead of attending two regular 50-minute discussion sections each week, the ESP students attended a workshop that met for two hours three times each week. Each workshop consisted of carefully designed, difficult problems that could best be solved when students worked together collaboratively. Students worked on the problems in groups of three or four while a teaching assistant circulated around the room asking strategic questions and offering hints if necessary. The groups were encouraged to interact outside the classroom and study together and socialize to help form a community of learners. End of course grades and course completion rates were compared between the two groups, ESP and Non-ESP. The results show that the mean grades of ESP students were 0.4 to 0.7 grade points higher than Non-ESP Students, and completion rates were up to 36% higher. Qualitatively the ESP students reported that they felt they belonged to a community of learners, as well as the university. Students felt more support from their peers and less isolation. Students reported feeling more confident and, through mastery of the material, they became more self-reliant (Baine, Burda, & Miller, 1997).

Math Excel Model

Math Excel has roots in the research of Uri Treisman and is modeled after the Emerging Scholars Program at the University of Texas in Austin. It is directed specifically at minorities and underrepresented populations, but allows open enrollment from students taking the mathematics classes. The group leaders do not stay with one group, but circulate among several small groups of students working on the assigned problem (Chenoweth, Kinnick & Walleri, 2003). Math Excel is a stand-alone workshop that meets for two hours each week in which students work cooperatively in small groups to gain understanding of mathematical concepts by working on challenging problems (Chenoweth, Kinnick & Walleri, 2003).

A Math Excel model that I observed recently at Oregon State University is a program where graduate students are assigned to assist groups of undergraduate students working to solve challenging mathematics problems. The graduate students act as the peer leaders for each group to encourage and guide, but not give answers. The Math Excel students meet once or twice a week for two hours in small groups to engage in workshop activities. The undergraduates who participate are self-selected by enrolling in a separate Math Excel class in which the learning activities take place. Because students enrolled in Math Excel as a separate class, it is possible have students from various sections of the same calculus class in the same Math Excel group. Results of a research study on this program showed that students who participated in the Math Excel program consistently earned higher grades than students not enrolled in the program by about half a grade (Duncan & Dick, 2000).

University of Kentucky has been using the Math Excel model in Calculus I and II courses since 1990. They targeted minority and underrepresented students for recruitment into the EXCEL classes. Students who participated in EXCEL attend the same lectures, have the same homework, take the same test, and are graded the same way as non-EXCEL students. The difference is the EXCEL students attend three two-hour workshops instead of the usual three one-hour recitation sections. In these workshops, small groups of students work on solving stimulating, challenging problems under the guidance of a teaching assistant leader. Workshop materials are not graded and unfinished problems are not taken home. Research results show that EXCEL participants have average grades often one grade point above non-EXCEL students, and their withdrawal and failure rate is much lower (Freeman, 1998).

The voluntary participation of students in this program is indicative of upper level more advanced classes where students do self-identify when they need help. It is important to note that it requires a certain level of maturity and determination to commit to extra study time and work even with the promise of a better grade and deeper understanding of the course content. Many first-time college students do not have the sense of commitment for this. They think it is unnecessary and a waste of time and money to sign up for an extra class. Experience and maturity are often needed to make that decision wisely. At the Tribal college most students would not take an extra mathematics class for any reason. The group work must be built in as an integral part of the course in order to be effective.

A variation of the Math Excel model was used at Lexington Community College in 1994 for teaching intermediate algebra students. In this research study half of the classes were taught using a collaborative method which included an additional two hour workshop where they worked in small groups on supplementary problem sets that were a bit more challenging than the homework or exams. Results of the study showed that the students who participated in the collaborative sections earned a grade nearly a letter above non-participants and the pass rate increased over 30% (Freeman, 1997).

Maurice Gilmore describes the Math Excel program at Northeastern University as an Emerging Scholars Program and a freshman calculus intervention program. It is described as a program for students who come to college well prepared, not remedial, but need a little push to achieve the level of work they are capable of doing. The program workshops are separate from the calculus course, graded on a pass/fail basis only to prevent too much competition, comprised of challenging enrichment materials that students work on together in groups. Workshops are run by graduate teaching assistants who are trained to assure the small groups function fairly, giving everyone a chance for input. Students in this study usually average about one letter grade or 10 points above the non-Excel students on the final exam. The attrition rate of 13% from one quarter to the next is about half the rate of non–Excel students of 28%. All students are invited to be part of the program and everyone is welcome. There are three goals of the program. The first is learning the mathematical content of the course. The second is learning how to work on mathematics in general, and the third is working on more successful group dynamics (Gilmore, Noel & Stephens, 1996).

"The key elements of a successful Excel program are the people (students and leaders), the process (collaborative learning in a supportive social atmosphere) and the problems (worksheets providing rich and substantive problems solving opportunities)" (Dick, Stone, Firor, & Cavinato, 2002, page 3). The program should not be portrayed as remedial or honors, but should be open to all students. Attendance is important and a strict attendance policy must be enforced. Collaborative groups must be respectful of each other, prepared to participate, contribute, and encourage learning from all participants. Worksheet activities are created by the group leaders. They need to have problems that are relevant to the concepts currently being taught in the course, challenging and contain a variety of problems to keep the students engaged (Dick, Stone, Firor, & Cavinato, 2002).

Supplemental Instruction Model

Supplemental Instruction (SI) is a nationally recognized academic support program that offers free, regularly scheduled study sessions for traditionally difficult, high risk courses. The study sessions are facilitated by undergraduate students, called SI Leaders, who have previously taken the course and demonstrated academic competency in the subject area. Three to five 50-minute sessions are held each week. SI Leaders facilitate and encourage collaborative group learning of course material, rather than acting as authority figures who lecture to participants (Iowa State University, 2007; Muhr & Martin, 2006; Martin & Arendale, 1994). The study sessions are designed to supplement the work being done in class. They are not make-up lectures for students who miss classes. Attendance is on a voluntary basis (Carnegie-Mellon, 2007; Martin & Arendale, 1994).

In the spring of 2001 the University Learning Center at Eastern Connecticut State University made a big change in the university's developmental mathematics program. The Learning Center took charge of offering the first two developmental mathematics courses. They began by requiring both classes be taught by instructors with at least a masters' degree in Mathematics Education or have a special degree in developmental education. They replaced the Algebra I developmental class with a class that covered similar concepts, but emphasized the connection between algebraic concepts and real-world problems. Hortencia Garcia (2003) did a study of the outcomes of the new pilot courses. Two pilot courses were taught with the same content, requirements, homework examinations and grading criteria, but the pilot courses had one class a week devoted to lab activities. Students were put into the pilot programs based on taking the computerized placement test and scheduling availability. Technology, supplemental instruction, learning styles and attitude toward mathematics were all used as part of the pilot classes. Students in the pilot classes showed a 10% increase in the number of students earning a grade of A or B and a 9% decrease in the number of students who failed. Students who took the class in the fall appeared to be stronger mathematics students than students who took the classes in the spring semester. A number of individual scores on the computerized placement test showed dramatic increases of a maximum of 48 points in the spring to 56.2 in the fall semester. This increase in scores is on a scale of zero to 120. This study showed that incorporating various tools such as supplemental instruction, workshops, technology, learning style and time management counseling enhanced student success in developmental mathematics courses (Garcia, 2003).

Research data from the National Center for Supplemental Instruction at the University of Missouri has results that indicate over a 13 year period students participating in SI at the University of Missouri-Kansas City earned 15-30% more A and B grades, 10-25% fewer D and F grades, and had final grades roughly one half a grade point above non-participants (Martin & Arendale, 1994). The data also indicated that the SI program improved the students' performance for different ethnicities at a range of academic levels (Martin & Arendale, 1994).

Table 4 lists several strategies of small group collaborative learning and compares various aspects of each. All of these programs have aspects that are similar. For example, they use the idea of developing a learning community of students to improve learning. The learning communities are composed of students in certain classes that are working toward a common goal, educational success. The various strategies use different methods and techniques to attempt to achieve that common goal of educational success.

> "With such a wide variety of institutions, the model must be adapted to each environment. … You have to respect the culture of the institution … the worst thing you can do is just hand something and say, 'This is how you do it', Triesman said (Conciatore, 1990, page 6).

Table 4: Comparison of various collaborative teaching and learning models.

	Target audience	**Level**	**Course structure**
PLTL	All students-mandatory, part of course	Non-remedial	Integral part of course
Math Excel	All students/minorities-optional, recruited, voluntary	Non-remedial	No curricula restructuring
Emerging Scholars	Ethnic minorities, women, rural students - optional, recruited, voluntary	Non-remedial	No curricula restructuring
Supplemental Instruction	All students-optional, recruited, voluntary	Non-remedial, high risk courses	No curricula restructuring

Table 4 continued: Comparison of various collaborative teaching and learning models.

	Pedagogy	**Workshop origination**
PLTL	Collaborative and student centered, Learning Community.	Instructor developed workshops - challenging, relevant activities.
Math Excel	Collaborative and student centered, Learning Community.	Teaching Assistant developed workshop in conjunction with course leadership.
Emerging Scholars	Collaborative and student centered, Learning Community.	Course leadership crafted problems difficult and related to lecture session materials.
Supplemental Instruction	Collaborative and student centered, Learning Community.	Teaching Assistant developed workshops- whatever the TA thought was needed and was approved by the course leadership.

	Group leadership	**Culturally based content**
PLTL	Student who recently completed the course with a grade of B or better receives extra training in group leadership.	Instructor designs curriculum to best fit with student experiences and learning styles. This implies use of culturally relevant content.
Math Excel	Instructor, department Teaching Assistant.	Lab materials may or may not contain culturally relevant content.
Emerging Scholars	Students who have demonstrated competence in the class or a comparable class and gone. through extensive two day training.	Lab materials may or may not contain culturally relevant content.
Supplemental Instruction	A “model” student who had successfully completed the class or a comparable class, ideally from the same instructor who is teaching this SI class.	Lab materials may or may not contain culturally relevant content.

Table 4 continued: Comparison of various collaborative teaching and learning models.

	Program Goals
PLTL	To improve students' comprehension of mathematics so students can successfully solve both routine and non-routine problems, to improve student attitudes about mathematics, to provide an alternate way of learning. PLTL may also strive to encourage students to consider a career in teaching. Improve student success, retention, and content mastery. Increase number of women and minorities, retention, enthusiasm. Improve student performance in the course.
Math Excel	To increase the number of students who are successful in mathematics, particularly students from groups that are typically underrepresented in mathematics such as African Americans, Native Americans, Hispanic, and women students. By helping the students become more successful in their conceptual learning of mathematics to increase the levels of retention and also to keep more career options open for these students. And to create mathematical learning communities (Ediger, 2005).
Emerging Scholars	MWP was initiated with three goals it maintained throughout: (a) to help minority students in the university excel rather than simply avoid failure; (b) to emphasize collaborative learning and small-group instruction; and (c) to provide faculty sponsorship-an element considered critical for success (Treisman, 1985).
Supplemental Instruction	1) Improve students' grades in targeted courses, 2) Reduce the attrition rate within those courses, and 3) Increase the eventual graduations rates of students (Arendale, 1994).

	Challenging & relevant/engaging problems
PLTL	Problems are created specifically by the course instructor for the purpose of challenging and engaging the students.
Math Excel	Contains challenging and relevant problems, up to the discretion of the teaching assistant in conjunction with course leadership.

Table 4 continued: Comparison of various collaborative teaching and learning models.

	Challenging & relevant/engaging problems
Emerging Scholars	Contains challenging and relevant problems, up to the discretion of the teaching assistant in conjunction with course leadership.
Supplemental Instruction	Contains challenging and relevant problems, up to the discretion of the teaching assistant in conjunction with course leadership.

(Ediger, 2005; Arendale, 1994; Fullilove & Treisman, 1990; Moreno & Muller, 1999; Baine, Burda, & Miller, 1997; Walleri, 2003; Duncan & Dick, 2000; Freeman, 1998; Freeman, 1997; Gilmore, Noel & Stephens, 1998; Dick, Stone, Firor, & Cavinato, 2002; Muhr & Martin, 2006; Martin & Arendale, 1994; Garcia, 2003).

Using these recommendations and other ideas from the literature, the research topic of implementing mandatory, small, peer-led collaborative learning groups in developmental mathematics classes at the Tribal community college was developed. The study examined the change in completion and perseverance rates of students involved in the learning groups and how their understanding of specific mathematics topics progressed. The study also looked at how the peer leaders changed as they led the groups through the workshop exercises.

CHAPTER 3

RESEARCH METHOLODOLGY

Introduction

This study was designed to measure the impact of mandatory, small, peer-led collaborative group learning workshops in developmental mathematics on completion, perseverance, and understanding of mathematical concepts for Native American students enrolled at a two-year Tribal Community College. The research was a quasi-experimental study of mixed design. This chapter outlines the methodologies used in the research study beginning with the research questions. The report continues with an analysis of the population and sample. It then discusses two pilot studies that have been completed. Finally the data-analysis techniques and a summary of the research design and methodologies are provided.

Research Questions

1) What impact did the implementation of small, peer-led, collaborative-group-learning workshops have on completion rates of Native American students in developmental mathematics classes at a two-year Tribal Community College?
2) What impact did these workshops have on perseverance rates of Native American students in developmental mathematics classes at a two-year Tribal Community College?

3) Did the implementation of the workshops improve the demonstrated mathematical procedural skills of Native American students at a two year Tribal Community College?
4) What other skills connected to the success of Native American students at a two-year Tribal Community College can be attributed to the use of small, peer-led collaborative-learning-group workshops?
5) What were the peer leader's perceptions of the benefits or deficits associated with their role in the workshops?

Population and Sample

The students enrolled in the pre-algebra class during fall semester, 2008, at a small rural Tribal community college were the population of interest for the research study. Approximately 95 percent of the entering students are placed in the developmental mathematics classes of basic mathematics or pre-algebra, with about equal proportions in each course. Placement testing is required of all incoming students and scores on this standardized test determine course placement. Adjustments are made by the instructor to the placement during the first two weeks of class. This usually results in two sections of 25-30 students each. Most students are new to college and this is the first mathematics class they will take.

This study included both sections of the pre-algebra course during one semester. One section will be referred to as the treatment section and the other as the control section of pre-algebra. This four-credit class met for four hours each week. One day each week was devoted to an activity. This day was used by the treatment group to work in small peer-led collaborative groups on an instructor-designed, peer-led activity while the control section was given the same activity, but worked on it individually, without the benefit of the group or peer leader. Students were not randomly placed in sections due to scheduling conflicts. Students selected a section of pre-algebra in cooperation with their advisor based on class schedule and available times. One section was offered at 10:00 a.m. and the other section was offered at 2:00 p.m. Both sections met Monday through Thursday each week in the same room. The 2:00 p.m. section was selected at random to be the treatment section and the 10:00 section was designated as the control section. Both sections were taught by the same instructor, who is also the researcher. I, the instructor/researcher, have taught mathematics at the high school and college level for over 25 years. I have been the primary mathematics instructor at the college where the research took place for the past 21 years. I am responsible for choosing the curriculum and assessing the mathematics program at the college. The allocation of students to the class sections gave highly similar class profiles based on: 1) first college mathematics course, 2) number of students repeating the course, 3) ratio of Native to non-Native students, 4) ratio of males to females, and 5) ratio of traditional to non-traditional students at the beginning of the semester. Table 5 characterizes the students in the two sections using several dimensions. The first is by class determined by time of day. The second indicated how many students are enrolled in this class as their first math class taken at the college level. The third indicates the number of students retaking the class. Native versus non-Native specifies the students' primary ethnicity. Traditional age is 18 through 24, non-traditional age is over 24 years old. The ratios of Native to Non-Native and male to female students in both the control and treatment classes are very comparable. Although the ratio of traditional to non traditional age student varies more this difference can be minimized. Non-traditional age students may have a higher initial level of motivation, they also have more family and work obligations to overcome. The attendance rate of both groups is similar, traditional age students choosing to be gone just to be gone whereas the nontraditional age students usually present reasons for missing class that instructors perceive as legitimate. These dimensions were not used to analyze the sample population data.

Table 5: Group Make Up, Control versus Treatment.

Group	Meeting Time	First College Mathematics Class	Repeat Class	Native/Non-Native	Male/Female	Traditional/Non-Traditional Age
Control N = 31	10 am	15	6	31 / 0	17 / 14	23 / 8
Treatment N =30	2 pm	18	4	27 / 3	14 / 16	19 / 11

Student withdrawals and dropouts are a problem at the college. Table 6 indicates the numbers of students attending the class at various times throughout the semester.

Table 6: Number of Students Attending Class by Time of Semester.

Number of students attending each class			
Group	Beginning of the semester	Midterm	End of semester
Control	31	21	17
Treatment	30	26	20

This attrition rate is comparable across most curricular areas at the college and is not unique to mathematics courses. As a rule, most students who do not quit before midterms finish the semester.

Pre-algebra

Pre-algebra is a four-credit semester course at the college. The purpose of this course is to provide students with a sufficient mathematical background to progress to the advanced algebra level of mathematics. It is designed as a developmental course, to build skills that are necessary but lacking in many students. This course is designed to teach students the fundamental mathematical concepts needed to be successful in college level mathematics courses. The course objectives include strengthening mathematical skills, as well as developing skills for continuing success such as good attendance, promptness, building self confidence, and strategies for working together.

Course Content Objectives for pre-algebra are as follows:

Upon completion of this course the student will:

1. Be able to perform operations on integers.
2. Manipulate variables, terms and expressions.
3. Be able to solve and graph linear equations.
4. Perform operations on polynomials: add, subtract, multiply and factor.
5. Perform operations on rational numbers: add, subtract, multiply and divide.
6. Graph linear and quadratic equations using the Cartesian coordinate system.
7. Solve systems of two linear equations.
8. Be introduced to square roots and quadratic equations (Tribal Community College catalog, 2007).

For the past ten years all sections of pre-algebra have used a common textbook and for the past eight years all sections have used a common syllabus. This ensures that all students completing the course have covered the same content material with the same emphasis at a similar pace. It also ensures that the students are graded on the same topics and that the students are held to very comparable expectations. Instructors of the course have varied, but they are guided by the department head who shares the common syllabus that was developed by a team of instructors several years ago. The textbook is a series of booklets written by King and Rasmussen, published by Key Curriculum Press, Emeryville, CA, called *Key to Algebra*. The booklets are written in large, friendly handwritten style font. Although the booklets are not printed in color they have excellent diagrams and show examples that are clear and do not skip any steps. The booklets instruct in a fairly traditional but user-friendly style. Student reaction to the booklets has been very positive. Student like the way they are written, the lightness and compactness of carrying a 37 page booklet instead of a 300 page book, the workbook style, the large number of practice problems, and the step-by-step method of instructions. The course syllabus, course schedule, and course exams are common to all sections. Homework assignments and quizzes are developed by individual instructors. All sections follow the same daily schedule, so very similar emphasis is placed on the topics that are crucial to subsequent mathematics classes. In this study, the workshop activities used by the treatment group were designed by me with expert input from other mathematics and science instructors at the Tribal Community College and Montana State University. A Native Studies instructor was also consulted to help with the cultural content of specific workshop activities.

Results of the First Pilot Study

An initial pilot study was conducted in spring semester 2006 to gain information on the workshop activity materials. Workshop activities have been developed elsewhere in the nation for college-level courses such as calculus, but very little had been developed for developmental mathematics classes such as pre-algebra. A purpose of this pilot study was to determine if the workshop activities were of appropriate content and length to engage and challenge the students. A second purpose of this pilot study was to determine what kind and how much training was optimal for the peer leaders, the length of the training, and what kinds of problems might be encountered within the peer groups. Guidance was provided via the Peer-Led Team Leader Handbook, but the researcher expected to encounter different issues due the unique makeup of the student body (Gosser, et.al., 2001).

For this pilot study both sections of pre-algebra were used. The classes met four days a week, with one extra day scheduled as a math lab. That is the day that was officially called “Workshop Activity” day. Initially there were 53 students enrolled in the two classes. Students were given the option to attend the workshops, but the workshops were not mandatory during this pilot study. They were divided into six groups and were led by three peer leaders. The groups were self-selected due to cultural traditions that prohibit verbal interactions between some individuals. Some withdrawals and dropouts occurred in the first half of the semester, but the groups remained fairly constant throughout the second half of the semester. The biggest change in all groups was due to students withdrawing or dropping out of class. Table 7 indicates the group make-up at midterms.

Table 7: Midterm Group Make Up for Pilot Study #1

Class & Group	Leader	Group size	Native/ Non-Native	Male/ Female	Traditional/ Non-Traditional Age	First College Mathematics Class	Repeat Class
1A	X	4	4 / 0	3 / 1	1 / 3	3	1
1B	Y	6	6 / 0	0 / 6	4 / 2	4	2
1C	Z	5	3 / 2	2 / 3	4 / 1	4	1
2A	Y	8	8 / 0	2 / 6	7 / 1	6	2
2B	Z	5	5 / 0	1 / 4	3 / 2	5	0
2C	X	8	7 / 1	3 / 5	3 / 5	5	3

During the initial pilot study, the weekly workshops were optional, but students attending the workshop activity day earned a homework score of 10 points that day as an incentive to participate. The final course grade was based on a total of 850 points. Tests over the booklets accounted for 700 points and the remaining 150 points were earned through homework, quizzes and workshop participation. Homework assignments and quizzes were given frequently, one to three per week, and workshops were offered weekly. Each was worth ten points and the best fifteen scores were used in the final grade. An additional 25-30 homework and quiz points were possible throughout the semester not counting the workshop activities. It is possible that the points for the workshop activities could have skewed grades, perseverance, and retention rates in the pilot studies. The extra points which were available for all students who turned in the activities could have been enough to boost the final grade to the next level, affecting grades, perseverance, and retention.

Data gathered from instructor observations, formal and informal interviews, and end-of-semester course surveys were used to discern the following results for this pilot study:

1) Most workshop activities were sufficient in terms of length and holding student interest. Several were too challenging and needed to be modified (Gosser et. al., 2001). Workshop activities were deemed too challenging if the groups did not get more than half way through them in a session.
2) Some groups were better "fits" than others. More motivated students and students with similar educational goals tended to group together. The most functional group size was about six students. Groups with more than six often developed subgroups that needed to be reminded frequently they were part of larger group. Smaller groups ran into problems with absenteeism so the already small group was usually smaller still. The last group formed had the most trouble; they were usually late additions to class or students who did not attend class on a regular basis.
3) Groups enjoyed the time doing the activities and did not complain about the extra hour each week.

4) There were three students who said they wanted to participate, but when they were put into a group they were only a disruption. The other members of these groups requested they be moved, they were and soon quit coming to the workshop sessions.

5) Grades and grade point averages of the students did not show much difference, but attendance was better during regularly scheduled classes in addition to the attendance at the optional workshop sessions. Students in both the workshop and non-workshop classes were given the opportunity to do the activity and get points for turning in the activity.

Table 8 shows attendance and grade information from Pilot Study #1.

Table 8: Attendance and Grade Information from Pilot Study #1.

Class 1	Number of students	% Attendance in class for semester	Grade of A	Grade of B	Grade of C	Grade of D	Grade of F/W
workshop	15	72	4	3	3	0	5
non-workshop	8	58	1	0	1	1	5
Total Class 1	23	65	5	3	4	1	10
Class 2							
workshop	21	70	3	5	2	5	6
non-workshop	13	51	0	1	2	1	9
Total Class 2	34	63	3	6	4	6	15
Total Combined	53	64	8	9	8	7	25

6) Leaders needed more help on how to direct/lead the group. The leaders were still acting as tutors and had to be reminded to facilitate not tutor.

7) Leaders enjoyed the group interactions and group work. They commented on how much they learned working with the students and how much they enjoyed working closely with the instructors.

8) The instructors found it was very time consuming, not only working with the students but almost equally working with the peer leaders. Scheduling time to work with the peer leaders was very important.

A brief survey was given at the end of the semester to measure the students' attitude toward mathematics. The results showed that about two-thirds of the students enjoyed doing the work with the other students, and student evaluations at the end of the semester indicated students felt the activities were worthwhile, although they were not sure how much it helped them mathematically. Most replied that it was more fun working in groups and they would like to do more work that way. Some students also reported that they did not like being "required" to spend an extra hour doing the workshop activity and it was unfair to penalize them the ten point homework grade if they did not attend. This concern was addressed by reminding students that only fifteen out of over twenty five homework and quiz grades were used for calculating the final course grade not counting the additional twelve available for attending the workshops. All students had over 32 possible homework, quiz, and activity scores. The students had many opportunities to earn the points without attending the workshop sessions, or turning in the activities.

After the first pilot study adjustments were made to several workshop activities. Two of the workshop activities were simply too long. The groups did not have enough time to work through them. The activities were shortened to better fit within the time allotted. This meant re-evaluating the target concept, the areas most confusing to students and the redesigning the activity with those thoughts in mind. A third activity was also modified as the narrative was unclear and caused confusion.

Results of a Second Pilot Study

A second pilot study of the research was conducted in fall semester 2007. The emphasis for the second pilot study was placed on the training of the group leaders. The students who would be peer group leaders had all worked for the college as tutors. All the tutors at the college attend a two-day training seminar before they are allowed to tutor. The training is directed toward accountability and procedures. The tutors are trained to perform as a second teacher and show students what they are doing wrong and how to do it correctly. The role of a peer group leader is different. The peer group leader is not to focus on showing a student or group of students how to do the problems, but rather let the group figure it out on their own with guidance and direction. To best train the peer leaders meant first un-training them from the role of a tutor and then working with them to help develop a method for leading and guiding a group of students toward a solution. For example, a peer leader might encounter a group that was having trouble solving a linear equation. A tutor would very likely just do the problem for the group on the board and the students would all copy it down. Peer leaders were expected not do the problem but instead ask guiding questions such as “what might you do first?”, or “what if the problem was…. (a simpler problem)?” This would allow the students in the group the chance to figure it out on their own. The peer leader also plays a big part in increasing self confidence and building self esteem.

During the second pilot study, the peer leaders enjoyed the one-on-one relationship with the instructors, although at times during the semester this interaction was a burden given their regular class work loads. The peer leaders, the course instructor and the researcher met weekly for an hour or more to discuss several issues that arose during the pilot study. Initially these discussions were used for the two group leaders to try out the workshop activity before they met with their own students. This was very helpful as it allowed the leaders to identify most problem areas, and highlighted where the leaders would need to do the most guiding. But it was found that more training was needed regarding how to handle specific individual students or group situations, and how to guide without showing the groups how to solve the problems. These suggestions were incorporated into the training given to the group leaders. Another area that was found to need clarification was the broader role of the group leader. The leaders were there to help, but not to provide individual tutoring and/or counseling services 24 hours a day, seven days a week. This was an important boundary to have for both the leaders and the group members.

According to the *Peer-Led Team Learning; A Guidebook* (Gosser, et. al., 2001) the team leader has a responsibility to guide the team to its highest capacity. To do this the team leader needs to be able to think of questions that they can ask other students to help them understand, and to guide their thought process in the right direction. This process not only helps the students in the group, but also makes the leader think in more depth about a concept. Most instructors have had the opportunity to try to explain a concept in different ways. The team leaders attempt to get the groups to think in different ways by asking questions in a probing manner. The team leaders needed to be taught how to work with a group and be given time to develop the necessary leadership skills. The second pilot study found it was necessary to keep reinforcing the idea of leadership. The students in a peer-led group would often want the leader to revert to the role of a tutor/teacher and show the group how to do an activity rather than to facilitate the group as it reasoned through it on its own. The biggest challenge our team leaders faced in the second pilot study was to motivate the students to find a way to help the students help themselves. That said, there were some instances where the team leader needed to offer a few ideas of his or hers to get the group moving again. The activities were designed to cover material that was currently being discussed in class. The workshops were intentionally challenging, but not beyond reach of the group. This pilot study included one section of the Pre-algebra class. A new instructor was hired at the last minute and the researcher decided the time frame was too short to bring the new instructor up to speed on the workshops, peer leaders, and small group activities.

Peer group leader training was the primary focus of the second pilot study. Results from the second pilot study are:

1) The peer leadership training was much more formal and directed toward specific leadership objectives. The topics included: a) the role of the group leader; b) the basics of group dynamics, such as team building and tolerance; c) basic theories of learning; d) listening skills and questioning techniques; e) learning styles; f)

reflective teaching; g) teaching tools; h) race, class, and gender issues; and i) student disability issues. Many of these topics were discussed in greater detail throughout the semester as time allowed and opportunities presented themselves. The peer leaders reported they felt prepared for most issues, but everyone was confounded by the attendance problem. Leaders found it was helpful to keep a journal. This helped them recall specific group interactions and individual student exchanges for later discussion.

2) Group issues that arose this semester could almost all be tied to attendance. The group participants had much better attendance than non-participants, but it was still very inconsistent. This created a separation between the group members and the peer leader. It was frustrating for the group leader to try to construct an atmosphere of working together and trust when the group members varied from week to week. The continuity was not there. This apathy was not restricted to this class. It appeared to be college wide.

3) As the only instructor of the treatment section in the second pilot, I felt less effective compared to the first pilot in which there was another treatment section and therefore another instructor to interact with. Although the training seemed to go more smoothly in some ways, and the group leaders were more prepared for issues that arose within the groups. The intensity of the one-to-one interactions of peer leaders with the instructor grew. It was easier having two instructors working with the peer group leaders, sharing responsibility for the training, answering peer leader questions, as in the first pilot study. The luxury of having

two points of view, an opportunity for modeling peer leader/student interactions and better communication with peer leaders was lost when only one instructor was involved.

4) The student results were similar to the first pilot. Attendance was worse overall than in the previous pilot study, but there seemed to be college-wide concern on the same issue. Nonetheless, the students who participated in the workshops had better attendance than the students who did not. And the grade distribution displayed in Table 9 points out that participants earned higher grades than non-participants.

Table 9: Attendance and grade information from Pilot Study #2.

Class 1	Number of students	% Attendance in class for semester	Grade of A	Grade of B	Grade of C	Grade of D	Grade of F/W
workshop	13	65	3	2	1	0	7
non-workshop	9	10	0	0	0	3	6
Total Class 1	22	41	3	2	1	3	13

<u>Treatment: Workshop.</u>

The treatment for the present research study added the use of small peer-led collaborative groups to the regular pre-algebra curriculum. This took place during one regularly scheduled class meeting each week. Students in the treatment section met three days a week for their usual class and on the fourth day they met for the small collaborative peer-led group activity. Groups from the treatment section contained four to eight students. The groups had designated areas for the activities, a library conference room and a program office. Students in the treatment section were initially split into four groups of students led by four team leaders. The workshop was required of all students in the treatment section, and it was held during the regular class time on an officially scheduled day of class.

The workshop activities were designed using the information provided to the researcher at a week-long PLTL training workshop and in the PLTL guidebook (Gosser, et. al., 2001). The PLTL model was first designed for use in a university chemistry classroom. The PLTL model gives peer-leaders the opportunity to get practice in leadership and it provides an active learning environment for the groups they are leading. This type of learning experience was later applied and adapted to other areas of science and mathematics. The critical components of the Peer-Led Team Learning Workshop Model are:

1) The workshop sessions are integral to the course. They are a necessary component of the course and in step with the material being taught in the course. The workshops are a natural extension of the concepts being taught in class that week. For example, if the class begins studying integers, the workshop that accompanies this content involves real life situations where integers are common for describing money, temperature, weight, elevations, etc. This activity works especially well in groups as students enjoy sharing their own life experiences with each other. It makes the whole group experience much more memorable and fun, not to mention it is a great icebreaker for learning something about one's fellow classmates.
2) The faculty work closely with the team leaders and are involved in creating the workshops so that they complemented the course material. In the present study, the workshop materials were developed, piloted and revised by the instructors and other mathematics faculty at the college prior to their use in the study.
3) The peer leaders are students who had successfully completed the course, worked closely with the faculty, and received ongoing training.

4) The material used in the workshop activities are challenging, integrated with the material being covered in the course and designed to encouraged collaborative effort from the group.
5) The organizational structure including use of small groups, room assignments, regularly scheduled time for workshops, etc. are designed to promote learning.
6) The institution supports the model, encourages creative and original ideas, and is willing to work with instructors to achieve success (Gosser, et. al., 2001).

In this study the students in the control group met three days each week for class as usual and on the fourth day they met and were given an activity to work on alone. The students met in the assigned class room each day of the week and were given the same activity as the treatment group as an individual assignment, due at the end of the hour. They were not encouraged to work together. But they were told they could ask the instructor for help, although few ever did.

All research data for present study was collected from the two sections of pre-algebra that were offered during the fall semester 2008.The workshops began during the second full week of classes in September, and continued for 15 consecutive weeks until the end of the term. Workshop activities and the course syllabus are included in the Appendices. The same syllabus was used for both the control and treatment class.

Treatment: Workshop Activity Design

The content of each workshop activity was designed to relate to the material that was being covered that week and presented as a challenging problem set in a relevant real-world context. Each activity was designed to make group members use their collective knowledge to complete the activity. The goals were; a) to encourage group members to talk about the problem, b) to give them practice using the new vocabulary and mathematical concepts, c) to get them thinking about different ways to apply the mathematical concepts, and d) to learn how to work together. The experiences in using mathematical vocabulary, defending and explaining one's ideas, seeing alternate ways to work out problems, and attempting to obtain the same correct answer were very new for many students. The activity was handed out in the group setting and turned in at the end of the hour. The students were not graded by how much they completed or by whether they arrived at a correct answer, only by participation. Attending, working on the activity, either in the small peer-led collaborative group (treatment section) or individually (control section) earned each participant ten points as a homework grade. Students who came late, left early or did not do the activity did not receive full credit. The students from the treatment group were kept on task by their group leaders. They may not have completed the activity, but students were actively engaged in discussion for the hour. In the case of the control group, the instructor/researcher watched the students and recorded how long they remained on task.

Treatment: Workshop Activities.

Workshop activities were developed by the researcher with the PLTL characteristics of being "appropriately challenging, integrated with other course components and goals, including exams, and designed to engage the students with the materials and one another" (Gosser, et.al., 2001, page 20). The topics were chosen to match the content taught during that week of class but with more real life applications and a slightly more engaging and challenging context. The development of the activities began with listing the major concepts for each week of the class. Next, several mathematics and science instructors brainstormed some possible topics and offered input as to what types of activities might fit the concepts and make interesting extensions of the concepts, keeping in mind integrating areas of science, culture and real life. From that list a theme was chosen and the activity was developed using the course concepts it was being designed to enhance. The activity was then reviewed for level of possible student engagement, mathematical content, and appropriate length and level. Once the activities were created they were given to a Native Studies instructor for advice regarding how to embrace and enhance cultural connections in the workshop activities. Some concepts simply do not lend themselves to connecting the students' culture to mathematics. However such connections were built into workshop activities when there was good fit. A list of the workshop topics is provided in Table 10.

Expertise in developing the workshops was provided by qualified professionals at the Tribal college as well as university colleagues. The instructors who helped develop the activities all had extensive experience working in the field of mathematics and/or education and were familiar with the goals and expectations of the project. One mathematics instructor had four years experience at the college and an additional ten years experience teaching high school students at one of the college's biggest feeder high schools. There were two science instructors who contributed to the development of the workshop activities. One grew up on the reservation, went to the college, went on to earn a bachelor's degree and is currently working toward a master's degree. The second was from a different Tribal college but had 10 years science

Table 10: Workshop Activities.

Week	Workshop Topics	Pre-algebra concepts by week
1	Integer Applications	Integers: Prime factors, addition, subtraction.
2	Area and Perimeter	Integers: multiplication, associative property.
3	Order of Operations	Order of operations, distributive property, division.
4	Linear Equation Applications	Equations: Addition principle, multiplication principle.
5	Identifying Errors Solving Equations	Equations: Addition/subtraction principle, multiplication/division principle.
6	Polynomials	Polynomials: Adding/subtracting, distributive principle.
7	Factoring Polynomials	Polynomials: common factors, multiplying monomials, binomials, and trinomials, factoring trinomials.
8	Identifying Errors Multiplying Polynomials	Polynomials: zero product rule, solve quadratic equations.
9	Rational Expressions	Rational numbers: dividing integers, solving equations, graphing rational numbers (number lines).
10	Simplifying Rational Expressions	Rational numbers: inequalities, absolute values, relations, functions.
11	Inequalities	Rational expressions: equivalent expressions, multiplying fractions, simplifying fractions, reciprocals, dividing fractions.
12	Application: motion problems	Rational expressions: adding/subtracting fractional expressions, least common denominators, solving equations.
13	Application: work problems	Rational expressions: proportions, ratio and percent problems.
14	Rectangular coordinates	Rectangular coordinates: plotting points, graphing, linear equations, slope, y-intercept.

teaching experience at a Tribal college. The Native Studies instructor was from the reservation, had attended the Tribal Community College years earlier, had gone on to earn a bachelor's and a master's degree, and is currently pursuing a doctorate in Native American Studies. The workshops were developed and piloted during the fall semester 2007. Modifications were made to the workshop activities based on expert feedback from the instructors and students. Modifications were made to clarify the activities, to adjust the length to be more appropriate, or to add cultural content.

Treatment: Selection of the Groups.

The treatment section of the pre-algebra class initially had 30 students enrolled; the control section had 31. Both sections had fairly typical withdrawal numbers during the first two weeks, and the actual numbers in the classes were 30 and 24 respectively.

Table 11: Number of students attending class after drop/add deadline, two weeks.

Number of students attending each class after two weeks			
Group	Beginning of the semester	Drop/Add Deadline	Midterm
Control	31	24	21
Treatment	30	30	26

Students in the treatment class were allowed to self select into groups of four to eight students. Self selection was allowed because cultural traditions prohibit some students from speaking with other students, although it has been somewhat of a policy at the college that in emergency situations these cultural traditions may be broken. Very traditional Native people will not break this rule for any reason. For example, a mother may not speak to her son-in-law. The traditional discourse was maintained by allowing students to group themselves to avoid this problem for our research. The groups began with a core of about four individuals and allowed other students to join their group as needed. The groups remained intact throughout the semester, but minor changes in group make-up occurred.

Data Collection, Analysis, and Research Design

The purpose of the study was to examine the change in completion and perseverance rates of students involved in the small, peer-led collaborative learning groups and to document how their understanding of specific mathematical topics progressed. The study also examined what other personal skills for success Native American students at a two-year Tribal Community College developed that might be attributed to the use of small, peer-led collaborative learning groups. And finally, the study looked at how the peer leaders changed as they led the groups through the workshop exercises.

This research study was approved by the Institutional Review Board of Montana State University and by administration at the Tribal Community College. All participants were informed of key aspects of the study and agreed to participate. Letters of informed consent were signed and precautions were taken to protect the identity of all participants.

Completion and Perseverance Rates

Grade and attendance records were used to collect data to respond to the student completion and perseverance rates. The grade records were used to analyze the number of students passing each course with a grade of A, B or C and who earned a D, F or withdrew from class. Attendance records were used to compute the percent attendance for each student, class, and semester. Historical data regarding course attendance, completion and grade distribution was gathered starting in spring 2003 through spring 2008, allowing comparisons of data from the terms when the pilot studies and full study occurred with data from other terms. Data from the control group and treatment groups were also compared during the research semester, fall 2008. This data was analyzed using descriptive statistics.

Demonstrated Procedures of Mathematics Concepts

Data for demonstrating procedures of mathematics for each student was collected in two ways. Copies of student work, such as pages from the workbook style textbooks, classroom quizzes, and tests were collected throughout the semester and kept for comparison documenting the development and progress of the use of correct mathematical concepts. This data was summarized by recording the date of various achievements on the Demonstrated Procedures for Mathematics Rubric, Table 12.

Dates were filled in on the rubric table as the individual's understanding progressed through the concepts. This progress was graphed by for each of the main concepts, providing a visual map for each student and class. This rubric was developed by the researcher, then reviewed and scored by another mathematics instructor who has an extensive experience with students of similar background at both the high school and college level. Revisions were made based on suggestions from this reviewer.

The topics in this course depended highly on knowledge of the prior concepts to be able to complete the work or projects encountered later. Errors we looked for included using faulty logic, false starts, careless mistakes, time spent on a problem, etc.

Table 12: Demonstrated Procedures for Mathematics Rubric.

Concepts	Novice	Nearing Proficiency	Proficient	Advanced
Adding, subtracting, multiplying and dividing integers.	False starts, faulty logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors time spent,	Right start, steps correct, leave out steps, apply, time spent
Adding, subtracting, multiplying and dividing variables, terms and expressions.	False starts, faulty logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors, time spent	Right start, steps correct, leave out steps, apply, time spent
Solving simple linear equations.	False starts, faulty logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors, time spent	Right start, steps correct, leave out steps, apply time spent,
Adding, subtracting, multiplying and factoring polynomials.	False starts, faulty logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors, time spent	Right start, steps correct, leave out steps, apply time spent,
Adding, subtracting, multiplying and dividing rational expressions.	False starts, faulty logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors, time spent	Right start, steps correct, leave out steps, apply time spent,

Specific mathematics topics that were examined for understanding included:

a) adding, subtracting, multiplying and dividing integers;

b) adding, subtracting, multiplying and dividing variables, terms and expressions;

c) solving simple linear equations;

d) adding, subtracting, multiplying and dividing polynomials; and

e) adding, subtracting, multiplying and dividing rational expressions.

The following section provides an example of typical errors made by the students as they learned to add, subtract, multiply and divide integers.

Adding, Subtracting, Multiplying and Dividing Integers.

Although the students have certainly seen problems involving negative integers, it is very difficult for many of them. The first time they attempt this type of problem answers are often incorrect. Table 13 shows examples of early-semester answers and late-semester answers. Results from the student tests covering each booklet were used to determine the level of understanding on each concept. It was expected that some students would struggle with a concept the first time they encountered it, but as they practiced the concept they would become more proficient with that concept.

Similar tables were used by the researcher and coding collaborator to classify the level of demonstrated mathematical procedures for each student and record when the student demonstrated that ability. As students master the mathematical concepts they demonstrate that understanding by using correct and appropriate mathematical procedures. Not all students are successful learning the concepts at the same time, but there seems to be a clear progression of what concepts are necessary to succeed at the next level. Copies of student work, pages from the workbook style textbooks, classroom quizzes, and tests were kept for comparison throughout the semester. This provided a chronologic record of each student's progressive understanding of various mathematical concepts throughout the semester.

Table 13: Examples of Integer Operations

Type of integer problem	Early in the semester answers, Novice.	End of semester answers, Proficient.
Addition	3 + -4 =7 or 3 + -4 = -7 not sure if the answer is positive or negative	3 + -4 = -1
Subtraction	2 - 6 = 4 or 2 -6 = -4 or 2 - 6 = 8 or 2 - 6 = -8 the first two answer are a little more common, but all answers appear in approximately equal proportions	2 -6 = -4
Multiplication	3 x -5 = -15, 3 x -5 = 15 about equal proportions of students pick of the sign of first or second number	3 x -5 = -15
Division	-12 ÷ -4 = -3, -12 ÷ -4 = 3 again about equal proportions of students choose the sign of the first or second number.	-12 ÷ -4 = 3

Data from the journals of the peer leaders was also used when appropriate to corroborate the data from the above sources.

Personal Skills Attributed to the Use of Small Peer Led Collaborative Learning Groups

Students who worked in the small peer led collaborative learning groups sometimes exhibited behavior typical of the group learning in other aspects of their college experience. Data on other personal skills for success that might be attributed to the use of small peer-led collaborative learning groups was collected by informal staff interviews and observations, student surveys, documentation from peer leader journals, and interviews with focus groups comprised of students from the small peer led collaborative learning groups.

Other data on personal skill development was based on observations done mainly by college staff in the student services area. Staff members were interviewed informally on a weekly basis and given the opportunity to describe student behavior they had observed when not in classroom or laboratory settings. The informal interview method was chosen specifically to fit in with the culture of the college. When I was new to the college nearly 25 years ago the college president took me aside and pointed out how important it was to take time and get to know the people you work with. It meant taking time to just sit in an office and visit for no reason, just to get to know the person and hear what they saw and heard. Once you get to know people they open up and talk more as they come to trust you. Not only do they tell you more but you understand better because you know the person doing the telling so you can relate to the context better. Since that time I made that part of a weekly routine, a short campus “walk about” to chat with or visit whoever might be in the office or I met in the hallway. So this became the natural method for collecting data from other college staff and faculty members. The informal interview protocol was reviewed by a Tribal elder/cultural expert who was familiar with the educational practices at the college and was tailored not to offend any cultural traditions. After each weekly interview I made detailed notes from the conversations.

The group leaders, instructor, and I observed students’ behavior outside of class time. Other instructors and college staff were also asked to watch for observable behavior changes in groups of students. This information was collected from the staff during discussions about students or groups of students that frequented their particular physical areas of the college such as the STEM study room or the TRIO tutoring lab through informal interviews described above. These observations were documented, classified and grouped by the type of behavior observed or reported.

Basic categories included:

1) Academic interaction, for example, groups meeting to work on academic assignments that had not worked together previously, initiating group work, extending the group to other academic areas, etc.
2) Social interaction, for example, groups meeting for social exchanges, such as eating lunch together, commuting, or just visiting that had no prior connections.
3) Mixed interaction, for example, groups working together for both academic and social improvement.

Information was also collected from the group leaders at their weekly meetings with me, about who might have observed a specific behavior of relevance to the study. These observations included interactions among students within a group or between groups either on campus or off campus at a community event. This data was analyzed by first reading through the data to get familiar with the content, codes were then added to identify specific ideas, which were then grouped into themes and patterns that emerged.

Students also completed a survey at midterm and at the completion of the course focusing on the usefulness of the workshop activity. The survey was designed for students in the small collaborative peer led learning groups, but it was given to all students in both the control and treatment groups. This survey had 36 questions that allowed for Likert style answers. The surveys were modified by the researcher based on a PLTL evaluation tool published in the *Peer-Led Team Learning; A Guide Book* and can be found in the appendix (Gosser, et.al., 2001, p. 130). Interview questions for the focus groups are also included in the appendix. The responses to these questions were coded and grouped by the type of response reported. This data was analyzed by comparing answers from the control group and the treatment group. Data from the journals of the peer leaders was also used when appropriate to add to the perspectives available in the data from the above sources.

Changes in Peer Leaders

To assess the changes in the peer leaders as they guided the groups through the weekly workshop activities and the semester progresses, each peer leader kept a journal of their interactions with the group and individual encounters. The peer leaders were given an outline of what things should be written about in the journal, this included:

1) date, time, group members present;

2) short description of workshop activity;

3) significant mathematical contributions, what were they and by whom;

4) significant social contributions, what were they and by whom;

5) what one thing made the biggest impression; and

6) other.

Journals were shared with me weekly when the leaders met with me to prepare for the next workshop activity. Any issues that had come up were dealt with and ideas were shared for improving the model. During the weekly meetings I also asked probing questions to find out if the leaders had found any strategies that were useful in the leaders' own classes. This was not a formal interview, but focus group questions with a four-person focus group comprised of the four group leaders. The group leaders would often share ideas with each other that they were a bit hesitant to share with me alone. The data, collected from the peer leaders in their journals and shared with me, was used to address the question of what are each leaders' perceptions of the benefits gained by facilitating as small, peer-led collaborative group learning activities. The data was analyzed using a qualitative approach of coding, grouping and arranging the ideas in themes or patterns that emerged.

Surveys from the PLTL handbook adapted for our use are included in the appendix (Gosser, et. al., 2001). The data from the two peer leaders was examined to discover noteworthy patterns, themes were established, and the themes were examined for interrelationships between the responses using inductive analysis (Patton, 2002).

Data Analysis Summary

The quasi-experimental design of the research is due in a large part to the researcher's inability to randomly assign students to a section of the pre-algebra class (Creswell, 1994). Constraints of other classes, work and family schedules were used to determine class enrollment, but the researcher could add the treatment to one section of the class. This design is typical in many real-life situations (Vogt, 1999). One section of the pre-algebra class was randomly chosen for the treatment, using small peer led collaborative group learning for developmental mathematics. The other section of the class was designated as the control section.

The following matrix, Table 14, summarizes how the data described in the previous section was analyzed to help answer the research questions.

Summary of the Research Methodologies

This research study was conducted under a quasi-scientific mixed method design. The real-life nature of the research did not allow me, the researcher, to randomly assign participants to either group, hence making a quasi-experiment (Creswell, 1994). Historical quantitative data was first collected to compare with the research data that was generated through the research period. Qualitative data was collected throughout the research to add depth and provide a deeper understanding of the problem. The combination of the two types of data allowed me, the researcher, to provide a more complete overall view of the problems by providing a richer type of data.
 Specifically the research sought to answer the overarching question of the impact of mandatory, small, peer-led collaborative group learning workshops in developmental mathematics in terms of completion rates, perseverance rates, and demonstrated procedures of mathematical concepts for Native American students enrolled at a two-year Tribal Community College, including describing other positive learning effects that might be attributed to this method and benefits which the peer-leaders gained from this experience.

Table 14: Matrix of Focus Questions and Data Analysis.

Focus Questions	**Data collection**	**Type of Analysis**	**References**	**Time Line**
1) What impact did the implementation of small, peer-led collaborative group learning have on completion rates of Native American students in developmental mathematics classes at a two year Tribal Community College?	Historical data from grade reports and enrollment numbers beginning 2003 through present for completion rate data	Percentages and z-test.	Gravetter & Wallnau, 2004	Collection: Historic data-Spring 2006, First Pilot study Jan-May 2006 Research data: Sept-Dec 2008 Analysis: Fall 2008 & Spring 2009
2) What impact did the implementation of small, peer-led collaborative group learning have on perseverance rates on Native American students in developmental mathematics classes at a two year Tribal Community College?	Historical data from grade reports and enrollment numbers beginning 2002 through present for perseverance rate data	Percentages and z-test.	Gravetter & Wallnau, 2004	Collection: Historic data - Spring 2006, First Pilot study Jan -May 2006 Research data: Sept-Dec 2008 Analysis: Fall 2008 & Spring 2009
3) Did the implementation of small, peer-led collaborative group learning improve the demonstrated procedures of mathematics for Native American students at a two-year Tribal Community College?	Data from exams, homework, and workshop activities was used to look for demonstrated mathematics procedures	Comparison	Gravetter & Wallnau, 2004: Creswell, 1994; Patton, 1997.	Collection: Historic data-Spring 2006, First Pilot study Jan- May 2006, Research data: Sept-Dec 2008 Analysis: Fall 2008 & Spring 2009

Table 14: Continued, Matrix of Focus Questions and Data Analysis.

Focus Questions	Data collection	Type of Analysis	References	Time Line
4) What other personal skills for success Native American students at a two year Tribal Community College might be attributed to the use of small, peer-led collaborative learning groups?	Student surveys, pre and post class, on student engagement, confidence and group skills. Instructor interviews and peer leader interviews and journals. (PLTL survey)	Data was collected, and then analyzed using a general model of developing themes or categories. A qualitative narrative that presents a picture of the data was written.	Creswell, 1994; Patton, 1997;	Collection: Second Pilot Study Aug-Dec 2006 Research data: Sept-Dec 2008 Analysis: Fall 2008 & Spring 2009
5) What are the leader's perceptions of the benefits or deficits associated with acting as small, peer-led collaborative group learning leaders?	Peer leader surveys, pre and post class. (PLTL survey)	Data was collected, and then analyzed using a general model of developing themes or categories. A qualitative narrative that presents a picture of the data was written.	Creswell, 1994; Patton, 1997.	Collection: Aug 2006-Dec 2006, Pilot study Jan 2006-May 2006 Research data: Sept-Dec 2008 Analysis: Fall 2008 & Spring 2009

Quantitative data was used to address the completion, perseverance and demonstrated procedures of mathematical concepts and survey responses were used to address other research questions. Qualitative data in the form of interviews, journals, and observations were used to address the other positive learning effects and peer-leader benefits, The mix of the two methods allowed for a large quantity of data to be analyzed and the qualitative method allowed for descriptions of themes and attitudes to emerge as evidence to support the quantitative results and increase the validity of the research (Creswell, 2003). Comparing data from various sources - surveys, interviews, observations, journals, grades, and attendance - also support the integrity of the results.

Limitations

This study has several limitations. First, the research has been conducted over ~~a~~ just two semesters for the pilot studies and one semester for the full study, and without a more lengthy study it is not possible to tell how much impact the intervention had on the students. Second, the intervention was carried out at one Tribal Community College in one level of developmental mathematics. This might not be valid at other levels, at other colleges, or with other instructors and peer-leaders. Thirdly, the researcher was also the lead teacher in the classroom. Details in this report may lead to generalizable conclusions that can be transported to other circumstances.

Researcher Perspective

The researcher in any qualitative study brings a unique perspective to the interpretation of the conclusion (Patton, 2002; Maxwell, 2005). Because of this it is important to include some information about the researcher in relation to the research project. My experiences teaching and interacting with my students provide me with viewpoints that I have brought to this study both intentionally and unintentionally. This section will disclose information about me, the researcher, of the study.

I have twenty-five years experience teaching mathematics. The first two years were as a teaching assistant at a state university, then one year at a very large high school, followed by one year at a smaller state college and ending with twenty-one years at this Tribal Community College. During my teaching career I have been active in various mathematics organizations that have kept me working together with college and university mathematics instructors across the state. I began teaching at the Tribal Community College as the first full time mathematics instructor eight years after the college received its initial charter and seven years after it began offering higher education classes. I have instructed mathematics classes at all levels from Basic Mathematics to Engineering Calculus. During my years as an instructor at the Tribal Community College I had five years where I was the only full time instructor and there were sixteen years where we had a second mathematics instructor. The college has had ten other full-time mathematics instructors over the past fifteen years and numerous adjunct instructors to fill in as needed. Supervising these instructors has given me insight to many teaching styles, methods and techniques. During this time I have also had the freedom to try many different approaches to teaching. Attending professional meetings to both share and learn has also contributed to my perceptions.

I have lived in the community nearest the college for the past 17 years and interacted with my students daily. This experience gives me extremely accurate understanding as to what might be considered normal day-to-day activities and real life situations for my students. They have experiences that are vastly different from mainstream America where I grew up. As one of my mentors stated, “You have more experience than anyone else in the world teaching college level mathematics to Native Americans from that Tribe.” It is these biases and preconceptions I bring with me to the research.

CHAPTER 4

RESULTS OF THE STUDY

Introduction

The results of the data collected and analyzed for this study are presented in this chapter. The data and analyses are presented as they address each of the research questions. The first section addresses the completion rates of students involved in the small, peer-led collaborative group learning activities. The second section addresses the perseverance rates of students involved in these activities. The third section presents data on student demonstrated procedures of mathematics. This is followed by a section on other personal skills for success the students have gained that might be attributed to the use of small, peer-led collaborative learning groups. And the final section provides the group leader's perceptions of the benefits they gained by acting as facilitators of the small, peer-led collaborative group learning activities. A summary of the findings concludes this chapter.

Completion Rates

Completion rates for the pre-algebra classes have been historically in the 20-33% level at the Tribal community college where the study took place. The three semesters in which the treatment was applied yield completion rate means that are more than 15% greater than the ten semesters when no treatment was used during the same time period. Completion rate for this study is defined as the percentage of students enrolled in a course who completed the course earning a grade of A, B or C. A final grade of D in a course does not meet the prerequisites for the subsequent course and is accordingly not considered a successful grade for completion. Historical data for pre-algebra completion rates is found in Table 15. Table 16 contains grade distribution information and attendance rates for the control and treatment classes for Pre-algebra in fall semester, 2008. Table 17 provides the numbers of students taking and completing pre-algebra for semesters from spring, 2003, through fall, 2008, grouped by treatment and no treatment.

Table 15: Historical data for Pre-algebra Completion Rates.

Completion rates in developmental mathematics courses from Spring 2003 through Spring 2008											
Percent of students earning a grade of C or better.											
Semester	sp 03	f 03	sp 04	f 04	sp 05	f 05	sp 06	f 06	sp 07	f 07	sp 08
Pre-Algebra	21%	33%	33%	16%	22%	34%	42%	45%	38%	32%	23%
Number of Students	N = 39	N = 33	N = 33	N = 58	N = 51	N = 50	pilot #1 N = 53	pilot #2 N = 47	N = 65	N = 44	N = 44

Table 16: Grade Distribution & Attendance Rates for Pre-algebra Fall Semester 2008.

Class	Number of students	% Attendance in class for semester	Grade of A	Grade of B	Grade of C	Grade of D	Grade of F/W	Completion rates
Treatment	30	49%	7	2	4	2	15	43%
Control	31	40%	2	6	3	0	20	35%
Total Students	61	45%	9	8	7	2	35	39%

Table 17: Numbers of Students Taking and Completing Pre-algebra for Semesters from Spring 2003 through Fall 2008 grouped by Treatment and No Treatment.

	Spring 2003 - Sp 2008 No Treatment	Spring 2003 – Sp 2008 Treatment	Fall 2008 No Treatment	Fall 2008 Treatment	Overall No Treatment	Overall Treatment
Number of Students Completing	117	43	11	13	128	56
Total Number of Students	417	102	31	30	448	132
Percent	28.05	42.16	35.48	43.33	28.57	42.42

The completion rate total for the three semesters of treatment, including two pilot studies, was 42.42%. The ten most recent semesters where no treatment was used had a completion rate total of 28.57%.

Using the data from the research semester, fall 2008, a comparison of the treatment (p_2) and no treatment (p_1) completion rates was done using a two-sample z-test for difference in proportions with the following null and alternative hypotheses:

$H_0 : p_2 - p_1 \leq 0$

$H_A : p_2 - p_1 > 0$,

where p_1 is the true proportion of students who would complete the class as taught in the conventional manner and p_2 is the true proportion of students who would complete the class when taught using small peer led collaborative group learning methods. Prior research results obtained in chemistry and calculus classes that have been reported in the literature (see chapter 1) found the use of small, peer-led collaborative group learning increased completion rates, thus appropriately leading to the formulation of one-sided hypotheses in this work.

The computed z value was z = 0.6273, with a statistical p-value of 0.2652 The p-value is the probability of observing a difference of 7.85% in the sample proportions if the null hypothesis is true (there is no difference in the proportion of all treatment and control students who complete the class). In many earlier applications of statistical testing, the significance level was specified in advance to require a p-value that allowed only a 5% or a 1% chance of rejecting a true null hypothesis. Using that criterion there is not sufficient evidence to conclude that the treatment class had a higher completion rate than the control class. It is now accepted that reporting a computed p-value allows the experimenter and others who are interested in the results to judge significance after incorporating the "error costs" into their consideration. Further study is needed to reach a more substantial conclusion.

However, this semester the treatment class had a completion rate that was 8% higher at 43.33% than the completion rate of the control class at 35.48%. These values are consistent and tend to fall within the general range of the previous five years data. This may be considerable when all possible benefits of changing teaching methods are considered. It is also worth noting that of the thirteen students completing pre-algebra in the treatment class in fall 2008, seven students earned an A, while just two of eleven students completing pre-algebra in the control class earned an A.

Based on these considerations and the personal costs to students in repeating developmental courses, sometimes several times, that are taught in the traditional method, this researcher prefers to declare these results meaningful at the Tribal College where the experiment was conducted.

Survey and interview responses indicated that students felt their grades benefited when they had a group that they could relate to. Several students commented that they felt they learned the material better when they had to explain it to other members in their group. These students included students of traditional age for community college attendance, that is approximately 18 to 24 years, as well as students of non-traditional age, that is over 24. Several comments from students on this topic follow:

> I just understand it better when it is explained in my terms (a traditional age female).
>
> When it is explained by John, he uses words and examples I can relate to, he knows what I need to hear to understand it (a traditional age female).

Other students felt they spent extra time learning, hearing, speaking, and practicing the mathematics so they expected to earn higher grades. Examples of this are:

> I have fun working with my group and spend way more time doing math than I would without the group, so I should get a better grade on my tests (a non-traditional age male).
>
> My group needs me to help explain things to them. I like to do it. I feel good when I can help and I have found by helping them I do better myself (a traditional age female).

Perseverance Rates

Perseverance rates for the pre-algebra classes have been historically in the 25-55% level at this community college. The three semesters in which the pilot studies and treatment were held yield a mean perseverance rate that is more than 7% greater than the nine semesters when no pilot study or treatment was used. Perseverance rate is the percentage of students who did not withdraw or quit attending the course during the semester of enrollment. They stuck it out to the end, still attending class, participating, doing assignments and taking exams. Table 18 shows the historical data for perseverance rates for Pre-algebra from spring semester, 2003, through spring semester, 2008. And Table 19 shows the perseverance rates for the control and treatment classes for fall semester, 2008. Table 20 shows the numbers of students taking and persevering through pre-algebra for the semesters from spring, 2003, through fall, 2008, grouped by treatment and no treatment. Note that the semesters of spring, 2004 and spring, 2006, both had more students earn a grade of C or better than actually persevered through the semester. This is explained by the several students who earned such high grades on the first tests that they did not need to take the final test in order to pass the class. These students officially quit attending class.

Table 18: Historical Data for Pre-algebra Perseverance Rates.

Perseverance rates in Pre-Algebra mathematics courses from Spring 2003 through Spring 2008											
Percent of students who did not withdraw or quit attending classes.											
Semester	sp 03	f 03	sp 04	f 04	sp 05	f 05	sp 06	f 06	sp 07	f 07	sp 08
Pre-Algebra	26%	39%	29%	41%	41%	56%	38%	61%	53%	58%	40%
Number of Students	N = 39	N = 33	N = 33	N = 58	N = 51	N = 50	pilot #1 N = 53	pilot #2 N = 47	N = 65	N = 44	N = 44

Table 19: Pre-algebra Perseverance Rates for Fall Semester 2008.

Class	Number of students.	% Attendance in class for semester.	Number of students who persisted to the end of the semester.	Number of students who withdrew officially.	Number who just quit attending without an official withdraw.	Perseverance rate.
Treatment	30	49%	14	3	13	47%
Control	31	40%	10	5	16	32%
Total Students	61	45%	24	8	29	39%

Table 20: Numbers of Students Taking and Persevering through Pre-algebra for the Semesters from Spring 2003 through Fall,2008 grouped by Treatment and No Treatment

	Spring 2003 - Spring 2008 No Treatment	Spring 2003 - Spring 2008 Treatment	Fall 2008 No Treatment	Fall 2008 Treatment	Overall No Treatment	Overall Treatment
Number of Students persevering	184	49	10	14	194	63
Total Number of Students	417	102	31	30	448	132
Percent	44.12	48.04	32.26	46.66	43.30	47.73

The perseverance rate for the three semesters of treatment, including two pilot studies, was 47.73%. The ten most recent semesters where no treatment was used had a perseverance rate of 43.30%.

Comparison of the research semester, fall 2008 semester, for treatment (p_2) and no treatment (p_1) was done using a two-sample z-test for difference in proportions with the following null and alternative hypotheses;

$H_0 : p_2 - p_1 \leq 0$

$H_A : p_2 - p_1 > 0$,

where p_1 is the true proportion of students who would persevere to the end of the class as taught in the conventional manner and p_2 is the true proportion of students who would persevere to the end of the class when taught using small, peer-led collaborative group learning methods. Prior research results obtained in a fundamental mathematics class that have been reported in the literature (see chapter 1) found the use of small, peer-led collaborative group learning increased perseverance rates, thus appropriately leading to the formulation of one-sided hypotheses in this work.

The computed z value was $z = 1.1517$, with a statistical p-value = 0.1247. The p-value is the probability of observing a difference of 14.4% in the sample proportions if the null hypothesis is true (there is no difference in the proportion of all treatment and control students who persevere to the end of the class).In many earlier applications of statistical testing, the significance level was specified in advance to require a p-value that allowed only a 5% or a 1% chance of making a type I error of rejecting a true null hypothesis. Using that criterion there is no evidence that the perseverance of all treatment students exceeds that of all control students. It is now accepted that reporting a computed p-value allows the experimenter and others who are interested in the results to judge significance after incorporating the "error costs" into their consideration. Further study is needed to reach a more substantial conclusion.

Looking at the results in a positive manner, for the fall 2008 semester, the treatment class had a perseverance rate nearly 15% higher at 46.66% than the perseverance rate of the control class at 32.26%.

Survey and interview responses indicated having a group that the student could relate to did help them stay in class until the end. Several students commented that they felt responsible for helping the other members of their group show up and pass the class. Others commented how they felt as if they belonged and it was important for them to do their best so that they did not let the rest of the group down. Examples of these statements are:

> I like working with my group, they help me when I get stuck so it is only fair if I help them when I know how to do the problems too. That way we all get a chance to learn (a traditional age female).
>
> Sometimes it seems impossible to do anything by yourself but in the group you get the extra push to do better. They won't accept me copying if I don't understand it (a traditional age male).
>
> If I don't go to help, no one else can explain the problems the way I can (a non traditional age male).
>
> I know I'm not the smartest one in the group, not the dumbest either, but it is important we all learn it so we can pass the class (a traditional age female).

Demonstrated Performance of Mathematics Concepts

In this section I will first discuss the quantitative results found using the demonstrated procedures of mathematics concept rubric. Then I will discuss the qualitative results pertaining to mathematics learning and performance from the surveys and interviews with the students.

Demonstrated Procedures for
Mathematics Rubric Results

The Demonstrated Procedures for Mathematics Rubric provided in Chapter 3 outlines five concept areas: 1) adding, subtracting, multiplying and dividing integers; 2) adding, subtracting, multiplying and dividing variables, terms and expressions; 3) solving simple linear equations; 4) adding, subtracting, multiplying and dividing polynomials ; and 5) adding, subtracting, multiplying and dividing rational expressions.
Records (tests, homework and quizzes) were examined for each student and the level of understanding (Advanced, Proficient, Nearing Proficiency, Novice, and Not Observed) for each concept was noted by date achieved. Students were enrolled in the pre-algebra class according to a score they earned on a standardized placement exam they took upon enrollment at the college. The placement exam does not give exact information about what concepts the students may or may not be proficient in, but it does provide information about which of the objectives for this class the student did not properly demonstrate when they took the placement exam.

If a student demonstrated novice ability in adding, subtracting, multiplying and dividing integers when each homework assignment was turned in and the first test was completed, this level of understanding would be recorded as achieved on the date of the first test. The same student may have gained proficiency in the concept by the second test as seen in the work shown on the exam. This would move the student across the rubric. Although the initial level of understanding upon entry into the course is unknown, it can be verified if on subsequent tests the level of understanding has changed. Rubric scoring was done by me, the researcher and class instructor, and an expert mathematics instructor who has over 30 years teaching experience and over 5 years experience with the pre-algebra curriculum. Student papers were scored by both evaluators and the scores were compared for accuracy. There was very little difference in the rankings between evaluators but any differences were noted, discussed, and re-ranked in order to standardize the scoring. The following charts shows how many students ranked at each rubric level at different times throughout the course. Student coursework was evaluated eight times throughout the semester, once after each exam, roughly at two week intervals. A typical student was chosen from both the control and treatment group as an example. The typical student is an actual student from each class that best characterizes the outcomes of the entire class. They were chosen by examining all the rubric scores from the class and finding the outcomes that were most common or most representative of the class, looking specifically at the beginning levels, horizontal movement on the rubric across the levels, and ending location on the rubric. The work from a typical control class student (shown in Table 21) and from a typical treatment class student (shown in Table 22), is represented indicating progression through the levels of achievement for the mathematical concepts throughout the semester. The charts for each student are displayed below.

Both students began the semester with very similar test scores and demonstrated procedures of the mathematical concepts. In fact, their rubrics were almost exactly the same through test three, the first six weeks of the semester. Then differences began to appear. There are three main differences noted. The first is that the control group student did not progress as far to the advanced side of the rubric as did the treatment student.

Table 21: Demonstrated Procedures for Mathematics Rubric-Control Class Student

	Not Observed	Novice	Nearing Proficiency	Proficient	Advanced
Adding, subtracting, multiplying and dividing integers.			Test 1, Sept. 10	Test 2, Sept. 22	
Adding, subtracting, multiplying and dividing variables, terms and expressions.		Test 2, Sept. 22		Test 3, Oct. 2	
Solving simple linear equations.			Test 3, Oct.2	Test 5, Oct.28	
Adding, subtracting, multiplying and dividing polynomials.		Test 4, Oct. 14 Test 6, Nov. 10			
Adding, subtracting, multiplying and dividing rational expressions.		Test 7, Nov. 24 Final, Dec. 11			

Second, the student from the treatment class took all seven tests where the student in the control class missed a test. And third, the student from the treatment class continually improved his or her demonstrated ability on previously learned concepts whereas the student from the control group appears to have stopped reviewing and was barely demonstrating knowledge of the new concepts.

Table 22: Demonstrated Procedures for Mathematics Rubric-Treatment Class Student

	Not Observed	Novice	Nearing Proficiency	Proficient	Advanced
Adding, subtracting, multiplying and dividing integers.			Test 1, Sept.10	Test 2, Sept. 22	Test 3, Oct. 2
Adding, subtracting, multiplying and dividing variables, terms and expressions.		Test 2, Sept. 22		Test 3, Oct. 2	Test 4, Oct. 14
Solving simple linear equations.			Test 3, Oct. 2	Test 4, Oct. 14	Test 5, Oct. 28
Adding, subtracting, multiplying and dividing polynomials.			Test 4, Oct. 14	Test 6, Nov. 10	
Adding, subtracting, multiplying and dividing rational expressions.			Test 7, Nov. 24	Final Dec. 10	

Survey Results

The survey given to the students was adapted from the PLTL handbook and designed to get feed back on how well the workshop materials and workshop protocol were functioning. This also provided insight into the way students viewed the class and workshop hours, as well as the use of the small, peer-led collaborative groups to help learn mathematics. Students in both the control and treatment classes were given the survey at midterm and at the end of the semester. The survey consisted of 36 items which could be answered in a Likert type format. The percent of responses from both classes were tabulated for the Midterm and End-of-Semester surveys and the results are given in the Table 23. The treatment was the use of small, peer-led collaborative learning groups for one class period a week to work on workshop activities that were a bit more engaging and challenging but similar to the coursework presented in class. The control class was given the same workshop activity but not encouraged to work together. They worked individually with the instructor present if they chose to ask questions. The items on the survey specifically addressed the workshop design and activities so some are not applicable to the control group. All responses are reported below, even for items that are not particularly applicable to the control students. However, the discussion of results in the narrative distinguishes between items relevant the treatment group only or to both groups. Table 23 provides the results of the survey: the control class at both midterms and the end of the semester and also the treatment class at midterms and the end of the semester.

Table 23: Student Survey Responses

Student Survey Results in Percentages										
Number of respondents Treatment midterm=20 **end of term=16** Control midterm=21 **end of term=17**	**1- strongly disagree**		**2- disagree**		**3-neutral (no opinion)**		**4 - agree**		**5- strongly agree**	
1. The Workshops are closely related to the material taught in the lectures.										
Treatment mid term / **end of term**	0.0	**0.0**	5.0	**0.0**	35.0	**35.3**	40.0	**46.1**	20.0	**17.6**
Control mid term / **end of term**	0.0	**6.3**	9.5	**0.0**	57.1	**5.0**	28.6	**31.3**	4.8	**12.5**
2. Workshops help me do better on tests.										
Treatment mid term / end of term	0.0	**0.0**	5.0	**5.9**	20	**35.3**	50.0	**41.2**	25.0	**11.8**
Control mid term / end of term	4.8	**6.3**	19.0	**18.8**	38.1	**37.5**	38.1	**31.3**	0.0	**6.3**

Table 23 continued: Student Survey Responses

Number of respondents Treatment midterm=20 end of term=16 Control midterm=21 end of term=17	**1- strongly disagree**	**2- disagree**	**3-neutral (no opinion)**	**4 – agree**	**5- strongly agree**
3. Interacting with the Workshop leader increases my understanding.					
Treatment mid term / **end of term**	0.0 **0.0**	5.0 **0.0**	10.0 **23.5**	55.**0** **46.1**	30.0 **23.5**
Control mid term / **end of term**	0.0 **6.3**	28.6 **12.5**	33.3 **37.5**	33.3 **37.5**	4.8 **6.3**
4. The Workshop materials are helpful preparation for exams.					
Treatment mid term / end of term	0.0 **0.0**	0.0 **0.0**	30.0 **41.2**	45.0 **35.3**	25.0 **23.5**
Control mid term / end of term	0.0 **6.3**	28.6 **12.5**	28.6 **37.5**	42.9 **37.5**	0.0 **6.3**
5. The Workshop materials are more challenging than most textbook problems.					
Treatment mid term / **end of term**	0.0 **0.0**	0.0 **0.0**	5.0 **17.6**	40.0 **23.5**	55.0 **58.8**
Control mid term / **end of term**	0.0 **0.0**	14.2 **0.0**	57.1 **0.0**	23.8 **18.8**	4.8 **81.3**
6. I believe that the Workshops are improving my grade.					
Treatment mid term / **end of term**	0.0 **0.0**	5.0 **0.0**	30.0 **35.3**	55.0 **46.1**	15.0 **17.6**
Control mid term / **end of term**	4.8 **6.3**	19.0 **25**	47.6 **31.3**	28.6 **37.5**	0.0 **0.0**
7. I regularly explain problems to other students in the Workshops.					
Treatment mid term / **end of term**	10.0 **5.9**	20.0 **18.8**	40.0 **35.3**	20.0 **58.**8	10.0 **0.0**
Control mid term / **end of term**	19.0 **18.8**	38.1 **18.8**	28.6 **56.3**	14.2 **6.3**	0.0 **0.0**
8. Interacting with other group members' increase my understanding.					
Treatment mid term / **end of term**	5.0 **0.0**	0.0 **0.0**	15.0 **23.5**	70.0 **52.9**	10.0 **23.5**
Control mid term / **end of term**	9.5 **6.3**	4.8 **18.8**	28.6 **37.5**	52.4 **37.5**	4.8 **0.0**
9. I would recommend Workshop courses to other students.					
Treatment mid term / **end of term**	0.0 **0.0**	0.0 **0.0**	45.0 **29.4**	40.0 **52.9**	15.0 **11.8**
Control mid term / **end of term**	4.8 **18.8**	9.5 **6.3**	66.7 **50.0**	19.0 **25.0**	0.0 **0.0**
10. In understanding the Workshops I am comfortable asking questions.					
Treatment mid term / **end of term**	0.0 **0.0**	0.0 **5.9**	20.0 **17.6**	65.0 **58.8**	15.0 **17.6**
Control mid term / **end of term**	0.0 **6.3**	23.8 **12.5**	57.1 **43.8**	19.0 **31.3**	0.0 **6.3**
11. The instructor encourages us to participate in the workshops.					
Treatment mid term / **end of term**	0.0 **0.0**	0.0 **0.0**	10.0 **17.6**	45.0 **52.9**	45.0 **29.4**
Control mid term / **end of term**	23.8 **0.0**	19.0 **18.8**	38.1 **50.0**	19.0 **18.8**	0.0 **12.5**

Table 23 continued: Student Survey Responses

Number of respondents Treatment midterm=20 end of term=16 Control midterm=21 end of term=17	**1- strongly disagree**		**2- disagree**		**3-neutral (no opinion)**		**4 – agree**		**5- strongly agree**	
12. The Workshops are often dominated by one or two students.										
Treatment mid term / **end of term**	10.0	**5.9**	15.0	**11.8**	70.0	**70.6**	5.0	**11.8**	0.0	**0.0**
Control mid term / **end of term**	0.0	**12.5**	14.2	**18.8**	42.9	**25.0**	33.3	**25.0**	9.5	**18.8**
13. Noise or other distractions make it difficult to benefit from the Workshops.										
Treatment mid term / **end of term**	5.0	**5.9**	15.0	**5.9**	65.0	**58.8**	20.0	**23.5**	0.0	**5.9**
Control mid term / **end of term**	0.0	**6.3**	14.2	**12.5**	57.1	**31.3**	23.8	**31.3**	4.8	**18.8**
14. Students who are uninterested or unmotivated make it difficult for others to benefit from the Workshops.										
Treatment mid term / **end of term**	5.0	**5.9**	10.0	**5.9**	50.0	**41.2**	35.0	**23.4**	0.0	**17.6**
Control mid term / **end of term**	4.8	**6.3**	9.5	**6.3**	61.9	**25.0**	14.2	**31.3**	9.5	**31.3**
15. I feel comfortable with the Workshop leader.										
Treatment mid term / **end of term**	0.0	**0.0**	0.0	**5.9**	5.0	**11.8**	85.0	**76.5**	10.0	**5.9**
Control mid term / **end of term**	0.0	**6.3**	9.5	**0.0**	42.9	**13.3**	47.6	**75.0**	0.0	**6.3**
16. The Workshop leader is well prepared.										
Treatment mid term / **end of term**	10.0	**0.0**	5.0	**0.0**	65.0	**35.3**	5.0	**46.1**	15.0	**17.6**
Control mid term / **end of term**	0.0	**6.3**	4.8	**6.3**	47.6	**31.3**	38.1	**43.8**	9.5	**12.5**
17. I am uncomfortable asking questions in the lecture.										
Treatment mid term / **end of term**	10.0	**0.0**	5.0	**17.6**	65.0	**52.9**	5.0	**23.5**	15.0	**5.9**
Control mid term / **end of term**	0.0	**6.3**	14.2	**6.3**	38.1	**43.8**	42.9	**12.5**	4.8	**31.3**
18. The Workshops are a big help in solving problems.										
Treatment mid term / **end of term**	0.0	**0.0**	0.0	**5.9**	30.0	**29.4**	60.0	**58.8**	10.0	**0.0**
Control mid term / **end of term**	0.0	**12.5**	9.5	**12.5**	57.1	**6.3**	33.3	**62.5**	0.0	**6.3**
19. I would like to be a Workshop leader in the future.										
Treatment mid term / **end of term**	15.0	**11.8**	10.0	**17.6**	50.0	**70.6**	15.0	**0.0**	10.0	**0.0**
Control mid term / **end of term**	9.5	**62.5**	19.0	**12.5**	52.4	**18.8**	19.0	**6.3**	0.0	**0.0**
20. In the Workshops I enjoy interacting with the other students.										
Treatment mid term / **end of term**	0.0	**0.0**	0.0	**0.0**	0.0	**23.4**	60.0	**58.8**	40.0	**17.6**
Control mid term / **end of term**	0.0	**12.5**	9.5	**0.0**	19.0	**25.0**	28.6	**56.3**	38.1	**6.3**

Table 23 continued: Student Survey Responses

Number of respondents Treatment midterm=20 end of term=16 Control midterm=21 end of term=17	**1- strongly disagree**	**2- disagree**	**3-neutral (no opinion)**	**4 – agree**	**5- strongly agree**
21. The workshop experience led me to join formal or informal study groups related to other courses.					
Treatment mid term / **end of term**	5.0 **0.0**	10.0 **29.4**	30.0 **58.8**	45.0 **11.8**	10.0 **0.0**
Control mid term / **end of term**	4.8 **6.3**	19.0 **25.0**	57.1 **62.5**	9.5 **6.3**	9.5 **0.0**
22. On average, I spend the following number of hours per week studying (in addition to time spent at lectures and workshops):	**1. 0-2 hrs**	**2. 2-4 hrs**	**3. 4-6 hrs**	**4. 6-8 hrs**	**5. 8-10 hrs**
Treatment mid term / **end of term**	10.0 **29.4**	25.0 **23.5**	15 **11.8**	30.0 **23.5**	15.0 **11.8**
Control mid term / **end of term**	38.1 **50.0**	23.8 **12.5**	19.0 **18.8**	9.5 **6.3**	4.8 **6.3**
Use the following scale: 1 = materials do not meet this objective at all; 2 = materials somewhat meet the objective; 3 = materials meet the objective rather well; 4 = materials meet this objective very well; 5 = materials are excellent for meeting this objective:					
The materials are:	**1**	**2**	**3**	**4**	**5**
23. well connected with lectures					
Treatment mid term / **end of term**	0.0 **0.0**	5.0 **0.0**	30.0 **46.1**	55.0 **46.1**	10.0 **5.9**
Control mid term / **end of term**	4.8 **6.3**	9.5 **31.3**	57.1 **31.3**	28.6 **31.3**	0.0 **0.0**
24. challenging					
Treatment mid term / **end of term**	0.0 **0.0**	5.0 **0.0**	25.0 **41.2**	35.0 **29.4**	30.0 **29.4**
Control mid term / **end of term**	0.0 **0.0**	14.2 **0.0**	33.3 **31.3**	42.9 **6.3**	9.5 **62.5**
25. developed to review fundamentals					
Treatment mid term / **end of term**	0.0 **0.0**	10.0 **0.0**	30.0 **52.9**	45.0 **41.2**	15.0 **5.9**
Control mid term / **end of term**	0.0 **18.8**	28.6 **31.3**	42.9 **25.0**	28.6 **25.0**	0.0 **0.0**
26. useful for group work					
Treatment mid term / **end of term**	0.0 **5.9**	30.0 **5.9**	10.0 **58.8**	35.0 **17.6**	25.0 **11.8**
Control mid term / **end of term**	19.0 18.8	23.4 **31.3**	23.8 **37.5**	33.3 **12.5**	0.0 **0.0**
27. motivational					
Treatment mid term / **end of term**	10.0 **5.9**	20.0 **35.3**	40.0 **29.4**	15.0 **23.5**	10.0 **5.9**
Control mid term / **end of term**	14.2 **56.3**	23.8 **12.5**	33.3 **18.8**	28.6 **12.5**	0.0 **0.0**
28. helpful for individual study					
Treatment mid term / **end of term**	5.0 **5.9**	20.0 **11.8**	55.0 **46.1**	10.0 **23.5**	10.0 **11.8**
Control mid term / **end of term**	4.8 **43.8**	33.3 **18.8**	42.9 **31.3**	9.5 **6.3**	9.5 **0.0**
29. Useful for reinforcing concepts.					
Treatment mid term / **end of term**	0.0 **0.0**	10.0 **5.9**	30.0 **41.2**	45.0 **46.1**	15.0 **5.9**
Control mid term / **end of term**	0.0 **25.0**	23.8 **18.8**	57.1 **43.8**	19.0 **25.0**	0.0 **0.0**

Table 23 continued: Student Survey Responses

Rate each of the following activities according to the amount of Workshop time devoted to the specified activity.					
Use the following scale: 1 = almost no time; 2 = 2 a small amount of time; 3 = a moderate amount of time, 4 = a large amount of time; 5 = most of the time.					
The amount of Workshop time devoted to the specified activity:	**1**	**2**	**3**	**4**	**5**
30. The workshop leader presents ideas and methods.					
Treatment mid term / **end of term**	0.0 **0.0**	0.0 **0.0**	25.0 **29.4**	55.0 **46.1**	20.0 **23.5**
Control mid term / **end of term**	28.6 **6.3**	33.3 **31.3**	28.6 **25.0**	9.5 **37.5**	0.0 **0.0**
31. The leader responds to student questions.					
Treatment mid term / **end of term**	0.0 **0.0**	0.0 **0.0**	20.0 **29.4**	40.0 **29.4**	40.0 **41.2**
Control mid term / **end of term**	0.0 **6.3**	28.6 **12.5**	42.9 **31.3**	14.2 **25.0**	14.2 **25.0**
32. Students work on problems in pairs or small groups.					
Treatment mid term / **end of term**	25.0 **5.9**	50.0 **29.4**	20.0 **46.1**	0.0 **17.6**	5.0 **0.0**
Control mid term / **end of term**	14.2 **0.0**	9.5 **0.0**	47.6 **6.3**	23.8 **25.0**	4.8 **68.8**
33. Students work on problems alone.					
Treatment mid term / **end of term**	25.0 **5.9**	50.0 **41.2**	25.0 **29.4**	0.0 **17.6**	0.0 **5.9**
Control mid term / **end of term**	4.8 **0.0**	4.8 **0.0**	14.2 **6.3**	38.1 **25.0**	33.3 **68.8**
34. Students present solutions.					
Treatment mid term / **end of term**	0.0 **0.0**	0.0 **11.8**	50.0 **58.8**	45.0 **23.5**	5.0 **5.9**
Control mid term / **end of term**	19.0 **3.8**	47.6 **31.3**	33.3 **25.0**	0.0 **0.0**	0.0 **0.0**
35. Hands-on activities.					
Treatment mid term / **end of term**	0.0 **5.9**	5.0 **11.8**	55.0 **52.9**	35.0 **23.5**	5.0 **0.0**
Control mid term / **end of term**	33.3 **37.5**	23.8 **31.3**	38.1 **31.3**	4.8 **0.0**	0.0 **0.0**
36. Technology and computer simulations.					
Treatment mid term / **end of term**	15.0 **11.8**	15.0 **29.4**	50.0 **23.5**	15.0 **29.4**	5.0 **0.0**
Control mid term / **end of term**	33.3 **25.0**	23.8 **37.5**	42.9 **25.0**	0.0 **12.5**	0.0 **0.0**
Modified from the Peer-Led Team Learning: A guidebook					

The first pattern that is evident in all of the surveys is that most students prefer to remain neutral on the answers. The first 21 items have the option of neutral or no opinion, the majority of the control class chose this alternative 71% of the time at midterms and 52% of the time at the end of the semester. The treatment group chose the neutral or no opinion alternative 38% of the time at midterms and 29% of the time at the end of the semester. This is fitting as the control group should not have an opinion on group work as that was the treatment. One item asked how much time they spend outside of class studying mathematics, an item everyone should have been able to answer. The final 14 items were directly tied to the workshop activity materials, which everyone was given at the weekly session.

I will examine the first 21 items dealing with the group working together on the workshop activities. Then I will compare the time spent outside of class for both classes. Finally, I will examine the last 14 items for both classes regarding the workshop activities.

Items about Collaborative Groups Working Together

The first 21 items all were directed at the small, peer-led collaborative learning group experience. These items can be sorted into 4 categories; 1) interaction related items (#3, 7, 8, 10, 11, 15, 17, and 20); 2) test or performance related items (#2, 4, 6, and 18); 3) workshop quality items (#1, 5, 9, 16, 19 and 21); and 4) distractions from the experience items (# 12, 13, and 14).

Interaction Related Items

The treatment group responded very agreeably to items regarding the person-to-person small group interactions. At midterm, approximately 85 percent of the students agreed or strongly agreed to statements describing potential benefits of the small group interactions. By the end of the semester the agreement was around 75-80%. These students were encouraged by the instructor to participate in the group workshop activities. They thought the interactions with the group leaders and other members of their group improved their understanding and they said they explained concepts to others in their groups. They were not afraid to ask questions in their small collaborative groups, but were not very forward about asking questions during the lecture classes. Overall they were comfortable with the peer leaders and enjoyed interacting with each other.

The control class had no reason to rank these items favorably. They were not encouraged to work in groups and had very few interactions with peers during the lecture part of the class. They also found the interactions, few and sparse as they were, favorable.

Test or Performance Related Items

The items put into this category inquired about how participation in the workshop activities influenced the students' mathematical understanding, possibly leading to improved grades/test scores. At midterms, bout 70% of the treatment class students agreed or strongly agreed with all the items about the influence of the workshops on their course performance, compared to about 60% by the end of the semester.

Approximately 38% of the control class students also agreed that doing the workshop activities would improve their mathematical understanding and help their grades. This comprised about half the percentage of students responding similarly in the treatment class.

Workshop Quality Items

There are actually two subcategories of items here: items pertaining to the content of the workshop activities and others focusing on the preparedness of the peer leaders.

The students from the treatment class indicated the workshop problems were closely related to the regular lecture concepts, but more challenging and engaging. By the end of the semester, about 65% of the students agreed or strongly agreed that (1) the peer leaders were well prepared; and (2) they would recommend the small, peer-led collaborative groups to others, compared to just 20% and 55%, respectively, agreeing with each statement at midterm. An item about wanting to be a peer leader in the future had a very low agreement rate, 25% at midterm had dropped to 0% by the end of the semester. Interviews at the end of the semester offered some insight into this, the students commented on how much time and expertise it would take to be a leader and that no one in their group was good enough. This follows with another item on joining small study groups, either formal or informal, for other classes. At midterm the class agreed 55% of the time that they would, but by the end of the semester this had dropped to 12%. It is not clear why the big drop occurred. Possibly no other study groups were active or available either formally or informally so there were none to join.

Students from the control group felt that the workshop activities were much more challenging than the regular textbook problems. They worked on the problems alone and rarely asked questions. When they got stuck, most quit; the problems were not graded anyway. Items about the peer leader are meaningless as this class did not have groups or peer leaders.

Distractions from the Experience Items

There were three items inquiring about distractions from the small, peer-led collaborative group experience. There were increases in the agreeable responses for all three items from midterm to the end of the semester. The first asked whether one or two students dominated the workshop. Five percent of respondents agreed or strongly agreed at midterm, compared to 12% at the end of the semester. The second item examined whether noise or other distractions made it difficult to benefit form the workshop. Twenty percent agreed or strongly agreed at midterm, compared to 30% at the end of the semester. And finally, the third item investigated whether uninterested or unmotivated students made it difficult to benefit from the workshop. Thirty-five percent of the students agreed or strongly agreed at midterm, increasing to 40% at the end of the semester.

Students from the control group had very similar responses to the distraction items. Noise, interruptions, uninterested and unmotivated classmates were all seen as inhibitors to their learning.

Time Spent Outside of Class

The amount of outside study time reported by each class had changed between the midterm survey and the end of the semester survey. The control class reported at midterms that the majority of the class (62%) spent less than four hours per week working on mathematics. By the end of the semester the time spent studying out of class was less than two hours for over half of the class. The treatment class reported at midterms that 35% spent less than four hours studying. By the end of the semester approximately 53% fell into this category. This was a very big difference between the groups as self described at midterm. Neither case being ideal, students in the treatment class spent appreciably more time studying outside of class than students from the control class throughout the semester.

Items about Workshop Activities

The final 14 items dealt with the makeup of the workshop materials. All students from both the treatment and the control classes were given the same workshop activities. The difference was in the way they completed the activities. The general consensus from both groups was that the workshop activities were connected to the lecture material, challenging, reviewed fundamentals, and reinforced concepts. The amount of agreement was much higher for the treatment class compared to the control class. Table 24 shows responses of students from the control and treatment class at the end of the semester.

Table 24: Student Survey Responses: Workshop Materials

Student Survey Responses: Workshop Materials						
Control End of Semester(N = 16)		**Treatment End of Semester (N = 17)**				
Use the following scale: 1 = materials do not meet this objective at all; 2 = materials somewhat meet the objective; 3 = materials meet the objective rather well; 4 = materials meet this objective very well; 5 = materials are excellent for meeting this objective:						
The materials are:		**1**	**2**	**3**	**4**	**5**
23. well connected with lectures	control	6.3%	31.3%	31.3%	31.3%	0.0%
	treatment	**0.0%**	**0.0%**	**46.1%**	**46.1%**	**5.9%**
24. challenging	control	0	0	31.3	6.3	62.5
	treatment	**0**	**0**	**41.2**	**29.4**	**29.4**
25. developed to review fundamentals	control	18.8	31.3	25	25	0
	treatment	**0**	**0**	**52.9**	**41.2**	**5.9**
26. useful for group work	control	18.8	31.3	37.5	12.5	0
	treatment	**5.9**	**5.9**	**58.8**	**17.6**	**11.8**
27. motivational	control	56.3	12.5	18.8	12.5	0
	treatment	**5.9**	**35.3**	**29.4**	**23.5**	**5.9**
28. helpful for individual study	control	43.8	18.8	31.3	6.3	0
	treatment	**5.9**	**11.8**	**46.1**	**23.5**	**11.8**
29. Useful for reinforcing concepts	control	25	18.8	43.8	25	0
	treatment	**0**	**5.9**	**41.2**	**46.1**	**5.9**

The control group was very negative regarding how motivational the activities were, and how helpful they were for individual study. This is to be expected as the workshop activities were designed with the collaborative group in mind.

The final seven items target how the time is spent during the workshop session. The treatment class indicated that most of the time was spent with students working together, presenting solutions and the peer leader helping as needed. The lowest marks pertained to the use of technology and computer simulations, which was accurate since technology was not a major component of the workshop experience provided in this study.

Once again, the control class had no real basis for answering these items. They did not work in the groups so their responses regarding how the time was spent were meaningless. But they did indicate that in their "group," that is the other students from their class attending the workshop, most students did work individually on the problems or in pairs. They also noticed the lack of technology use in the classroom.

In summary, the treatment class responded with agree and strongly agree that working on the workshop material in the small collaborative groups with a peer leader was beneficial, helped them learn the concepts better, and earn a better grade in the class. They enjoyed the time they spent interacting with other students and the peer leader and spent more time doing mathematics than they would have working on the subject alone. Data showed they spent more time working on mathematics outside of class than the control group.

Interview Results

Students were interviewed at the end of the semester and group leaders kept journals recording information about each workshop activity. This data was read and coded by me and another instructor familiar with the course expectations and this study. After the data was read and coded, the codes were grouped by patterns and themes emerged (Creswell, 2003, 2007; Maxwell 2005). The student interviews were designed to target the treatment class for information about the workshop experience. Interview questions are included in the appendix. The control group was not interviewed.

The interviews consisted of three main topics. These will be discussed in order as follows. The first topic was to describe participation in the small, peer-led collaborative learning group. Each participant had a different role within his or her group and each group interacted differently. The second interview topic was how well the workshop content and materials helped with learning the mathematical concepts, which workshops were the most beneficial and which were not very helpful. Consensus was found on the most helpful workshops. General agreement was that several of the workshops gave the opportunity for more interaction between group members and that meant more practice on difficult content. This interaction was the valuable part of the workshop. The final interview topic concerned the overall collaborative learning experience. It was a tough idea to get used to but a very helpful tool to have for future use.

Participation in the Small Collaborative Peer Led Learning Groups

Each group ended up with an "Internal Group Leader", and depending on the workshop and who was present, one or two "Math Whizzes", one to four "Normal Groupies", and maybe a "We Need Lots of Help!" member. These names came about during conversations at the weekly meetings with the peer leaders and the researcher. The peer leaders were asked not to use student names in our discussions so they began using these nicknames when describing various members in their groups and the names stuck for Leader, Math Whiz, Normal, and Need Lots of Help students. The researcher added the description of Internal Group Leader to distinguish that leader from the peer leaders and Normal Groupie to describe the common group member. Not all roles were set in concrete, some group members moved between roles during a single workshop activity session, others changed roles in different weeks according to the peer leaders.

Internal Group Leader

It was clear from entries in the peer leader journals that each group had definite internal group leaders, not counting the peer leader which was assigned to each group. It appeared that these leaders were chosen by default as the members who might have had the best mathematical background when the class began or were the most outspoken member of the group. This was described by the peer leaders during our weekly meetings. The peer leaders also said several students felt that they were put on the spot to "act as a leader", not because they were the best at mathematics, but because other group members thought they were good at mathematics or because no one else would "step up".

The Internal Group Leader's role was described by the peer leader as the person whom the other members would look to first when they got stuck and the person who was in charge to keep the group on track. During the interview at the end of the semester, the group described the job the Internal Group Leader as the person who was to tell the rest of the group how to do the problem or what they had done wrong. Students who became internal group leaders expressed that they got very frustrated when they did not know how to do a problem or what to suggest, or when everyone else in the group thought all they had to do was copy the internal group leader's work. This group leader also stated they were sometimes quite unhappy being in the position and having others copy their work. Several comments to this effect were:

> Somehow I got nominated to be in charge. At first I thought that was cool, but when I realized that the rest of the group thought I'd do all the work and they could just copy I got really mad and quit doing anything for awhile (traditional age female).
>
> I knew I was the best one at math in my group. I have always been pretty good when I try so I did not mind helping the others. They got so mad when I did not know how and they would not help me. They expected me to already to know it, duh, I am in the same class for a reason (non-traditional age female).
>
> We were supposed to be a group. The teacher said we had to work together, help each other solve the problems. It never turned out that way in the beginning, I had to tell them what to do (traditional age male).

Group members still had to learn that the idea behind the whole collaborative effort was to help everyone learn, not to copy someone else's work. This was noted by the peer leaders and brought up at the meetings between me and the peer leaders. I addressed this issue in class and the peer leader dealt with it during the workshop sessions. After a few workshop sessions the groups and the peer leaders began to report the internal group leaders had figured out when they were completely stuck and had no ideas that this is when they could get help from the peer leader assigned to each group. The peer leaders felt they were very helpful in getting this interaction started. They would interject hints and ideas into the group discussion before being asked. This helped to guide others in the group to an inspiration that would help solve the problem. Peer leaders said the workshop activities ran more smoothly as the semester progressed. They also reported the groups got familiar with what they were expected to do and had the opportunity to practice functioning as a group with the peer leader to direct them.

By the fourth week, the workshop activities and the groups were running quite smoothly according to the information shared at the weekly meetings between the peer leaders and myself. The peer leaders said they had gotten much better about stepping in before the internal leaders got overwhelmed. The peer leaders also were pleased they were becoming much more practiced at keeping the various group members on track. Copying had nearly vanished, except a few students occasionally tried it when they arrived late to class. By this time the group members were not shy about speaking up and informing the latecomers that they “do not learn how to do math by copying” (several students used almost this exact language). Peer pressure and support had begun to form in these groups.

None of the groups reported that the lead role within them had changed, but the peer leaders did note they saw changes. In each group the peer leaders pointed out how often the role of the internal group leader was split and conferred on two individuals, one person who could organize or lead people and one who was “in charge” of the mathematics. The person who organized people got the group started and would do a lot of policing without needing the peer leader to step in. This meant keeping gossip to a minimum or telling others to be quiet and get to work. The peer leaders observed the one "in charge" of the mathematics was either a person good at mathematics or a person not afraid to ask for guidance from the peer leader. If the person was good at mathematics, they would often take the lead and tell the others how to do problems and show where mistakes occurred. If the person was not so good at mathematics, then this leader would call on others who he or she believed to be good at mathematics to explain things to the rest of the group. Sometimes this leadership role was combined in one person, and at other times it was distributed across several people. The peer leaders and I had many very interesting discussions about group leadership. It was a challenge to them, but they offered each other advice based on what they observed within their groups. It was then we began noticing the similarities between the internal group leadership.

Math Whizzes

The students who were labeled as the math whizzes were the members of the group whom the other group members considered to be good at mathematics. The group members did not label each other this way, it was a title given to these individuals by the peer leaders. Most of the students in the groups knew each other before they entered into the groups. In many cases they had grown up together, attended secondary school together, or were related on a Native socio-familial level. In describing the math whizzes the peer leaders and I found they fit into three categories. The first category had the students who were good at mathematics, they liked mathematics and could fairly easily identify and apply an appropriate procedure to various problems they encountered in the workshops. When students in this group were directly questioned at the end of the semester, they said learning the mathematics was not always trouble-free for them but with practice they could figure it out. The second category consisted of the students who felt they were definitely in the wrong category, and the peer leaders agreed. Again through the end-of-semester interview questions they stated they had always been mediocre or bad at mathematics and were amazed at how many of their peers thought otherwise. Most did not have the courage to speak up and say otherwise so they went along with their role in the group. The third category was a self selected group who put themselves into this group when they really needed a lot of help to understand the concepts. There were two students who classified themselves this way and the peer leaders thought it was for self confidence reasons. These two individuals were well known on campus, popular, athletic, and involved in activities. We presumed that if they considered themselves "math whizzes" then others would as well and it would help their public image and maybe help their grade, a very overly optimistic viewpoint. These students were very vocal and liked being at the center of attention. During the end-of-semester interviews, these two students remained very quiet.

The "Math Whizzes" were the group members whom others turned to for most of the questions and to check the answers. According to the peer leaders, the math whizzes were the ones who got to do most of the explanations to the other group members. They also would work ahead and go back when asked by others to explain concepts. It was not clear if they were feeling picked upon to have to slow down and show others how to do the work or just bored because they had to go slowly for the group. They did not comment much about it in class, but they also did not appear to enjoy taking on the teacher/mentor role of explaining the mathematics. The peer leaders did report that when the "Math Whizzes" were asked to explain a problem or how to do a step, it was clear if they knew the mathematics. The ones who did understand did good jobs of explaining and helping the others through the problems. At times the answers were short, and the "Math Whizzes" appeared to be losing their patience. The peer leaders said they now were in tune with the group and would usually notice this. It provided them an opening to take over and redirect the group. The math whizzes who did not know the mathematics well, moved on quickly, often using a distracter to get the group off topic instead of helping them.

> Hey, why did you break my pencil man! Give me back my paper (a traditional age male).
>
> Wow, did you see that? It must have been a … (a traditional age female).

By the end of the semester these people were not called upon very often for anything. Being very vocal and in need of attention, they were more a distraction for the groups. This was expressed in the end-of-semester group interviews and in the surveys given at midterm and the end of the semester. The peer leaders felt they did a nice job of redirecting most of this energy back into constructive questions and explanations.

Normal Groupies

The students who were considered "Normal Groupies" were in the majority in each group according to the peer leaders. They are what I, as instructor, would consider the majority of a class. At the weekly meetings with the peer leaders we talked about these students and decided that they are not good or bad at the mathematics involved in this class, but need to take the time to practice and do problems. It was observed by me and the peer leaders that they usually have a fairly negative attitude toward mathematics. The peer leaders said this was due to years of being told they are not good at mathematics, years of failure, and years of remediation. My experience at the college is they were capable students, just never had the opening to demonstrate it. Again my experience told me these students need extra encouragement and praise for very small successes. They need instant feedback and acknowledgement of achievement. I expressed this to the peer leaders so they could use this to their advantage. The peer leaders did note that many students in the class were fast to give up, with the excuse the class was too hard and/or the instructor expected too much. The peer leaders said the groups needed constant reinforcement of their ability and boosting of self–esteem. As one peer leader said "the members of my group are so insecure they need constant reassurance of everything. I get so mad when they ask me if five times eight is forty. They know that, why do they ask?"

The peer leaders commented that the groups had changed as the semester progressed. The peer leaders suggested the "Normal Groupies" became more confident, but were not sure if it was because they felt better about knowing the mathematics, or were becoming more comfortable with the other members of the group. The “Normal Groupie” had developed into students who are not afraid to ask for help and pose questions to whoever could help. Two of the peer leaders noticed that they even challenged the “Math Whizzes” once or twice when they found a mistake. The “Normal Groupies” appeared to have benefited greatly from having a group to work with, as well as peers to explain concepts to them and give them the chance to change their mathematics attitude and ability.

We Need Lots of Help

The final group as identified by the peer leaders was the group of students who really do need a lot of help. They were lacking the very basic mathematical skills that are considered building blocks for the concepts taught. The peer leaders noted that these students had been identified by their peers as very poor readers, as having very short attention spans, and being distractions in class. The “We Need Lots of Help” students were not present in each group and peer leaders agreed the groups without them functioned better. They are not common, but the groups that had one or two certainly could pick them out. An observation from myself, as instructor, is that even before the groups were formed the majority of students avoided sitting near these people in the lecture class. I asked several students why some tables were nearly empty and others packed. The response was “if you sit by Jane, you can’t pay attention, they keep talking, asking questions, bugging you so you don’t learn anything.” The other students knew that being at the same table would be a detriment to their own learning so they avoided it as much as possible.

Neither the peer leaders nor I ever heard a group complain when a “We Need Lots of Help” student joined, but the group was affected. Only three students in the treatment class were put into this category by the peer leaders and two of them had virtually dropped out by midterms. This was not seen as a bad thing for the groups. They commented that it made the workshops go a lot more smoothly and faster. Peer leaders observed the groups got more done and had better exchanges during the activities. There was notable anxiety when the “We Need Lots of Help” member showed up. One peer leader thought, “it was as if the group was holding its breath hoping this person would not distract the group or slow its progress too much.” The student who did persist to the end had moved up to the low end of “Normal Groupie” by the end of the semester.

Peer leaders suggested how to help the groups form or not form roles for the next semester. Roles are inevitable for different members of each group. What concerned the peer leaders the most was the self perception of the students and how they passively let others categorize themselves and their abilities. The peer leaders were surprised that so many students did or said nothing about their perceived role in the group. The peer leaders pointed out in a purely social gathering of the same students they would have seen slightly different social structures. Some of the most social students ended up leading and the most academic students submitting to the social structure. As the peer leaders they thought this was unfair and should have had the “power” in the group re-distributed. None of the discussion in the group interviews indicated despondency with the group structure. There were comments on the group makeup however. The groups were formed by the students themselves choosing who they wished to work with. This method for grouping was chosen due to cultural limitations and the socio-familial relationships between students. One group made several comments about how the smart students were all in a different group.

Workshop Content and Materials

The second interview question addressed the content of the workshop activities and how well it complemented the regular coursework. The students were asked if the workshop activities were beneficial to their overall understanding and learning of the class concepts. During the course of the semester thirteen workshops were scheduled. They were weekly activities and each was designed to complement the coursework being studied at that time. The workshop activities are provided in the appendix. A list is provided in Table 10 that shows the workshop activity topic along with the mathematical concepts taught during lecture the same week.

Helpful and Beneficial Workshops

The four interview focus groups did come to agreement on which workshop activities were the most helpful, but the agreement was more on the mathematical concepts and topics which were the most difficult. Hence, the extra time and work gave them more practice to learn the material better. The more interaction between group members, the better they learned the material. The workshop activities that were said to be the most helpful were # 3, 5, 7, 8, & 12. The students' remarks about the workshops they identified as most valuable are summarized below, followed by a summary of the patterns that emerged regarding what aspects of the workshop content, design or interactions with others led to a valuable experience.

Workshop #3, Order of Operations, was chosen during interviews as beneficial not for the content but because it was fun. According to the students, it was fun because they had been working in the groups for several weeks and were finally getting comfortable with each other, how they were supposed to be interacting, and what the whole idea of a small collaborative group was. The material was "kind of" interesting, and since the negative integers are confusing when dealing with order of operations problems, having some extra practice never hurts. Seeing how other people do a problem is enlightening, but the most valuable part was hearing other group members talk about how they do the problems. What they do first, how they remember rules, and special names or images they might use, all are very helpful. The students explained that the other group members could speak their language, and explain things in words and experiences they understood. An example of this is simplifying the expression $5 – (2x + 3)$. One nontraditional student explained to his group that there is a ghost one integer in front of the parenthesis and that the ghost one makes it a multiplication problem: $5 – 1(2x + 3)$ becomes $5 – 2x – 3 = 2 – 2x$. The notion of putting a one in front of the parenthesis had been explained in class but just the name of a "ghost one" seemed to help several students immensely. It was the combination of having enough experience working in the small collaborative peer-led learning groups and the right activity that made this a favorite.

Workshop activity #5 was another designated as very beneficial. The activity dealt with solving simple linear equations and some that used order of operations. Still struggling with the order of operations, this added an extra step, not just simplifying an expression but solving an equation. Many students are very resistant to showing any work, since it takes too much time and paper to write it all down according to their rationale. This workshop activity compares how two people solve the problem. One is done correctly the other may be incorrect or may be another way of doing the same problem correctly. It is a new idea to countless students that one problem can be solved many ways yet reach a common answer in instances where a single right answer exists. This activity gives the groups a chance to talk about and explain each step, who they think did it correctly or why they think one step is incorrect. The previous activities provided the students with common engaging and challenging problems to solve together. This one gave them the opportunity to disagree, a chance to defend their ideas and knowledge. One group said the discussion got so serious they had to have the peer leader stop the argument and justify each step of both solutions. They did not realize they felt so passionate about math to get into that type of argument. It was very enlightening for them. They asked questions of the peer leaders such as “Do math teachers really look at our work to know why we get the problems wrong?” One student commented, “I thought I was the only one who did it wrong that way.” Two groups said it was easier to choose the one that was wrong when they had two to pick from.

Workshops #7 and 8 both gave additional practice with factoring of polynomials. These two were the activities that all groups said were most helpful, also the hardest by far. Factoring has historically been one of the most difficult concepts for students in this class. The textbook covers common factors, factoring binomials and factoring trinomials all in less than a week.   This is a rapid pace, common in most pre-algebra textbooks and classes. The concepts are very interrelated and taken independently are not complicated to master.   As one focus group participant stated, “Each type of factoring done individually makes sense but when they are all combined and you have to figure out what to do; then they get impossible.” Others agreed that there are too many rules too fast. So these two workshop activities were unanimously chosen as the hardest but also the most beneficial.

Workshops 7 and 8 are an example of where the peer leaders saw the “Math Whizzes” offering a great deal of help. They would explain over and over again the steps they used and how they knew what to do first. The peer leaders also noticed how hard the “Math Whizzes” tried to be patient, but by the time they had explained their method for factoring enough times they were done. The peer leaders had to step in and help out. They tried to use the same language as the “Math Whiz” so as to not confuse. But the groups sometimes became very frustrated. During the initial workshop on this topic, Workshop 7, there were no real breakthroughs in understanding when it was all mixed together. Workshop 8 continued to work with the concept of factoring. The one week between workshops made a big difference. The problems were very similar. The initial response when the activity was handed out was one of dismay. Factoring is the one topic in the class that the students’ hope they will never see again so if they just can hold on until it is over they will be home free, mathematically speaking. The peer leaders know the level of challenge and frustration this topic presents to most students, and have expressed it to the groups. By the time they finished this activity over half the group felt confident they knew how to factor. They had a great feeling of accomplishment and if they could just keep doing some until the test they would not forget how to factor. The peer leaders found it interesting that, as difficult as this concept was, the students picked it as the most useful. Some of the students again stated that "it just is easier if we teach it to ourselves and do the factoring our way." There was really no different way, just the chance to speak, talk about it, try it out, made it "their way".

The last workshop that the students said was very beneficial was #12, figuring out the amount of money they spend on gasoline each year depending on the gas mileage their car gets and if it is worth the money to buy a car that gets better mileage. This problem was not tied directly to the lecture material but was more of a common interest problem. This research data was collected in the fall of 2008, just after gas prices in the United States exceeded $4.00 per gallon for the first time. The effect of high gas prices on the students was enormous. The scenario was fictitious, but very appropriate for the typical student. The problem did not require a lot of algebra concepts that had been learned throughout the semester, but it was practical. It was an idea that most of the students had wondered about but had not considered mathematically. Some of them said they had been wondering if they should buy a new car, but never thought about "doing the math." The peer leaders thought this activity was chosen because it was practical, it was real life mathematics, and it showed the students that mathematics could be useful and was worth learning.

In summary the workshop activities the students choose to be the most helpful were chosen because they provided extra practice regarding concepts many students found difficult. The reasons the students gave for choosing these workshop activities as most useful were they allowed them to: 1) explain and talk about the mathematical concepts using their own language, examples, and vocabulary; 2) apply and explain their own methods, and re-organize their mathematical connections; and 3) apply the mathematics to useful practical problems.

Least Helpful Workshops

The workshops that the groups thought were not helpful were the first two and the last one, Workshops #1, 2 and 14. The first two were "just busy work" and "a waste of time." The groups did not like these workshops although they commented that the problems were similar to the ones done in class. When prompted as to why the first two were chosen as least helpful, it was because "one person had them done and the rest of us just copied, we learned nothing." The first and second workshop activities were scheduled at the beginning of the semester and most students appeared to have very limited experience or training working in small collaborative learning groups. The students were just learning how to collaborate and what was expected of each member of the group. The groups were not functioning as collaborative groups at this point and would need a little more time and practice to begin to work effectively. The final workshop had almost the same effect. The groups knew it was the last activity and were anxious to be done. The activity did not get the full attention of the group, in fact this was the least attended group meeting all semester. In order for the groups to work they need the positive interdependence component of collaborative groups. That is, everyone in the group needs everyone else in the group in order to be successful; it takes everyone to solve the problem. When group members are missing the group is not functional as a collaborative unit. The group interaction, in general, was the most valuable part of the activities. When that was missing the activities lost value to the members.

In summary the least helpful workshop activities had one overarching theme: the groups were not functioning as collaborative entities. The group members were either just learning the basics of collaboration or they were too impatient to participate as part of the group. The students in the groups had experienced a well functioning collaborative group at some point during the semester so they had a comparison of what was helpful and what was not.

The students' perceptions between the most helpful and least worthwhile workshop sessions can be summarized by the amount of productive collaborative group interaction that was present. When the groups were working well together (talking, explaining, listening, and challenging), the activities were identified as very helpful. When the groups were ineffective or nonfunctional, the activities were not valued.

Overall Small, Peer-Led Collaborative Learning Group Experience

The final topic posed to the groups for the end of the semester interview was inquiring about the overall experience of working in the small, peer-led collaborative learning groups. Responses varied from person to person more than group to group.

The categories of responses were identified and then grouped into larger themes. As the process unfolded, it became apparent that the themes fit the data best when the responses were sorted by student backgrounds. Backgrounds that were used for sorting were: 1) traditional college student, entering college directly from high school, single living at home; 2) traditional college student, single or married, supporting family with at least a part-time job; and 3) non-traditional college student, either returning to college or entering college after or currently employed.

Students who have never had a fulltime job, just entering college directly from high school and still living at home rarely had experienced working in a group other than as a member of a sports team. They were new to the idea of group learning or needing anyone for help or support. In general, their impression was that the small groups and extra activities were unnecessary and they would have done just fine without them. The comments implied that this collection of students had no idea that the groups might have helped them achieve better scores than they would have earned working independently and that they went along with the obligation of working in the group being part of the group only because it was a course requirement. They did enjoy having friends around and getting to talk during the workshop sessions, the number one reason why they attended the workshop sessions at all. In their opinion this method of learning is not a part of normal academia.

Students who were traditional age, but supporting a family with at least a part-time job, either married or single, had a little different impression of the group collaboration. They saw value in having others to help them and knew they valued being part of a team effort. One student commented "it takes a collaborative group effort to pass pre-algebra, just like it is takes my family to help raise my son."   She recognized that alone it would have been a much more difficult or impossible task. Another theme students in this category voiced was that the groups made things much more fun and that made it easier to work on mathematics more often. They realized that because they do their favorite work first, some things get left for last and mathematics is one subject that they usually saved for last.   It moved up on the list of things to do because it became enjoyable doing it, not something dreaded and frustrating. These students had experience working in collaboration with family or friends because of their child or children, so they knew what it meant. They know how valuable it is to have someone else take the responsibility if even for a short time. It is so much easier to function if you have several people working toward a common goal and how difficult it is when you are pulled too many different directions. This category of students was just beginning to experience collaboration in other aspects of their lives. For the most part they enjoyed the experience and thought that it would be helpful to get study groups formed for other classes as well, even without the peer leader. The classes specifically mentioned were the science classes, biology and chemistry. They wanted someone to be able to talk the concepts over with or someone else to explain them. Then they quickly added, "it is not that the teacher does a bad job of teaching, it's just we need to hear again and again in different words".

The third group, nontraditional students who have been in the workforce in a variety of capacities for different lengths of time in diverse positions, had a different view of their small, peer-led collaborative learning group experience. This was a small group but the familiarity with collaborating with others on the job was apparent. The idea of working together for college classes was new, but they had all participated in activities at work that required group effort. Some interesting stories were told of how they had projects at work that required several people from different areas in the office and it was very difficult getting them all to work together productively. It was frustrating to wait for information from one person that was critical before anyone else could proceed with their part of the project. This is similar to what they found in their collaborative learning group with one major advantage, the peer leader. This individual, the peer leader, could supply the missing information or at least steer them in the right direction. This was missing in the work environment. They valued the role of the peer leader, compared it to having a good boss who understood people and could motivate them to do their job quickly and accurately. They also recognized the other roles that were "played" by others members of the group. One pointed out the "We Need Lots of Help" member of her group was like her office mate that always showed up late, had excuses for everything, and never did her job at work. Even as others tried to help it just provided more excuses not more productivity. There were lots of people at work who fell into the "Normal Groupie" category. They were most of the employees, did their jobs and showed up on time. Some tasks at work got them excited and they became leaders for a small part, and then fell back into the usual routine. The leaders were like the bosses about whom it was made very clear there are good and bad ones. The good ones listen to the employees and help them to perform their job the best way they can. The bad ones are "We Need Lots of Help" people who got promoted somehow.

This group of older more mature students thought the groups were a very helpful part of the class and encouraged the Mathematics Department to keep teaching that way, maybe even convincing other departments to try using groups more often. They pointed out how they did get very frustrated with some things that happened and some people in the group. But they said it was part of life, no one is perfect. The one spot they identified as a problem area with the groups was that of motivation. There had to be a better way to motivate the students in the group. Some students worked hard but the others just did not want to participate and it distracted the whole group. There were times when they, the older mature students, just wanted to tell some of the group to leave, go home, and let the ones who wanted to learn, learn.

Peer Leader Journals

During fall semester, 2008, the four peer leaders made weekly journal entries for each workshop experience and also for the meeting with me as researcher/instructor. The peer leaders observed what happened in our meeting and what happened in their groups and recorded it in their journals before the next meeting with me. The journal entries were compared to the responses the students interviewed from the focus groups gave regarding the participation in the groups, the workshop activity content and the overall group experience. After reading through data from the peer leader journals, coding the narrative, identifying patterns and discovering themes, trends were noted (Creswell, 2007).

Participation in the Small Peer Led Learning Group

The observations of the peer leaders in terms of participation in each group got more and more detailed as the semester progressed. The initial workshops were typically described in very short phrases: Person A talked the whole time, Person B just was gossiping, Person C did all the problems and the others copied them, Person D sat alone and did nothing, Person E got angry because no one was working on the assignment. Throughout the course of the semester the descriptions became more detailed and better portrayed what had occurred. As the researcher, I encouraged the peer leaders to write more complete descriptions of the workshop interactions at our weekly meetings. I believe the peer leaders got more comfortable writing down details about their observations as they became more involved in the project. They realized the information they were providing was used to improve the workshops and help them function better as leaders, they saw that they were not alone in their observations, but the different groups had common experiences. Common themes were noted through the journals.

One common theme in the peer leaders' journals was that many students were initially reluctant to have to come to class and work in groups. Students who complained loudly made it uncomfortable for those students who wanted to be there. The better students complained the most as they felt they had better ways to spend their time. The not-so-good students also were not happy since they did not want to be stuck with students who might make fun of them or resent them for being so bad at mathematics.

According to the evidence in the peer leaders' journals, the students' comments were not quite this straightforward, but certainly lend themselves to the peer leaders' interpretation. For example, students made statements recorded by the leaders such as: "Why do we have to work in groups when I can do it by myself faster?", "I'd rather just do it myself when I chose to do it.", "Everyone is just going to copy my work, how is that going to help them learn it?", "I hate working in groups.", "I can get help at home, I do not need to work with these people.", or "Why can't we just do it alone?" In response to these comments, in my role as instructor, I gave a short presentation in class about how working in small, peer-led collaborative learning groups can improve student performance and attitude. I encouraged the students to give the groups a try for a few weeks before deciding how useful they were. The peer leaders also encouraged the students to give the groups a chance, and simultaneously made sure they had some fun icebreaker activities to get started each week to begin to build camaraderie in the group. Then, as the group worked through the first few workshop activities, the peer leader was careful to be very attentive to the group and how the members were interacting. This seemed to get the group through the initial phase of working together and what followed was much easier.

There were very few comments initially that indicated the students wanted to work together, such as "I am so glad John is in my group. He is so smart!" More common were statements such as "I am not going to let anyone copy my answers," "This is a waste of my time," and "This is better than homework, but it takes so long". After the first few workshop sessions it must have become apparent to the students that these sessions were not going away and they were expected to participate. The students were also getting practice being in groups, working with others and interacting with others in a semi-social way, yet more academic and not familiar to them.

After the first couple workshop activity sessions the attitude was changing for some of the students. The idea of a collaborative learning group was new to them but most met the challenge head on. They were beginning to make new friends and decide that it did help to work together. Very few students were just copying as those students had already gotten chased out or teased out of the groups. The groups were beginning to get serious about getting the work done and most were good at involving everyone. If group members were not paying attention, the rest of the group did get impatient with them and although they would often go back through a problem, the attitude of the group was much more "get with it," we don't have time or patience to do it over just for you. Occasionally the peer leader noted they had to be the one to refocus the group and get them back on track. Sometimes one student might take the effort to go back and work the problem with the other who missed it. This usually happened after the rest of the group was done or gone for the day. It was not whole group collaboration, but a good start towards it.

According to the peer leaders' journals, by the second half of the semester the groups had worked together enough that they were very familiar with each other and needed very little reminding of the activity at hand. They would get started on the activity at once and work to get it done. Students were more comfortable asking questions and getting someone else to explain it to them. The idea of collaboration was beginning to show. There was a definite pattern of who took the role of explaining, although it was not always the same person. The explanations depended on who asked and how they asked. If it was a short simple "how did you get that" anyone would answer, usually a person sitting near the one who had asked. If the explanation required a more in-depth mathematical answer then it fell to "specialists" in each group. In one group this was the most patient person. In another it was the most motherly, the person who took the time to make sure everyone was understanding and no one was left out, and in another it was the most knowledgeable, the "Math Whiz." It was interesting to watch through time who answered what questions and from whom. The students who asked the most questions were identified by this time. Depending on who asked, the person who answered changed. As the semester progressed this became more and more pronounced. It got to be rare to need two people to explain something. This usually began as all-verbal explanations, and then progressed to writing on the edge of the paper. It took about three to four weeks before the students were asking for markers to write on the white boards. One person loved the white board and wrote out everything, even unnecessary things according to the rest of the group. Others used it more sparingly or not at all. Plenty of scratch paper and markers were available for use with each group.

An issue that got attention in the peer leaders journals was what to do with students who added late. The groups had already been formed, some late additions fit right into an existing group and others felt as outsiders in all the groups. In our college this has much to do with the student population. Many of the students are related by blood or clan system and that enabled them to fit into a group more easily. The students who added late and were not part of this social-familial group had more trouble. One commented how they sure wished they had been in on the group from the beginning. They thought it would have made a big difference. These students really never did find their "position" in the group, in essence they felt like outsiders the whole semester.

Another issue that was getting attention by midterm was what to do with students who showed up late for the workshop activities. Most groups would take the first few minutes to visit and gossip as normal; then they would get down to business. When a group member came in 15 minutes late and wanted to copy, the others got angry and said no. They were supposed to be working on this together, not copying. So the late comer had to wait until they had finished the activity and hope to find a sympathetic friend to help them with the first part they had missed. This worked out reasonably well, but the habitual offender found it was harder each time to get someone to stay after to help. Instead, what appeared to be happening was peer pressure to show up on time and work with everyone else. The groups would often show up for the activity all together, as if they had picked up members on the way to the classroom. My interpretation of the effects of the peer pressure noted by the peer leaders is that this pressure may have had benefits including helping students to stay on task and work through the activity. The sooner they all got started, the sooner they all got done. If they did get stuck they had more resources within the group to help them get unstuck, or to ask for help.

A final issue that arose as the semester progressed and was frequently noted after midterm was the problem of students who simply quit coming to class. The college traditionally has a large number of students with poor attendance after the first PELL grant disbursement. Students who had been regular contributing members in their groups now were not attending. For some students this was short lived and they only missed one or two workshop activities, but others never really got back to attending regularly. There was no clear explanation why some came back and some did not. The college has tried to explain the numbers of dropouts or "stopouts", and the reasons why. The most common reason by far given by the students in response to the college's queries is that they do not have the financial support necessary to continue, including money for gas, daycare and food. The second most common reason is the students say they simply are not ready for college. They need more time to get serious and commit to studying. After several unsuccessful attempts to contact my specific students, the college's retention personnel suggested I use the information they had collected provided above.

According to the peer leaders' journal entries, there also got to be more and more arguments between group members on the correct way to do a problem or what the correct procedure was. Peer leaders indicated the students acted more confidently over time, as they gained a sense that they knew what they were doing and how to do it. As a result, when given a different method by another group member or the peer leader they questioned it more often. The peer leaders noticed that students seemed to be having "fun" seeing different ways to do the problems. The top students often would not back down from "their" way of doing a problem, but the other students in the group benefited from seeing more than one way to do a problem. According to the peer leaders, usually one method or one person would dominate each group and that was the way they'd all ultimately learn to do the problem. For example, with regard to multiplying binomials there are two common methods, using the distributive rule twice or using the acronym FOIL (First, Outer, Inner, Last). The results are the same in either case, but the order the terms are multiplied in may vary, hence the order the answer is written in may also vary. Both methods are taught in class, but many students remembered FOIL from previous mathematics courses and chose to use that method. This would then be the method of the group.

<u>Content of Workshop Activities</u>

The peer leaders did not write much about the content of the workshop activities except as they experienced them during our weekly meeting. This was mainly their impression of the workshop and how they thought the students might react. The main purpose of going through the activities with the peer leaders before they went through the activities with their groups was to give them an idea of what to expect for questions and how the group might react to the activity. Some were easier, some had questions that might need additional explanations, and others just elicited conversation due to the examples used or current events. The peer leaders found having this awareness quite helpful.

The first few workshops were pretty straightforward and most of the dealings the leaders had with the group were to help with the interpersonal communications within the group itself. They found themselves regulating the way group members spoke to each other. Some responses were very rude and nasty so the peer leaders corrected the response and modeled how to respond in a respectful manner. The peer leaders found that they needed to pull the group together and to get everyone to participate in at least some aspect. The other issue was getting the group to recognize them as a leader or a guide, not a tutor or second teacher. This was the most challenging part for the peer leader. The group would get very frustrated when the peer leader would not do the problem for them or tell them how to.

After the first three or four weeks, the groups began to function more like collaborative groups. The journal entries noted things like the "students would not ask me for the answers, but still want to confirm the answers they got were correct". And the students now talked with each other, involved the whole group, usually, and were at least civil to each other. As the weeks went by concepts taught at the beginning of the course began to show up again in later concepts. Some students learned them well the first time and did not notice the increased complexity. Other students had a very difficult time recognizing previously learned concepts or combining them with new ones. This is where group leaders noted the collaborative groups were very effective. When someone could not remember a math concept, they got help immediately from others. They were almost shamed into relearning it, and really learning it this time, not just memorizing it for the test. The best example of this is factoring polynomials. This was first introduced about midterm. A few weeks later it was revisited when the idea of rational expressions came up. Students who had a method for classifying and factoring various types of expressions were called upon and expected to share their methods with the ones who needed reminding. The ones who got it taught for the second time were told "to learn this" because it would keep coming up. One comment was "it is like the fall, it just comes back and back again."

By the end of the semester the collaborative groups were very used to working together on the workshop activities. The students who were on the fringes of the group had either dropped out so they were no longer present and a distraction or they had become full participants and were no longer seen as distractions. They generally seemed to be happy the semester was over. They took pleasure in being done with the class.

I, as instructor and researcher, had a convenient view of the control class during the weekly workshop activity day. The control class was given the activity to do, but not encouraged to work together. They stayed in their usual seats and the usual classroom. My observations led me to contrast the descriptions from the peer leaders of the students in the treatment class to the students from the control class. This only took a short observation of the room while the activity was in progress. Often the students from the control class would show up for the activity, write in a few answers and leave as fast as possible not caring if they had the right or wrong answers. No students stayed the full hour, very few papers were complete, and most had incorrect answers to nearly every problem. The papers were not graded and points were awarded to anyone who turned in a paper.

Overall Experience of Working in a Small, Peer-Led Learning Group

The peer leader journals indicated that the peer leaders would have enjoyed an experience like this in one of their classes. It was so much different than any they had experienced in the college classes they had taken. It was not expected that the experience would be all good, but it was something different and they welcomed the opportunity to try something new. One leader suggested it would be interesting to see how older, second year college students would handle working in groups this way. She wondered if it would take a longer or shorter period of time to get the group functioning properly. And if the instructor put the groups together, would that work better? The peer leaders did say they thought they had the hardest part, leading the group. It was almost a competition between them as to whose group was doing the best in class.

Here are two examples the peer leaders gave of a situation that stretched their leadership skills. The first example began as one of the small groups was working through the fourth week's activity. At first the group seemed to be fine, and it was business as usual. Then, essentially all interaction between the group members became inflamed. The peer leader said she thought they all must have been having a bad day at once. No matter what statement was made or question asked, the person asking got snapped at. The group essentially fell apart. The peer leader was not sure what to do, and her comments to the group received the same types of response. In the end she basically told the group they were done for the day, sent them out of the room and got the students split up. The peer leader was a bit apprehensive about the next week's workshop meeting, but the group came together as if the bad day never happened. At our weekly meeting the other peer leaders had no better ideas, and although they were not sure they would have come up with that solution, but were glad it worked.

A second situation in which a peer leader felt pushed beyond her experience and expertise was when two students in the group began arguing. This episode was during the ninth week of the workshops, so the group was fairly well used to working together and they had been encouraged to have discussions about various ways to carry out the mathematical procedures. The discussions had always been friendly, with students presenting their "best" way to do the problem. The leader admitted she was not paying attention at the beginning of the discussion, but it soon escalated beyond a discussion and she took note. Wishing she had stopped it sooner, she was now faced with "What do I do now?" The students were so involved with each other they did not listen to her verbal requests to stop. She finally got up and slammed the door to the room. That got them to stop long enough for her to begin explaining the problem her way, the way the leaders had solved the problem working together in the weekly sessions with the instructor. The peer leader said that was the only time all semester she broke the leader rule and instead of trying to guide the students in the right direction, she showed them exactly how to do the problem. She did not take any questions, she did not stop to let the group catch up, she just put it all on the board and had them copy it down. One of the other peer leaders at our weekly meeting mentioned she would have liked to have just slugged both arguers in the arm, but knew better than to initiate physical contact. The others suggested pounding on the table or breaking a pencil to get their attention. Once again, the following week the two antagonists were back to interacting on a constructive basis.

Fortunately, most group meetings ran smoothly without aggression or hostility. These examples were the most difficult encounters throughout the treatment semester and both pilot studies. They were frightening for the peer leaders and group members. They were also resolved quickly enough, without incident, and there was a quick return to normal. The group members did not really comment on them.

An example of another type of challenging situation for the peer leader was when a group got stuck on some very elementary mathematical concepts. They were so easy she did not know how to lead students to the answers, and when she tried they did not believe her. This was the case with definitions of geometric shapes - circle and rectangle. The “internal group leader” erroneously explained that a rectangle had three sides, they had some great triangle pictures drawn, and it seemed everyone had forgotten the word triangle or had it confused with rectangle. But they believed their “math whiz” who had made a silly mistake, but took them along in the reasoning. Shortly after this the same group was stuck on a circle problem. Again the “math whiz” in this group had explained to the group that a circle was in essence any simple smooth curve that could be drawn in a plane. The idea of equidistant from a center point was never included in the description or definition. The group did not question this, went along with his picture, and again would not believe the peer leader that their definition was missing an important characteristic. In a room without computers and without other textbooks for reference, she finally suggested someone look up definitions of these shapes on their cell phones. That seemed to settle the issue and point out to the group that there are many ways to get hints.

Other Personal Skills for Success

The fourth focus question that this research study attempted to address was what other personal skills for success the students in this treatment group might have realized that can be attributed to their participation in the small, peer-led collaborative learning groups. Again the interviews at the end of the semester with the students and peer leaders were used to try to answer this question, as were the entries in the peer leader journals. In addition to the student interviews and peer leader interviews, interviews with college staff and faculty were also used to provide information on this question. The data from the interviews was coded, and examined for patterns, then grouped into themes (Creswell, 2007).

Student interviews and peer leader journals indicated growth for nearly all participants in the areas of interpersonal communication and self confidence or self-esteem. Students learned how to listen to others and repeat what they heard. They also learned how to discuss concepts in non-threatening ways with respectful language. They could disagree but still be pleasant to each other. Some students were much better at the end of the semester in taking turns and not dominating a discussion. Some students were not afraid to speak up and say something. It was very hard to get some students to even sit with the rest of the group at first, but by the end they were all in a circle together. Both the student interviews and the peer leader journal entries noted how self confidence had grown in many of the students. Students stated they were not afraid to speak up and point out errors anymore, or to say they did not understand and have someone explain it to them. They also said they were still a bit shy but liked to show someone else how to do a problem. It made them feel good to know they knew the concept and could help someone else. The realization that they were good at it was very enlightening for some. The attitude toward doing this “math thing” they did not really like had changed too. They would not say they liked it, but it was not as bad as they had thought it was for years, in fact it was learnable and a valuable tool to learn. They expressed that there was merit in knowing mathematics. It was worth putting in some effort.

Various college faculty and staff were informally interviewed weekly to identify other personal skills for success they might have observed in the students associated with the peer-led collaborative learning groups. The students at the college spent a large amount of time in our student union building, library, and outside in the Arbor area. The students involved in the peer-led collaborative learning groups were no exception. They often would be found in our computer labs as well. Staff members who were heading up programs such as “TRIO, Title III, and STEM/TCUP” where tutoring was centered, were often present in these favorite hangouts for students. So, weekly informal “interviews” were held with the staff and we mainly discussed the behavior and actions of students who frequented these areas. A separate weekly “interview” trip was made to the library and computer labs. Although I worked daily with all the staff and faculty it was important to realize that this weekly trip was made for the sole purpose of collecting data on student behavior. Individual observations were also made by me, the instructor and researcher, as I carried out my normal job activities as a faculty member, department head, and serving on various committees. Data from the informal interviews and my observations were compared with the themes obtained from the student data to add support for the themes or add new themes as realized.

At first the informal “interviews” consisted more of the interviewer talking to the staff members about the peer-led collaborative group learning, what the students were learning in class in terms of collaborative group work and what they might expect to see outside of class. Definite leads were given to the staff members of what they might observe in the students: working in a group, discussions, arguments, confidence building, etc. This would give the staff members some things to watch for and some ideas of what I expected to happen. It may have provided a bias to the staff as to what actions to watch for, but also opened the discussion to things that were happening already that had not been shared before. This may have presented a skewed representation by the staff. Interviews about the observations from the staff were summarized after I returned to my office.

Early in the semester, one of the staff in charge of the tutors mentioned how they were mostly happy with the way the tutoring had been going, but noticed a definite trend among students in that they expected the tutors to teach the lessons, not to just help with problems. The staff member had to explain to the students that the tutor was there to help, not to teach, and that the student had to go to class and still meet with the instructor. Tutors were not teachers! The staff member also felt as if the tutors were being used to do all the homework while the students just copied down the work and answers. This was not what the tutor or the support program intended to happen, but they did not know how to stop students from expecting this practice. Later in the semester, the same staff member commented she had observed less outright copying, but the students still would allow the tutor to do all the work if they would. This staff member speculated that the difference might be because the students who were still in class had now figured out they had to learn the concepts and material themselves to pass the classes. The students and tutors observed may or may not have been part of the small peer-led collaborative groups.

The observation that was mentioned the most often was the use of the academic support program rooms for group work. In the past it was very likely that one or two students might come in together for help from a tutor. During this semester it was noted that the rooms were often filled by groups of five or more students. When the room was full there were usually other students wanting to use the room too. And the students did not always want a tutor for help, just a place to work together. They did not turn down help from a tutor if offered but the tutors would usually just observe until asked a question. The groups of students were often from the treatment class. Other groups were formed by the peer leaders for the purpose of better learning material for their classes.

The second most common observation was that the students were more vocal than the staff had remembered them in the past. Students were not afraid to speak up and give their opinion of how to do a problem or offer a plan to get started. Students also would speak up when a mistake was made, no matter if it was a concept error or a just a careless mistake. In addition to talking about the mathematics, the staff members commented on the overall level and quality of verbal interactions between students. They would take more time to do their work and to visit. They seemed content to be together working. The level of verbal interaction varied greatly between students. A staff member commented how she would greet the students as they entered her area and finally by the end of the semester two of the students would say hello back. She saw that as an enormous step for these two individuals. A faculty member stated he had noticed that his classes had more questions from students this semester than he remembered from past years. Another faculty member noted that his students challenged him in class more often, both his opinions and some of the facts he presented. It was stimulating, inspirational, and annoying. He was not sure it was a good thing, but it made him reconsider some of his lecture materials.

One group of about six young men had a set time they would meet in one of the program rooms two or three times a week. They would do homework together, not the workshop activity, but the practice problems assigned by the instructor. This started out straightforward enough, but as the group became more and more comfortable with each other and the interactions got to be a very loud and obnoxious. The staff in that particular program room would plan to leave their office for the hour and let the men have the room. This group of men would actually get to the point of yelling at each other and were very active learners. They used the blackboards in the classroom to draw pictures and show others how they did the problems. They argued over the best ways to do the problems. They had very heated discussions but they came out of the session with the problems done and feeling they had accomplished what they set out to do, finish the homework. The program staff did mention they were very glad the semester was over and would no longer need to give up “their space” for these young men. This was the most drastic example of students using a collaborative learning group. This group was not part of the treatment class, but instead had one member who was a peer group leader for the treatment class. He had organized this group to help himself get through a higher level mathematics class. The group had another common characteristic; they were mostly members of the same college club.

A third theme that showed up as the data was analyzed was that students had better attendance. This was noted by some staff comments such as they were surprised to see so-and-so on campus again. Or they saw so-and-so today and did not expect to see them. Direct comments about attendance were not offered but as the hints were given the idea became clear. Attendance must be up if students were seen on campus by staff members who did not expect to see them. Or possibly the student was in the support services area instead of their classes.

A fourth theme was the attitude of the students. The staff members stated that the students did not seem as down or negative about the mathematics classes when they were in their groups. There were still things they complained about, but the students were not being completely negative. Some students commented on how they liked that the mathematics teachers were trying things to make mathematics better for them. They liked how the teachers cared enough to try a new approach even though they were hesitant about the peer-led collaborative learning groups. Students commented on the groups, some had positive comments and others did not like them. The comments were often about how much homework they had to do and how much time it took. Overall, the students seemed happier and had a better attitude than other semesters about the mathematics classes in general. The amount of mathematics being talked about and written down was greatly increased.

A fifth theme was the idea of student support from each other. The staff sought out for informal interviews are all involved in student support. They are on campus with the purpose of helping students by having tutors available, having computers available, having other services either available or providing recommendations (for transportation, daycare, etc.) The staff found that some of these services were now being carried out through the groups. The groups would make sure other member got to classes. They often would offer rides if needed and even meals during study sessions. They opened their houses up for study sessions and even for a student who had no way home one night. It was a small piece but caught the attention of staff members watching the students interact. Students encouraged each other to attend tutor night before the final exams.

Moral support was a little subtle, but the idea crept into the themes through several examples. One was the way a group helped a member through a relationship breakup. They shielded this member from the ex and made sure she was not left alone to confront the ex on a one-to-one basis while on campus. A different example was how a student with transportation issues was encouraged to meet with a group member at night since she was unable to make it to class. This kept her caught up and involved until she was mobile again.

Group Leader's Perceptions of the Benefits or Deficits Acquired

The peer leaders played a very integral part in the small collaborative group learning. "It is the peer leader who shapes the interpersonal relationships and intrapersonal attitudes that transforms a random group of students into a high-performance team" according to Kampmeier in the *PLTL: A Handbook for Team Leaders* (Roth, Goldstein, Marcus, 2001, p.v). This role was new to the students who were chosen to be the peer leaders. They had a lot to learn and many new ideas to try out. You cannot just put a group of students together in a room and assume they can work together. It takes a lot of practice and direction to get the group functional and working together toward the common goal. This was the charge to our peer leaders. In taking on this role the peer leaders themselves would go through a transition. This change would affect how they perceive themselves and how others identify with them.

Benefits Acquired

The first benefit was training, mentioned by all the peer leaders, and it was chronologically one of the first encounters we had with them. The peer leaders began their semester with training to cover some of the very basic ideas of collaborative groups. A lot of the material presented at the peer leader training was new to the leaders, so they said the experience was one benefit of being a leader. Even before the peer leadership training began the leaders had to apply for the position. One of the leaders stated that she was surprised she was asked to apply for the peer leader position. She did not see herself as a leader and was concerned she would not be able lead. Her mathematics skills were good, but she was hesitant to accept the responsibility. It was not an easy role for her to fit into, but she did a wonderful job and was well liked as a peer leader. Her self image changed with respect to the peer leadership position. All the peer leaders talked of changes in their self image. Some of these changes can be seen quite clearly comparing results of a survey given to the four peer leaders at midterm and at the end of the semester. Table 25 has the percentages of responses for each statement on the survey at midterm and at the end of the semester (in bold).

Table 25: Self Rating Checklist: Midterm & End of Semester- Peer Leaders.

Self Rating Checklist-Midterms & End of Semester-Peer Leaders								
Mid Term = 4 **End of Semester = 4**	**Very seldom**		**Sometimes**		**Often**		**Almost Always**	
1. I understand the goals of the Workshop program.								
Mid Term **End of Term**	0.0%	**0.0%**	25.0%	**0.0%**	50.0%	**25.0%**	25.0%	**75%**
2. I understand the professor's goals for the modules and for the course as a whole.								
Mid Term **End of Term**	0	**0**	50	**0**	50	**25**	0	**75**
3. I prepare well for the workshops								
Mid Term **End of Term**	0	**0**	50	0	50	**25**	0	**75**
4. I can get the workshops sessions started easily.								
Mid Term **End of Term**	0	**0**	50	**0**	50	**25**	0	**75**
5. I am happy with the amount of control I have in the Workshop (not too much, not too little).								
Mid Term **End of Term**	0	**0**	75	**0**	0	**50**	25	**50**
6. I am patient.								
Mid Term **End of Term**	0	**0**	0	**0**	50	**0**	50	**100**
7. All the students participate on a regular basis.								
Mid Term **End of Term**	25	**0**	50	**25**	0	**50**	25	**50**
8. I am adept at keeping the conversation going among the students.								
Mid Term **End of Term**	0	**0**	25	**50**	75	**50**	0	**0**
9. I am good at asking questions that help students approach the problems.								
Mid Term **End of Term**	0	**0**	25	50	**75**	**50**	0	**0**
10. My students look to me for help the appropriate amount of time (not too often, not too seldom).								
Mid Term **End of Term**	0	**0**	50	**0**	50	**75**	0	**25**
11. The Workshop students talk easily with one another.								
Mid Term **End of Term**	0	**0**	25	**0**	75	**50**	0	**50**
12. I am able to tell people they are incorrect in a constructive way.								
Mid Term **End of Term**	0	**0**	25	**0**	75	**75**	0	**25**
13. I am confident about my explaining the material when it is appropriate for me to do so.								
Mid Term **End of Term**	0	**0**	25	**0**	50	**0**	25	**100**
14. I know how to handle it when someone asks me a question I can't answer.								
Mid Term **End of Term**	0	**0**	0	0	75	**0**	25	**100**
15. My Workshop stays on task the right amount of time each week.								
Mid Term **End of Term**	0	**0**	75	**0**	25	**100**	0	**0**
16. I can get the students back on track when they get distracted.								
Mid Term **End of Term**	0	**0**	50	**0**	50	**75**	0	**25**
17. I am able to break the tension when needed: I can keep the stress within the group at a manageable level.								
Mid Term **End of Term**	0	**0**	0	**0**	50	**0**	50	**100**
18. I help students see connections between old and new material.								
Mid Term **End of Term**	0	**0**	0	**0**	75	**25**	25	**75**
19. I take different learning styles into account when I plan a workshop session.								
Mid Term **End of Term**	0	**0**	75	**25**	25	**50**	0	**25**
20. I treat all students fairly.								
Mid Term **End of Term**	0	**0**	25	**0**	25	**25**	50	**75**

Table 25: Self Rating Checklist: Midterm & End of Semester- Peer Leaders.

Mid Term = 4 **End of Semester = 4**		**Very seldom**		**Sometimes**		**Often**		**Almost Always**	
21. I keep tabs on individual student's progress with the workshops problems.									
Mid Term	**End of Term**	0	**0**	25	**0**	75	**50**	0	**50**
22. I know how to make referrals to other campus resources when necessary.									
Mid Term	**End of Term**	25	**0**	0	**25**	75	**25**	0	**50**
23. I think about the possible impact of race, class, and gender issues on students learning.									
Mid Term	**End of Term**	50	**0**	0	**25**	50	**50**	0	**25**
24. If I had a student with a disability in my Workshop, I would know how to plan for support for him/her in my Workshop sessions.									
Mid Term	**End of Term**	50	**0**	25	**50**	25	**50**	0	**0**
25. I maintain a positive attitude.									
Mid Term	**End of Term**	0	**0**	25	**0**	50	**0**	25	**100**
Modified from the Peer-Led Team Learning: A guidebook									

At midterm, the peer leaders indicated they understood the goals of the workshops and the class as a whole sometimes or often, but the end of the semester they replied almost always. At midterm, the peer leaders gave sometimes or often as the response for nearly every statement: preparing well for workshops, keeping the workshop discussion going, asking questions that help the students, keeping the workshop on task, getting the students back on track once they are distracted, etc. By the end of the semester, the peer leaders were marking nearly all the responses as often or almost always. They had learned many leadership qualities for working with a group of people. These included people skills such as getting the workshops started easily, being patient, telling the students they are incorrect in a constructive way, explaining material, handling a situation where they did not know the answer, breaking the tension when the stress level is too high, treating each person fairly, and helping students see connections. The peer leaders also indicated they had learned management skills. Keeping tabs on various individuals while working with the group, preparing for the workshops, having the right amount of control of each session, getting everyone to participate on a regular basis, taking different learning styles into account while planning the activity, and knowing how and where to make referrals for other resources as needed are examples where the peer leaders expressed growth in management. One area where all the peer leaders noted they benefited was in maintaining a positive attitude. It would have been easy to fall into the mindset of the student groups and get discouraged; but the leaders found they could be positive, and as they expressed their positive attitude the groups took on the same attitude. As one leader put it, “I looked forward to my workshop session, it made me forget all my problems because I had to concentrate 100% on being positive and helping the group have a good experience.”

The peer leader journals offered insight into other benefits that the leaders gained. They did not specifically state it as a benefit but it was a mentioned in an upbeat way. Two of the journals mentioned the way the peer leaders had been received when they were using the copy machine in the teachers’ lounge. This is normally off limits to students and the students get scorned for being in the room and more so for using the equipment. These two peer leaders expressed delight in the way they were treated by faculty members and even had a faculty member offer help if needed. They had unexpectedly entered a new circle of peers, including faculty and staff members. The same two leaders commented in their journals on how the staff put them in charge of a room full of students when they did not expect it. The journals were quite vague on personal growth, not talking so much about their own growth so much as about changes in their group. All of the peer leaders commented on how much easier it got to prepare for the workshop activity sessions and that the preparations now took less time. They commented on how much easier it got to run the workshop activity sessions. Specific remarks that related to this theme were: “my group did not get in a big argument today”, “my group stayed on task and when one person tried to distract the group stopped it”, and “they (the group) did not try to get me to do the work for them; they only asked for hints!” This indicated that the groups were also becoming self-reliant and learning how to regulate themselves.

Another area of growth that was noted in the journal entries was the area of academic learning. The leaders gave different examples of where they learned something new while conducting the workshop or found out later how important an idea was that they had recently explained. One criterion for being chosen to be a peer leader is that the individual recently took and passed the class with a grade of A or B. That does not mean the peer leader knows everything nor has an extensive mathematical background above and beyond the content being studied in the class. It is not surprising that there were concepts the peer leaders were unsure of when they encountered them in the workshop activity. Several times it was expressed that the group had a different method for doing the mathematics than they were familiar with. Specific examples were multiplying and factoring polynomials. Exponents were another area where the leaders found their way was different from how the students in their groups did things. Real life application problems were interesting to the leaders. The methods the students used to solve the problems was almost always different from what the peer leader would have suggested and more than once the peer leader was confused by how the group was solving the problem. They had to have it explained to them and then with an open mind figure out where to go from there. Many times school mathematics does not match real life mathematics although both work for solving the problem. The groups used more labor intensive but understandable methods in some cases and the peer leaders noted they were definitely much easier to understand, even though longer and harder to calculate. This helped one peer leader with an issue at her church and another helping with her child's homework.

When asked in particular about wanting to be a teacher none of the peer leaders were willing to change majors, but they were all much more willing to keep working in this capacity. The biggest detriment was the time commitment. Being a peer leader took more time than any of us had imagined. We had assumed the peer leaders would put in about six hours of work each week; three hours of lecture, one to two hours of workshop activity time, and maybe another hour of journaling the weekly workshop and meeting. It was the additional hours of group members asking for help that added up quickly, this was easily another three or four hours each week for individual peer leaders, typically about an hour each day class was in session. Even though the leaders were paid for each hour they worked, the time commitment was more than they had expected.

Summary of Results

A mixed method quasi-experimental research study was conducted to provide answers to the following research questions concerning the implementation of small, peer-led collaborative group learning in developmental math classes a two year Tribal Community College: 1) changes in completion rates, 2) changes in perseverance rates, 3) demonstrated procedures of mathematics , 4) new personal skills for success and 5) the leader's perceptions of the benefits or deficits acquired by facilitating small, peer-led collaborative group learning activities.

Both quantitative and qualitative data were used to address the questions. A rubric was used to analyze the demonstrated procedures of mathematics. The results showed that students involved in the small, peer-led collaborative learning groups' demonstrated higher proficiency on the examined mathematical concepts, they were more involved in the traditional portion of the class, and they continually increased their demonstrated use of the mathematical concepts.

Student surveys and interviews, peer leader interviews and journals and informal staff interviews provided information about any new personal skills for success the students might have gained and the leaders' perceptions of the benefits or deficits accrued by acting as a peer leader for a small collaborative learning group.

New personal skills for success reported by the students can be summarized as follows: they discovered that working in groups can be both fun and academically empowering. The students became more comfortable with themselves and others as they took turns explaining mathematical concepts to each other. They found they were much more confident in their own work once they explained it out loud to someone else. They gained the virtue of accountability and reliability by working with others who counted on them as part of larger group. Many students found themselves taking on new roles of more trust, responsibility, and respect within their peer groups. The new personal skills can be summed up by saying they grew both academically and socially by being an active participant of the small, peer-led collaborative learning groups.

Peer leaders changed as a result of their experience as the leader of the small peer led collaborative learning group. The benefit they saw as most empowering was the growth they made as a leader and the growth in their interpersonal communication skills, specifically in the areas of motivation, re-direction, and guidance. They also gained confidence and self esteem as they learned how groups functioned, why some groups were dysfunctional, and how to help a group manage itself. Peer leaders found good time- management skills to be a great value.

In conclusion the findings indicate that the use of small, peer-led collaborative learning groups may possibly improve grades, persistence and overall attitudes in developmental mathematics students.

CHAPTER 5

CONCLUSION

This chapter provides a short review of the purpose and the design of the research study. Then it reviews and interprets the results described in Chapter 4. Implications of the study for higher education mathematics instructors, college administrators, students, support staff and the research community are then discussed.

Review, Purpose and Design of the Research Study

The issue of unprepared college students in need of remediation in mathematics and writing is an ongoing problem at nearly all colleges and universities but is immense at community colleges where it is not unusual for over 80% of the students to enroll in a developmental mathematics course. Students must complete this course to progress to the next level, which may turn out to be yet another developmental mathematics course. Often students must take three or four developmental classes to reach the college level classes. This is a big drain on the students' financial resources and time. Specifically, the lack of success for Native American students in developmental, entry-level mathematics courses at the tribal community college has an enormous effect on future opportunities in education and employment as well as political and social advancements (Greene & Forester, 2003).

The purpose of the study was to determine if the use of mandatory, small, peer-led collaborative group learning workshops in developmental mathematics classes had a measurable impact on completion, perseverance, and the demonstrated use of mathematical procedures for Native American students enrolled at a two-year Tribal Community College. The study also looked at how the peer leaders change as they led the groups through the workshop exercises. This research study took place on a small Tribal Community College campus. The study was quasi-experimental since the students and their advisors chose the section of pre-algebra that best fit their schedule. There were two sections of the course, one was randomly selected for the control section the other became the treatment section. The treatment consisted of having the students work together on a workshop activity designed to be engaging, challenging and relevant for one class period each week in small, peer-led collaborative learning groups. Peer leaders were chosen according to the criteria that they had recently completed the course of pre-algebra with a grade of A or B, were willing to undergo the training necessary and work in the capacity as a peer leader. The peer leaders were trained to help the groups by guiding their thinking and questioning in the direction of a solution and also to help the group learn how to collaborate to achieve the best results. The control group was given the same workshop activity to work on, but neither encouraged to work together nor actively assisted by a peer leader. A mixed-method approach was used, involving collection and analysis of both quantitative and qualitative data, with the goal of providing a more complete understanding of the processes and outcomes studied.

As the researcher, I was faced with carefully presenting both the positive and the less satisfactory parts well, because there is a known and definite tendency for Tribal

College instructors and students to just throw up their hands and do nothing out of frustration and years of discouragement.

Research Questions and Findings of the Study

The overarching research question was: How does the implementation of a small, peer-led collaborative learning group affect students in developmental mathematics courses at the Tribal Community College? To speak to this problem, five sub-questions were addressed. The questions and a brief summary of the results for each follow.

Question #1

What impact did the implementation of small, peer-led, collaborative-group-learning workshops have on completion rates of Native American students in developmental mathematics classes at a two-year Tribal Community College? The results of the quantitative analysis on grade distribution data show that students in the treatment class were not significantly more likely to earn a grade of A, B or C than students from the control class. However, the percent of students from the treatment class completing the course was over 15% higher than the percent of students completing from the control class.

Question #2

What impact did the workshops have on perseverance rates of Native American students in developmental mathematics classes at a two year Tribal Community College? Perseverance is the resolve to complete the course, not to drop out or to quit before the end of the semester. Students in the treatment group who completed the entire course attended class an average of five days more, out of 50 possible days, than students in the control group. Forty-seven percent of the 30 students starting the treatment class persisted through the last day, compared to 32% of the original 31 control class students.

Question #3

Does the implementation of the workshops at improve the demonstrated mathematical procedural skills for Native American students at a two-year Tribal Community College? Both quantitative and qualitative data were used to address this question. Using the Demonstrated Procedures for Mathematics Rubric and comparing performance levels of the students through the content area three differences were noted between students from the control class and the treatment class: 1) the students from the treatment class moved farther to the advanced performance level side of the rubric than did the control class, 2) the students from the treatment class showed a higher productivity rate than the control class, i.e. they turned in more work and took more tests, and 3) students from the treatment class were continually reviewing concepts from the class so they performed better on later tests that included previous concepts.

Survey, interview, and journal data indicated the small, peer-led collaborative learning groups made the work more fun and worthwhile even when doing very challenging problems. The time spent studying out of class was higher for students in the treatment group, with the rationale that working with others was more fun, more motivational and more satisfying than working alone. Treatment class students also felt they earned better grades by working together to learn the mathematical concepts.

<u>Question #4</u>

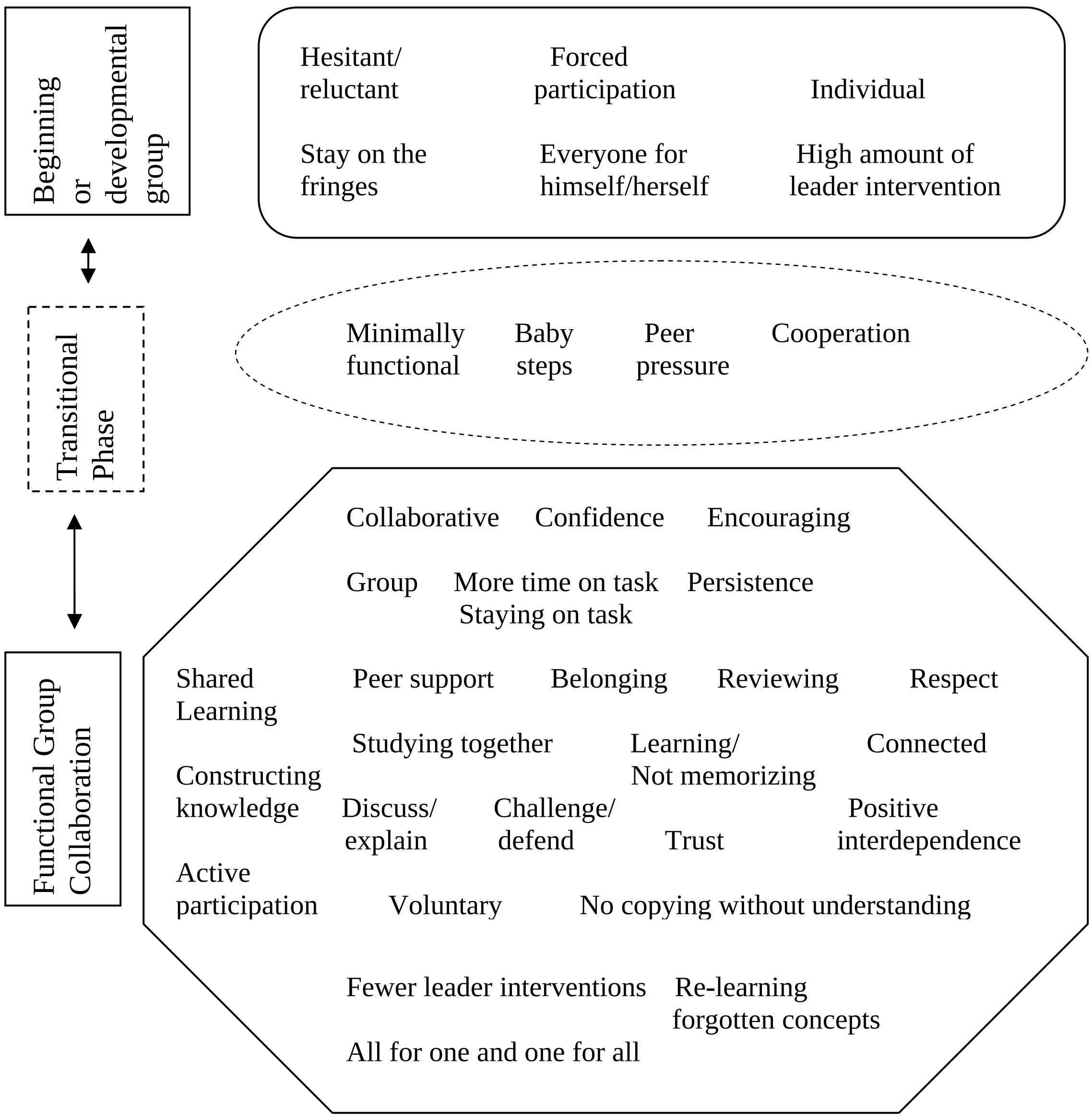
What other skills connected to the success of Native American students at a two-year Tribal Community College might be attributed to the use of small, peer-led collaborative learning groups? A combination of journal entries, student interviews and informal staff interviews were used to answer this question. The results can be split into two main categories, growth in personal or social skills and growth in academic skills. Personal and social skills that were reported to have improved were numerous. They included personality transformations such as becoming more confident, reliable, accountable, trustworthy, responsible, assertive, and having higher self-esteem. They also noted changes in their willingness to support and protect others when necessary. Many of these changes were attributed by the students to the experience in the course of having to talk in the groups, explaining the mathematical concepts or defending their methodology. Academic skills that were accepted as new or improved included becoming more vocal, having a better attitude toward their classes and hence better attendance. They identified the teamwork, including collaboration on the challenging problems, as the major contributing factor for their success. The teamwork, which began so inefficiently, eventually became a key force, and students began to use peer pressure to keep each other on task and promote the idea of learning instead of copying. Although the peer leaders continued to play a constructive role as facilitators, the students felt more confident when they talked over the mathematics within their groups and tried it out their way.

During the work with the groups the peer leaders noted patterns in the growth and development of the group as a whole. Although each group is based on the actions of individuals, the group functions as a distinct entity and patterns across the groups were fairly consistent. The peer leaders observed the growth or progression of the small group collaboration throughout the semester. The progression was not always forward, at any point a regression may occur and move the group backward as easily as forward. In the beginning the groups were often very hesitant or reluctant to perform. Each person functioned individually, and the students generally preferred to stay on the fringes, to not get involved, and to work for himself or herself only. A high amount of peer leader intervention was needed to get participation, begin to unify the group and to get the members to start to work together.

Then a transitional period occurred during which the students at began to cooperate with each other and to use peer pressure to get each other to participate. The peer leaders were needed to facilitate the group interactions, but not as frequently or as intensely as in the developmental stages of the group. This is one of the first steps the group makes toward a united functional collaborative group. From this point, the group may regress or move forward to become a functional collaborative group. There are many traits that characterize a functional collaborative group. A few of these characteristics are collaboration, respect, encouragement, support, trust, as well as discussing, explaining, challenging and defending ideas. As the notion of joint construction of knowledge or “shared learning” grows, so does the notion that no one gets left behind without understanding.

Figure 1 expresses the growth or progression of the small group collaboration as observed by the peer leaders throughout the semester.

Figure 1: Group Growth as a Distinct Entity.



The time it takes to move a group from the developmental stage to the functional collaborative group varies. The findings from this research project showed it took approximately three scheduled group meetings, distributed over three weeks in this study, to reach the transitional stage and then one or two more scheduled group meetings to move the group to being relatively functional. Not all groups moved at the same pace or achieved the same level of collaboration.

Question #5

What are the leaders' perceptions of the benefits or deficits associated with facilitating small, peer-led collaborative group learning activities? Interviews, journal entries and observations were used to address this final question. Data from the three sources were combined to present the leaders' perceptions of their changes throughout the semester. They documented the following three areas of change, although some changes fit into more than one of the areas: 1) personal, 2) academic and 3) leadership. Personal changes the peer leaders attributed to their leadership role were growth in self confidence and self esteem. By self confidence I mean the way the leaders dealt with other people and situations, compared to self esteem which is the way the leaders conceived of or valued themselves. They noted their personal relationships had changed as they became more comfortable with interpersonal communication skills. They were able to make better decisions and could be more tactful in dealings with others. Academic benefits were described solely as new ways to do mathematics. The leaders were surprised at how many different methods there were for solving problems and that they had never seen many of them. The longest list of benefits related to the leadership skills derived from being a peer leader. This included learning how to better motivate, supervise, guide, and re-direct discussions. The leaders found out they had to have very good management skills, of both personnel and time, to get through an activity. They learned to portray a positive attitude and any perceived deviation from that would cause issues within the group. Finally they were appreciative of the many varied methods they saw for learning, teaching, and working together. The only negative component of the leadership role that was mentioned was the time commitment necessary for meeting with the instructors and groups. This was turned into a time management lesson and hence ended up a learning experience as well.

Challenges and Strategies for Further Implementation

In order to sustain and/or expand the program several issues need to be addressed. The first is buy-in from faculty, staff and administration. These three groups must be convinced that there is value in implementing a program of this sort and that it could be much more successful if used on a larger scale within a single institution. It is widely recognized in colleges and universities, and especially in Tribal Colleges, that instruction in developmental mathematics classes is a major impediment to the success of huge numbers of students. Consequently, administrators and instructors alike easily accept a relatively minor improvement in performance as having “practical significance” in the light of the costs of student failure while continuing the errors of previous teaching methods. Tribal colleges are also charged with and responsible for cultural adjustments that will benefit their graduates and communities, and there are possible associated outcomes that are incidental but might have major impact on the reservation societies. An increase in the percentage of students completing a class as described in this report is meaningful but expanded across the entire mathematics curriculum or throughout the college has added potential.

The second issue that needs to be addressed is recruiting and retaining a cadre of potential peer leaders. The peer leaders in this study said they were hesitant to reapply as peer leaders for other courses due to the time commitment required, although they saw value in what they gained while acting as a peer leader. Leaders will likely find that once they have gained certain leadership skills that the time commitment decreases. The challenges of working with a group will remain but hopefully the rewards of doing so surpass the burdens. One piece of advice is not to overload the peer leaders. Often our good students over-commit themselves or are asked perform too many outside activities and their own studies suffer. It is critical that the peer leaders do not feel as if they are hurting themselves when trying to help others. And lastly, the challenge of implementing any new program may not come easily and it is important not to give up, but to seek advice if things are not working as they should be. Together we can succeed but we must model the collaborative learning environment we desire our students to follow.

Implications

Implications of this research project are relevant to several groups: instructors of mathematics in higher education, their students, college administrators, student support personnel, and researchers. Discussions of possible implications follow.

Implications for Instructors of Mathematics in Higher Education

The findings of the study indicate that the implementation of small, peer-led collaborative learning groups in developmental mathematics courses at this Tribal Community College had a positive effect on the students. Not only did the percent completion and perseverance rates improve but students seemed to have a better overall attitude toward the class and college in general.

This study supports the literature review on collaborative learning, small group work and peer-led interventions. As the social interactions become more sophisticated, there is more discussion, negotiation, questioning and exploring. The learners truly work together to solve the problem. It becomes imperative for everyone to work together to achieve a solution. The central idea behind all three types of learning, collaborative learning, small group work and peer-led interventions, is that when learners are actively taking part in their own learning, that is, actively constructing knowledge, they learn more. The learners are talking and questioning each other, moving above their "comfort zone", tearing down and restructuring the concepts in their minds. The teacher assumes the role of facilitator. Teachers and learners are learning from each other, sharing experiences. All learners are part of a small group, share in discussions, learn team-building, and gain a sense of support by the community, which increases success and retention. This may also lead to improved attitudes toward the subject (Matthew, Cooper, Davidson & Hawkes, 1995; Garfield, 1993; Hilberg et al. 2002; Smith & MacGregor, 1992; Davidson, 1985; Davidson & O'Leary, 1990; Pewewardy, 2002; Rao, 2005; Slusser & Erickson, 2006; Tinto, 1998;). The use of small groups often foster increased academic achievement, better attitudes toward learning, motivation, and persistence (Campbell, Jolly, Hoey, Perlman, 2002; Overmeyer, 2005). Peer learning is a two–way sharing of knowledge where all participants receive mutual benefits from working together (Anderson & Boud, 1996).

Instructors can examine their current practices and uncover ways to adapt their current methods to improve student understanding by incorporating an aspect of small group work, collaborative learning and/or peer led interventions. Instructors can use these findings to enhance the quality of learning that is occurring in their classes and help empower their students to achieve at a higher level. Small group work, collaborative learning and peer-led interactions can be added to any course in any amount. Each instructor will have to adapt and modify methods to fit the needs and readiness of their students, and their individual comfort level or readiness, keeping in mind a combination of the methods might produce the most overall progress. Keep in mind this will not be easy, it may be frustrating, it will take much more time than you ever imagine, the learning curve is steep, but the rewards for all involved are worth the trouble.

A positive attitude and a competent instructor are vital to the success of developmental students (Roueche & Roueche, 1999). Instructors cannot do this alone; peer-led intervention needs to be a collaborative effort between the instructors, administrators, and student support staff. Count on your support staff to help with any technical support issues. Support people are usually the ones to go to for any logistical needs, such as additional study areas and extended contact time. Explain your ideas, ask for advice and remember students interact differently with the student support staff than the instructors. The students go to the support staff for help, they ask questions and they express concerns that many instructors never hear. The support staff has a lot to offer. Use them, talk to them, discuss your plans, ask for suggestions, solicit their help, and never forget what valuable resources you have in the offices down the hall. Do not expect these changes to come easily they will be hard for both instructor and student, but persistence will pay off. Students need time to learn and adjust to new learning techniques that are not part of their traditional academic experience. Students may not initially understand why the instructor is using new methods or what benefits they might gain, but getting the students to "buy in" is an important start to any program. Once that is accomplished the path is wide open for growth.

Implications for Students

Students must be open and willing to try new techniques for learning. Give ideas a chance, make an honest effort, and look to older more experienced students for advice. Students are advised to seek courses that offer facilitated opportunities to interact with peers while engaging in challenging problem-solving exercises, and to develop the skills necessary to contribute to or help to guide these groups of peers. Whenever you first try something new remember it takes some practice before the thing becomes familiar and comfortable. Don't be afraid to push forward and move outside your comfort zone.

Implications for College Administrators

College administrators need to recognize that there are many methods for teaching and learning, and perhaps the most constructive are the most non-traditional.

Instructors need the freedom and support to teach using different approaches and try out new ideas. Administrators need to take the time to listen to the instructors, hear their ideas and provide constructive feedback. Keep an open mind and a positive attitude. Give the instructor a chance to research, try out and validate new approaches. Once an implementation has begun, the administration needs to support the instructor by checking on the progress, offering suggestions for improvement, and curtailing negative remarks that may have entered the college gossip circles. The instructors need to collaborate with each other as well as staff and administrators to achieve the best possible results. Continual communication between instructors and administrators is best for identifying and solving issues before they start. Administrators can use research to encourage instructors to try new ideas and provide professional development to the instructors willing to work toward improving student success. "No matter what component of developmental education was being studied, an emphasis on training and professional development improved its outcomes" (Boylan, 2002, p. 46).

Instructors need to be reassured that by trying new and innovative teaching methods they will not be penalized as part of their professional assessment and they may require additional time allocations that are currently not in place. Instructors must help create an atmosphere that emphasizes the importance of developmental education with other instructors and advisors so it can be passed along to the students (Boylan, 2002; Roueche & Roueche, 1999). Administrators and instructors need to take the time to share the accomplishments and challenges of new pedagogies, both within the college community and with other colleges. The implementation of any new idea, successful or not, is not complete until the forum is given and time has been taken to report the outcomes.

I would like to thank my college administrators not only for being supportive and open to new ideas, but encouraging them. Without continual interest and support from my administration this research project would have been very hard to accomplish.

Implications for Student Support Personnel

Student support personnel should be the instructor's principal and most faithful allies. Instructors and student support personnel have one very important thing in common, the reason they exist is to help the student. Collaboration between these two groups is imperative for the sake of the student. One cannot perform its function within the college environment without the other. Theirs is a symbiotic relationship that cannot be broken. That said, instructors need to work with the student support staff when developing new methods and collaborate fully to get the best feedback and advice that can be given in regard to the final product, a more successful and thriving student (Boylan, 2002; Roueche & Roueche, 1999)).

Often support staff see and hear things that the instructor does not. The students have a different relationship with members of the support staff which is valuable in collecting information that can enhance the educational process and make it more successful and effective. Each position at a college holds a puzzle piece and when all work together they can make a great picture. If each position attempts to function individually without communication with others, the college is just a mass of disconnected people. Support staff need to take the time to listen to the ideas of the instructor and offer suggestions. They need to provide instructors with honest feedback and constructive explanations, and encourage them to try new things to improve the educational experience for our students. They need to keep a positive attitude with the instructors just like they do when working with students. They need to be to working with the instructors and students in new ways. They need to be observant and report honestly and accurately to the instructor, without compromising student confidentiality.

If professional development is offered so faculty and staff can be more informed about a new program, the support staff need to embrace the opportunity and attend. All programs are more successful if everyone has had appropriate training (Boylan, 2002; Roueche & Roueche, 1999). It will not be easy for the instructor to implement a new program, and the students may at first provide the biggest resistance. Support staff need to encourage students to give it their best shot since most things get better with practice and experience. While their official title may be *student support staff*, supporting the student also means they support the instructors who teach the students.

I would like to thank the student support personnel at my college for their regular input, providing both the students and myself valuable space and information which helped improve this project and make it a success.

Recommendations for Further Research

Very little research has been published on academics and academic programs at Tribal colleges. The Tribal college offers a rich blend of indigenous culture, unique perspectives, and western principles. The interaction of these ideals provides an extraordinary mix of potential outcomes. Further study is necessary to reach more substantial conclusions.

Application Throughout a Single Curricula Area

Effective programs, like those using peer-led collaborative learning groups in developmental mathematics courses, are designed to improve student success in the current mathematics class and ultimately increase the student's success and achievement throughout their entire college experience. Extending the research treatment to cover all of the mathematics classes, developmental through advanced, may lead to a more solidified, constant, and sustained result. In one semester the students recognize the merit of group collaboration and teamwork. Given three or four semesters, the typical number of classes most Tribal College students take to complete the mathematics requirement for an associate degree, the students could become very proficient at navigating a collaborative group effort and helping a group through challenging problem solving issues. It may be that a longer period of time has a more profound influence on attitude as well.

Application Across Curricula Boundaries

Since the small, peer-led collaborative learning group experience appeared to be successful at improving achievement for students in a developmental mathematics course, why not extend this method across curricula boundaries? The Peer-Led Team Leader model that this research was based on has been adapted from a chemistry model and used on university campuses for physics, calculus and graduate classes. Research showing use in lower level classes is very limited, but the method can be adapted to fit almost any curriculum area. Including the small, peer-led collaborative learning groups in many or all aspects of an entering freshman's courses might lead to significant results in terms of overall retention.

Adding a Competitive Component

During the course of the research it has been suggested to add a component of competition to increase the motivation for collaboration within the groups. There are a variety of ways this may be accomplished. Competition between groups is a cultural norm that has been and still is a very prominent theme in some Native American tribes. Stories explain that competition between clans keeps them alert and non-complacent, striving for advantage. Various models of competition, including some adapted from traditional cultural models, could be implemented and studied.

Looking at Longitudinal Data

After two semesters of pilot treatment and data collection, data for this study was recorded for one semester in a single treatment class and one control class. Longitudinal studies following students throughout their college career to see if any of their learned group skills are employed would be an interesting extension of this research. Another possibility is to extend the study into the workplace to see if the collaborative group skills the students learned in college have an impact on their performance in jobs in the workplace during or after their course experience.

Summary

This study provides an examination of how the implementation of small, peer-led collaborative learning groups affected Native Americans learning developmental mathematics in a Tribal Community college. It is clear from the results that the students participating in the collaborative learning groups outperformed the students who did not participate in several ways: percent completion of the course, percent perseverance (sticking it out to the end), their demonstrated use of more advanced mathematical procedures throughout the semester and seemingly better attitudes toward mathematics and college in general. The results also indicate that the students involved in the small, peer-led collaborative groups felt they grew in self-confidence and self esteem. Students were more vocal and confident about defending their mathematical ideas and other issues that arose during the group sessions. The students experienced personal growth in many areas such as reliability, accountability, trustworthiness, responsibility, assertiveness, and various interpersonal communication skills. The students enjoyed being able to collaborate and work with other students on classroom activities. The opportunity to test their knowledge, and explain concepts to each other was challenging but inspiring.

Additionally, the peer leaders noted similar elements in personal growth, an increase in self confidence and self esteem. Their skills working as a leader to make decisions, motivate and supervise others developed. They felt very gratified knowing they were able to help others and at the same time increasing their group management skills, increasing their mathematical knowledge, and improving their attitude toward mathematics and the college experience.

REFERENCES

Achieve, Inc., (2005). Rising to the challenge: Are high school graduates prepared for college and work? Peter Hart Research Associated, Public Opinion Strategies, Washington, D. C. [Electronic document], Retrieved August 1, 2007 from http://www.achieve.org/files/pollreport_0.pdf

ACT, (2005). Crisis at the core: Preparing all students for college and work. ACT 2005 [Electronic document], Retrieved August 1, 2007 from http://www.act.org/path/policy/pdf/crisis_report.pdf

Adelman, C. (2004). Principal indicators of student academic histories in postsecondary education 1972-2000, US Department of Education, Washington D.C. [Electronic document], Retrieved August 13, 2007 from http://www.ed.gov/rschstat/research/pubs/prinindicat/prinindicat.pdf

AISES (1994). *Guidelines for effective mathematics and science programs for American Indian precollege students.* American Indian Science & Engineering Society (AISES) through a grant from the National Science Foundation (NSF).

Akst, G. & Hirsch, L. (1991). *Selected studies on math placement*. RRIDE, National Center for Developmental Education, Reich College of Educations, Appalachian State University, Boone NC. (ERIC Document Reproduction Service No. ED 354964).

Alleri, R. (2003*). Oregon collaborative for excellence for excellence in the preparations of teachers,* Core Institution Case Study, Portland State University, 2003,

AMATYC, (2006*).Beyond crossroads, implementing mathematics standards in the first two years of college*. The American Mathematical Association of Two-Year Colleges. [Electronic document], Retrieved April 14, 2007 from http://www.beyondcrossroads.com/

AMATYC, (1995). *Crossroads in mathematics: Standards for introductory college mathematics before calculus*. The American Mathematical Association of Two-Year Colleges. [Electronic document], Retrieved February 12, 2005 from http://www.amatyc.org/Crossroads/CROSSROADS/V1/index.htm

AMATYC, (2008*). Guidelines for the academic preparations of mathematics faculty at two-year colleges.* The American Mathematical Association of Two-Year Colleges, Position Papers. [Electronic document], Retrieved September 15, 2008 http://www.amatyc.org/documents/Guidelines-Position/GuidelinesforAcademic.htm

American Indian College Fund, (2005). [Electronic document], Retrieved April 23, 2006 from http://www.collegefund.org/colleges/main.html

Anderson, G., & Boud, D. (1996). Extending the role of peer learning in university courses. *Research and Development in Higher Education*.19.

Aragon, S. (2002). An investigation of factors influencing classroom motivation for postsecondary American Indian/Alaska Native students. *Journal of American Indian Education*, 41(1).

Arendale, D. (2004). Pathways of persistence: A review of postsecondary peer cooperative learning programs. In I. Duranczyk, J. L. Higbee, & D. B. Lundell (Eds.), *Best practices for access and retention in higher education*, (pp. 27-40). Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota. [Electronic document], Retrieved May 11, 2006 from http://www.gen.umn.edu/research/crdeul/monographs.htm

Arendale, D. (1994). Understanding the supplemental instruction (SI) model. *New directions for teaching and learning*, N60. [Electronic document], Retreived May 11, 2007 from http://www.tc.umn.edu/~arend011/SIoverview94.pdf

Ashburn, E. (2007). An $88-Million Experiment to Improve Community Colleges. *Chronicle of Higher Education*, 53(33), p32-34. (ERIC Document Reproduction Service No. EJ 763850).

Astin, A. W. (1985). *Achieving educational excellence*. San Francisco, CA: Jossey-Bass.

Baine, A., Burda, A. & Miller, S. (1997). A community approach to learning calculus: fostering success for underrepresented ethnic minorities in an emerging scholars program. *Journal of women and minorities in science and engineering.* 3(3).

Baker, S. Gersten, R. & Lee, Dae-Sik (2002). A synthesis of empirical research on teaching mathematics to low-achieving students. *The Elementary School Journal*, 103(1).

Barta, J. (1999). Native American beadwork and mathematics: *Winds of Change*, 14, Spring.

Barta, J., Abeyta, A., Gould, D. Galindo, E., Matt G., Seaman, D., & Voggessor, G. (2001). The mathematical ecology of the Shoshoni and implications for elementary mathematics education and the young learner. *Journal of American Indian Education* 40(2), 1-27.

Berke, T. (2003) Peer-led team learning an active learning strategy that works. National Education Association - Advocate Online - Thriving in Academe October 2003, [Electronic document], Retrieved July 21, 2005 from http://www2.nea.org/he/advo03/advo1003/front.html

Bradely, C. (1984). Issues in mathematics education for Native Americans and directions for research, *Journal for Research in Mathematics Education*, 15.

Boughan, K. (1995). Developmental placement and academic progress: Tracking "at-risk" students in the 1990's entering cohort. Enrollment Analysis EA95-2. MD (ERIC Document Reproduction Service No. ED 377908).

Boylan, H. (2002). *What works: Research-based best practices in developmental education.* Boone NC: Continuous Quality Improvement Network with the Nations Center for Developmental Education.

Brown, L., & Lara, V. (2007). Professional development module on collaborative learning, Texas Collaborative for Teaching Excellence, [Electronic document], Retrieved July 10, 2007 from http://www.texascollaborative.org/Collaborative_Learning_Module.htm

Bruffee, K. (1995). Sharing our toys: Cooperative learning versus collaborative learning. *Change*, 27(1) p12-18. (ERIC Document Reproduction Service No. EJ 497831).

Bruffee, K. (1993). Sharing our toys: Cooperative learning versus collaborative learning – cover story. [Electronic document], Retrieved July 10, 2007 from http://findarticales.com/p/articles/mi_m1254/is_nl_v27/ai_167397000/print

Burley, H. (1994). Persistence: A meta-analysis of the college developmental studies programs. Paper presented at the Annual Forum of the Association for Institutional Research. New Orleans, LA.

Bush, W. (2003). Bridging the gap between culture and mathematics: The Appalachian perspective. Paper presented at annual meeting of American Association of College of Teacher Education. New Orleans, LA.

Bush, W. (2003). Understanding mathematics and culture in rural contexts. (ERIC Document Reproduction Service No. ED 482729).

Buss, T. F., Redburn, F. S. & Guo, K. (2006). *Modernizing democracy: innovations in citizen participation, transformations trends in governance and democracy*. M. E. Sharp, Armonk, New York.

Butterfield, R. (1994). *Blueprints for Indian education: improving mainstream schooling.* (ERIC Document Reproduction Service No. ED 372898).

Cajete, G. (1994). "Appendix: An outline of indigenous teaching and learning orientations" in *Look to the Mountain*. Kivaki Press, Durango, CO.

Cajete, G. (1994). *Look to the Mountain*: an ecology of indigenous education. Kivaki Press, Durango, CO, 1994, p224-227.

Cajune, J. (2001). Developing culturally integrated content lessons guideline for American Indian content in Montana. Office of Public Instruction Indian Education for All publication Connecting Cultures and Classrooms developed by Sandra Fox, National Indian School Board Association, Polson MT and OPI, Fall 2006.

Cahalan, M. (1986). College level remediation. Fast Response Survey system Report No 19. Department of Education, Office of Educational Research and Improvement, Washington, DC. (ERIC Document Reproduction Service No. ED 274290).

Campbell, P.; Jolly, E.; Hoey, L., & Perlman, L. (2002). Upping the numbers: using research-based decision making to increase diversity in quantitative disciplines. (ERIC Document Reproduction Service No. ED 463714).

Cardona, C. & Artiles, A. J. (1998). Adapting classwide instruction for students' diversity in math. Paper presented at the annual convention of the Council for Exceptional Children, Minneapolis, MN. (ERIC Document Reproduction Service No. ED 421839).

Carnegie–Mellon (2007). Enhancing education. [Electronic document], Retreived October 11, 2007 from http://www.cmu.edu/academic-development/supplemental-instruction/index.shtml

Center of Educational Statistics, (2004). The condition of education 2004. [Electronic document], retrieved August 10, 2007 from http://nces.ed.gov/programs/coe/2004/section5/indicator31.asp

Chavez, M., & Maetas-Flores, M. (1991). Minority student retention: ENLACE, *New directions for Community Colleges*, N74 summer 1991.

Cheek, H. (1984). Increasing the participation of Native Americans in mathematics. *Journal of Research in Mathematics*, 15.

Chenoweth, T.G., Kinnick M.K., & Walleri, R. D. (2003). Lessons learned from efforts at institutional change: Case studies of six OCEPT institutions. [Electronic document], Retrieved July 13, 2009 from http://www.math.vcu.edu/g1/journal/Journal6/8ChenowethKinnickWalleri.pdf

Clariana, R. B. & Smith, L. J. (1989). Progress reports improve students' course completion rate and achievement in math computer assisted instruction. Paper presented at the annual meeting of the Mid-South Educational Research Association, Little Rock, AR. (ERIC Document Reproduction Service No. ED 317170).

Cohen, A. M. (1984). Mathematics in today's community college. Paper presented at the Sloan Foundation Conference on new directions in two-year colleges, Atherton, CA. (ERIC Document Reproduction Service No. ED 244656).

Collins, T. (1999). Attracting and retaining teachers in rural areas. (ERIC Document Reproduction Service No. ED 438152).

Conciatore, J. (1990). From flunking to mastering calculus Treisman retention model proves to be "Too Good" on some campuses. *Black Issues in Higher Education*, Special Report-Recruitment Retention, February 1, 1990.

Conley, D. T. (2006). *What we must do to create a system that prepares students for college success.* WestEd, Policy Perspectives. San Francisco CA. [Electronic document], Retrieved October 15, 2007 from http://www.wested.org/online_pubs/pp-06-01.pdf

Cuseo, J. (2009) Cooperative/collaborative structures explicitly designed to promote positive independence among group members, Center for Teaching, Learning & Technology, [Electronic document], Retrieved September 24, 2009 from http://www.ctlt.ilstu.edu/additional/tips/coopStruct.php

Curtis, J. (2000). Germanna Community College student outcomes assessment 1999-2000: a progress report to the Virginia community college system. (ERIC Document Reproduction Service No. ED 450860).

Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Upper Saddle River, NJ: Merrill Prentice Hall.

Creswell, J.W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed) Thousand Oaks, CA: Sage.

Creswell, J. W. (1994). *Research design: Qualitative & quantitative approaches.* Thousand Oaks, CA: Sage.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches.* Thousand Oaks, CA: Sage.

Davidson, N. (1985). Small group cooperative learning in mathematics; a selective view of research. In R. Slavin, *"Learning to cooperate: cooperating to learn*."

Davidson, N. & O'Leary, P. (1990). How cooperative learning can enhance mastery teaching. *Educational Leadership*, February.

Davison, D. (1990). An ethnomathematics approach to teaching language minority students. From Chapter 11 of *Effective Language Education Practices and Native*

Languages Survival. Edited by Reyhner. Choctaw, OK. Native American Language Issues.

Davidson, D. M. (2002). Teaching mathematics to American Indian students. A cultural approach. In J. E. Hankes & G. R. Fast (Eds.), *Changing the Faces of Mathematics. Perspectives on Indigenous People of North America* (1 ed., Vol. Ch.2, pp. 19-24). Reston, VA: NCTM.

Davis, J. (1999). Developmental course taking in community colleges. (ERIC Document Reproduction Service No. ED 430624).

Demmert W. G. Jr. & Towner, J.C. (2003). A review of the research literature on eh influence of culturally based education on the academic performance of American Indians Students. Portland OR :Northwest Regional Lab.

Dick, T., Stone, T., Firor, K., & Cavinato, A.G. (2002) Excel: peer teaching in collaborative Groups. Proceeding of STEMTEC conference pathways to Change, April 19-20, 2002, in Washington, D.C. [Electronic document], Retrieved August 10, 2007 from http://k12s.phast.umass.edu/stemtec/pathways/Proceedings/Papers/Dick-p.doc

Dillenbourg, P., Baker, M.;,Blaye, A., & O'Malley, C. (1996). *The evolution of research on collaborative learning*. [Electronic document], Retreived Augaust 15, 2005 from http://tecfa.unige.ch/tecfa/publicat/dil-papers-2/Dil.7.1.10.pdf

Dorner, C. D., & Hutton, I. (2002). Mathematics placement tests and gender bias. *College and University*. V77 N3.

Driscol, N. (2000). *Psychology of learning for instruction*, Massachusetts: Allyn & Bacon.

Duncan, H. & Dick, T. (2000). Collaborative workshops and student academic performance in introductory college mathematics courses" a study of the Treisman Model Math Excel program. *School Science and Mathematics*, V100, N7.

Ediger, J. (2005). Math excel: An educator incubator, paper written with support from WRITE ON! A writing retreat facilitated by the Oregon collaborative for excellence in the preparation of teachers (OCEPT) funded by the National Science Foundation, unpublished manuscript.

Epper, R. M. & Baker, E. D. (2009). Technology solutions for developmental math: An overview of current and emerging practices. [Electronic document], Retrieved September 15, 2009 from http://www.gatesfoundation.org/learning/Documents/technology-solutions-for-developmental-math-jan-2009.pdf

Falk, I.H. & Harrison, L.B. (1998). Community learning and social capital:" just having a little chat". *Journal of Vocational Education and Training*, 50(4).

Fast, C. (1980). Making the best better: the LCC individualized math story. Paper presented at the Oregon Developmental Educational Association, Eugene, OR. (ERIC Document Reproduction Service No. ED187371).

Fixico, D. (2003*). The American Indian mind in a linear world. American Indian Studies and traditional knowledge*. Taylor & Francis Books, Routledge, New York and London.

Flores, B., Martinez, J.R., Knaust, H., Darnell, A., Romo, L., & Della-Piana, C.K. (2003). The effectiveness of a mathematics review for student placement into college-level mathematics. Proceeding of the 2003 American Society for Engineering Education Annual Conference & Exposition.

Florida State House of Representatives (1996). An analysis of postsecondary student preparedness and remedial education needs. A Joint Interim Project of the Committee on Higher Education and the Committee on Education. (ERIC Document Reproduction Service No. ED 396633)

Ford, B. & Klicka, M. A. (1998). The effectiveness of individualized computer assisted instruction in basic algebra and fundamental of mathematics courses. Buck County Community College, Newtown, PA. (ERIC Document Reproduction Service No. ED 428962)

Freeman, M. (1997). Math and science on a personal level. Appalachian Rural Systematic Initiative. NSF (ERIC Document Reproduction Service No. ED 415936).

Freeman, M. (1998) Math Excel calculus among friends. The MathExcel Advantage. [Electronic document], Retrieved December 7, 2007 from http://www.ms.uky.edu/~freeman/mathexcel.html

Freeman, C. & Fox M. A., (2005). *Status and trends in the education o f American Indians and Alaska Natives*. National Center for Education Statistics, Jessup, Md (ERIC Document Reproduction Service No. ED485861).

Freemyer, J.; Ajamian A., & Lecuyer, J. (1995). Collaborative learning at Glendale Community College. (ERIC Document Reproduction Service No. ED338364).

Freire, P. (1970). *Pedagogy of the oppressed,* Continuum Publishing Company. NY.

Fullilove, R. E. & Treisman, P. U. (1990). Mathematics achievement among African America undergraduates at the University of California, Berkeley: An Evaluation of the Mathematics Workshop Program. *The Journal of Negro Education*, 59(3).

Gaston, J. L.(2005). Summing up a unique peer-led team learning mathematics project. Inquirer, 12. [Electronic document], Retreived November 18, 2005 from http://lib1.bmcc.cuny.edu/facres/inquirer/inquirer12.pdf

Garcia, H. (2003). From theory to practice: A case for developmental mathematics. *Research & teaching in Developmental Education.*

Garfield, J. (1993). Teaching statistics using small-group cooperative learning, *Journal of Statistics Education,* 1(1).

Gliner, J. A. & Morgan, G. A.(2000). *Research methods in applied settings: An integrated approach to design and analysis*, Laurence Erlbaum Associates, Inc., Mahwah, NJ.

Gilliland, H. 1999. *Teaching the Native American*, 4th ed. Dubuque, IO: Kendall/Hunt.

Gilmore, M., Noel A. & Stephens T.P. (1996). Progress and process in Math Excel at Northeastern University. [Electronic document], Retrieved March 29, 2009 from http://www.math.neu.edu/WWW_math/Undergrad/excel.html

Gokhale, A. (1995). Collaborative learning enhances critical thinking, *Journal of Technology Education*, 7(1), Fall 1995.

Golden, P. (2008), Positive interdependence-The heart of cooperative learning, teaching techniques, [Electronic document], Retrieved September 24, 2009 from http://tlc.ivorypalacesweddingsupplies.com/index.php?option=com_content&view=article&catid=34:teaching-techniques&id=75:positive-interdependence-the-heart-of-cooperative-learning&Itemid=68

Gosser, D., Cracolice, M., Kampmeier, J.A, Roth, V., Strozak, V., & Varma-Nelson, P. (2001*) Peer-led team learning: A guidebook*, Prentice Hall, Upper Saddle River, NJ.

Gravetter, F. J. & Wallnau, L. B. (2004). *Statistics for the behavioral sciences*, (6th edition), Wadsworth Division, Thomson Learning, Belmont, CA.

Greene, J. P. & Forester, G. (2003). Public high school graduation and college readiness rates in the United States. Education Working paper No. 3, September 2003, [Electronic document], Retrieved June 25, 2005 from http://www.manhattan-institute.org/html/ewp_03.htm

Greene, J. P. & Winters, M. A. (2005). Public high school graduation and college readiness rates: 1991-2002. Education Working paper No. 8, February 2005, [Electronic document], Retrieved July 16, 2007 from http://www.manhattan-institute.org/html/ewp_08.htm

Guthrie, L. (1992). Retention and performance of at-risk students in the California State University system. Knowledge Brief Number Ten. Far West Lab. for Educational Research and Development, San Francisco, CA., (ERIC Document Reproduction Service No. ED 357667).

Hanlon, E., & Schnieder, Y. (1999). Improving mathematics proficiency through self efficacy training. (ERIC Document Reproduction Service No. ED 433236).

Hardiman, B., & Williams, R. (1990). Teaching developmental mathematics: the interactive videodisc approach, *T H E Journal (Technical Horizons in Education)*,17(8), p. 63.

Harvey, F. A., & Charnitski, C. W. (1998) Improving mathematics instruction using technology: A Vygotskian perspective. Proceedings of selected research and development presentations at the national conference of the association for educations communications and technology. St Louis, MO, February 1998.

Haukoos, G., & LeBeau, D. (1992). Inservice activity that emphasizes the importance of the culture in teaching school science. *Journal of American Indian Education,* 32(1).

Herzog, S. (2005). Measuring determinants of student return vs dropout/stopout vs transfer: A first to second year analysis of new freshman. *Research in Higher Education*, 46(8).

Hilberg, R. S., Doherty, R. W., Dalton, S. S., Youpa, D., & Tharp, R. G. (2002). Standards for effective mathematics education for American Indian students. In J. E. Hankes & G. R. Fast (Eds.), *Changing the Faces of Mathematics: Perspectives on Indigenous People of North America* (1 ed., Vol. Ch.5, pp. 25-35). Reston, VA: National Council of Teachers of Mathematics.

Hindes, V. A., Horn, K., & Brookshaw, K. (2002) Making WAVES. Presentation at the International Conference on the First-Year Experience Synopsis, University of Bath, 2002.

Hoachlander, G., Sikora, A., & Horn, L. (2003). Community college students: Goals, academic preparation and outcomes. National Center of Educational Statistics. Postsecondary Education Descriptive Analysis Reports. Washington, D.C.

Hoffelder, A. M. , & Hoffelder, R. L. (2003). A Gender comparison of academic preparation and general chemistry success as seen in two approaches to instruction fall semester 2002 Miami University-Oxford OH.

Horn, L. & Weko, T. (2009). On track to complete? A taxonomy of beginning community college students and their outcomes three years after enrolling: 2003-2004 through 2006. A Statistical Analyses Report. Institute of Educational Sciences, NCES. Washington, D. C.

Illini Instructor Series (2004) Students learning together: Collaborative or cooperative learning. University of Illinois, Center for Teaching Excellence. [Electronic document], Retrieved July 10, 2007 from http://www.oir.uiuc.edu/Did/Resources/Illini%20Instructor/collaborative.htm

Illinois Community College Board, (1998). Remedial/developmental education in the Illinois Community College System. IL. (ERIC Document Reproduction Service No. ED416924) [Electronic document], Retrieved July 10, 2007 from http://www.iccb.org/pdf/reports/RemedialRpt1998.pdf

Illinois Community College Board, (1997). Remedial/developmental education in the Illinois Community College System: Scope, cost, structure, outcomes, and policies. IL. (ERIC Document Reproduction Service No. ED411901). [Electronic document], Retrieved July 10, 2007 from http://www.iccb.org/pdf/reports/RemedialRpt1997.pdf

ILS, (1991). Students at various levels aided by ILS, *T H E Journal (Technical Horizons in Education)*, 19(2), p 46.

INTIME (2001). Culturally responsive teaching. *Integrating new technologies into the methods of education (INTIME).*

Iowa State University, (2007). Dean of Students Office, Academic Success Center. [Electronic document], Retrieved October 11, 2007 from http://www.dso.iastate.edu/asc/supplemental/

IPEDS (2006), Little Big Horn College report.

Jacobson, E. (2006). Higher placement standards increase course success but reduce program completions. *Journal of General Education*, 55(2).

Johnson, D., Johnson, R., & Holubec, E. (1998). *Cooperation in the classroom*. Boston: Allyn and Bacon.

Johnson, D.W., & Johnson, R.T., & Stanne, M. B. (2000). Cooperative learning methods: A meta-analysis, Minneapolis, Minnesota.

Johnson, R. T., & Johnson, D. W. (1994) An overview of cooperative learning, In creativity and collaborative learning, Brookes Press, Baltimore, 1994. [Electronic document], Retrieved May 5, 2006 from http://www.co-operation.org/pages/overviewpaper.html assessed 9-24-2009

Jones, G. (2002). Academically dismissed and probation students in a two-year college for 1994 and 1998. (ERIC Document Reproduction Service No. ED 454890).

Juneau, S. (2001). *A history and foundation of American Indian education policy*. Helena, Mt.: Montana Office of Public Instruction.

Kangas, J. (1992). Success and retention rates for Gateway U classes, Spring 1992. Research Report #256. CA. (ERIC Document Reproduction Service No. ED 349049).

Karash, R. (1994-2002). Learning org dialog on learning organizations, [Electronic document], Retrieved September 24, 2009 from http://world.std.com/~lo/

Keeler, C. M., & Steinhorst, R. K. (1994). Cooperative learning in statistics. *Teaching Statistics*, 16(3), p. 81-84.

Keeler, C. M., & Steinhorst, R. K. (1995, July). Using small groups to promote active learning in the introductory statistics course: A report from the field. *Journal of Statistics Education*, *3*(2). [Electronic document], retrieved December 30, 2006 from http://www.amstat.org/publications/jse/v3n2/keeler.html

Keeler, C.M. & Voxman, M. (1994), The effect of cooperative learning in remedial freshman level mathematics, *AMATYC Review*, 16(1-2).

Keller, M. (2000). College performance of New Maryland high school graduates – Students outcome and achievement report, Maryland Higher Education Commission.

Kellogg, K. (1999). *Learning communities*. (ERIC Document Reproduction Service No. ED 430512).

Klein, B. (2005). Developing learning communities. [Electronic document], Retrieved June 14, 2005 from http://www.4faculty.org/includes/digdeeper/lesson4/learning_communities.htm

Kline, C. & Williams, E. (2007). Transitioning out of high school: A quick fact stats sheet. National High School Center. American Institutes for Research, Washington, DC 20007. (ERIC Document Reproduction Service No. ED 501081).

Koehler, G. & Burke, A. (1996). Transforming the treadmill into a staircase: preparing nontraditional first generation college attenders for success. (ERIC Document Reproduction Service No. ED 414959).

Lesnak, R. J. (1993). Using linguistics in the teaching of developmental and remedial algebra. PA (ERIC Document Reproduction Service No. (ERIC Document Reproduction Service No. ED 366383).

Lipka, J. (2002). Schooling for self-determination: research on the effects including native languages and culture in the schools. (ERIC Document Reproduction Service No. ED 459989).

Lipka, J., Hogan, M.P., Webster, J.P., Yanez, E., Adams, B., Clark S., & Lacy, D. (2005). Math is a Cultural Context: Two case studies of a successful culturally based math project. *Anthropology and education quarterly*, 36(4).

Littleton, R. Jr. (1998). Development education: Are community colleges the solution? MS. (ERIC Document Reproduction Service No. ED414982).

Lucas, J. (1993). A survey of developmental mathematical population, courses and entry requirements of American Indian higher education consortium community colleges. MA Thesis, Central Michigan University.

Maack, S. C. (2002). Basic mathematical skills research report. Rio Hondo College, Whittier, CA. (ERIC Document Reproduction Service No. ED466749).

Maack, S. C. (2002). Whatever happened to students who entered in fall 1995? Persistence at Rio Hondo College. (ERIC Document Reproduction Service No. ED 466878).

Madsen, K. (2003). So what if educations survive! Who cares and who should. Proceedings of the Annual Conference of the American Council on rural Special Education. Salt Lake City, March 2003. (ERIC Document Reproduction Service No. ED 476203).

Martin, D., & Arendale, D. (1994). Supplemental instruction (SI) Review of research concerning the effectiveness of SI from the University of Missouri-Kansas City and other institutions from across the United States. National Center for Supplemental Instruction, University of Missouri-Kansas City, Center for Academic Development, Kansas City, Missouri, January 1994.

Martinez, D. & Ortiz de Montellano, B. (1988). Improving the science and mathematic achievement of Mexican American students through culturally relevant science. (ERIC Document Reproduction Service No. ED 296819).

Mather, J. R. C. (1997). How do American Indian fifth and sixth graders perceive mathematics and the mathematics classroom? *Journal of American Indian Education*. 36(2).

Matthew, R., Cooper, J., Davidson, N., & Hawkes, P. (1995, July/August). Building bridges between cooperative and collaborative learning. *Change*, 27, p. 35-40.

Maxwell, J.A. (2005). *Qualitative research design: An interactive approach* (2nd); Sage Publications, Thousand Oaks, CA.

McCabe, R.H. & Day P.R. Jr. 9 1998). Best practices in developmental mathematics, Mathematics Special Professional Interest Network, National Association for Developmental Education.

McCleary, T. & Old Horn, D., (1997). *The social and family structure of the Apsaalooke*, Montana: Little Big Horn College.

McClenney, K. (2009). Helping Community-College Students Succeed: A Moral Imperative. *Chronicle of Higher Education*, 55(33), p60. (ERIC Document Reproduction Service No. EJ841251).

McClure, C., Redfield, D., & Hammer, P. (2003) Recruiting and retaining high-quality teachers in rural areas. AEL Policy Briefs, Charleston, West Virginia December 2003. [Electronic document], Retrieved April 19, 2006 from www.aasa.org/files/PDFs/Policy?PBRuralTeachers/pdf

Mid-continent Research for Education and Learning McREL, (2003). *Effective standards based practices for Native American students: A review of the literature*. Aurora, CO. [Electronic document], Retrieved June 5, 2008 from www.mcrel.org

Modern Language Association, (2006). A community college teaching career. [Electronic document], Retrieved March 19, 2008 from http://www.mla.org/commcollege_teachcar

Montana Office of Public Instruction (2009). [Electronic document], Retrieved March 18, 2008 from http://www.opi.state.mt.us/

Montana Office of Public Instruction, May 9, 2006, News release.

Moore, A. (1993). Computer assisted instruction, (ILS) for adults. Paper presented at the annual international conference of the National Institute for Staff and Organizational Development of Teaching Excellence and Conference

Administrators, Austin, TX. (ERIC Document Reproduction Service No. ED377897).

Moore, J. (2005). Undergraduate mathematics achievement in the emerging ethnic engineers programme, *International Journal of Mathematical Educations in Science and Technology*, V36, N5.

Moreno, S. E. & Muller, C. (1999). Success and diversity: the transition through first year calculus in the university. *American Journal of Education*. Nov 1999, 108(1).

Moses, B. (2001). Radical equations, civil rights from Mississippi to the algebra project. [Electronic document], Retrieved March 1, 2003 from www.pbs.org/now/siciety/moses.html

Muhr, C., & Martin, D. C. (2006) Team SI: A resource for integrating and improving learning. *New Directions for Teaching and Learning*, #106, Summer 2006 Wiley Periodicals. [Electronic document], Retrieved May 14, 2007 from www.interscience.wiley.com

Matusov, E., Hayes, R., & Pluta, M. J. (2005). Using discussion webs to develop an academic community of learners. *Educational Technology & Society*, 8(2).

Myers, J. (1991) "Cooperative learning in heterogeneous classes", *Cooperative Learning*, 11(4).

Myers, J. (1991). Cooperative or collaborative learning: towards a constructive controversy, *Cooperative Learning*, 11(4).

National Center of Educational Statistics (2004). [Electronic document], Retrieved March 19, 2008 from http://nces.ed.gov/programs.quarterly.vol_2/2_2/Q4-5.asp

Nelson-Barber, S. & Estrin, E. T. (1995). Culturally responsive mathematics and science education for Native students, *Regional Educational Laboratory Network.* United States Department of Education.

Neutzling, E. (2003). Crossing the finish line: A strategic approach designed to help community college students persist and graduate. Columbus State Community College, OH.

New York City Board Of Education, Office of Educational Assessment (1987). Chapter 1/P.S.E.N. Remedial reading and mathematics program 1985-86 End of the Year Report (ERIC Document Reproduction Service No. ED292906).

Noel-Levitz (2006). Student success in developmental math: Strategies to overcome a primary barrier to retention. [Electronic document], Retrieved July 11, 2008 from https://www.noellevitz.com/NR/rdonlyres/B4148B72-C135-4AD4-A04C-2F66821C872C/0/ENABLEMATH_paper_0706indd.pdf

Northeast Regional Resource Center, Learning innovations at WestEd & University of the state of New York, The New York State Education Department. (2004). Keeping quality teachers, The art of retaining general and special education teachers. Albany, NY. [Electronic document], Retrieved April 22, 2008 from http://www.vesid.nysed.gov/specialed/publications/persprep/qualityteachers/intro.htm

Ohio Board of Regents, (2006). Costs and consequences of remedial course enrollment in Ohio public higher education: 6 year outcomes for fall 1998 cohort, August 2006. [Electronic document], Retrieved August 10, 2007 from http://regents.ohio.gov/perfrpt/special_reports/Remediation_Consequences_2006.pdf

Ohio Board of Regents, (2005). Making the transition from high school to college in Ohio 2005: a statewide perspective. December 5, 2005 [Electronic document], Retrieved August 10, 2007 from http://regents.ohio.gov/perfrpt/hs_2005/HS_Transition_2005_statewide%20v2.pdf

Old Coyote, B. (personal communication, March 2004).

Olson, L. (2006). California high schoolers get preview of college –placement test. *Education week*, 25(33).

Overmeyer, G., (2005). A meta-analysis of recent literature on the effects of cooperative learning on achievement in undergraduate mathematics. Colorado State University. Master’s thesis.

Palmer, G., Peters, R., & Streetman, R. (2003). Cooperative learning. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology*. [Electronic document], Retrieved October 10, 2007 from http://projects.coe.uga.edu/epltt/ "http://projects.coe.uga.edu/epltt/index.php?title=Cooperative_Learning"

Panitz, T. (1996) A definition of collaborative vs cooperative learning. [Electronic document], Retrieved July 14, 2007 from http://www.city.londonmet.ac.uk/deliberations/collab.learning/panitz2.html

Panitz, T. (1997). Collaborative versus cooperative learning-a comparison of the tow underlying concepts which will help us understand the underlying nature of interactive learning. *Cooperative Learning and College Teaching*, V8, No. 2, Winter 1997. [Electronic document], Retrieved March 2, 2005 from http://home.capecod.net/~tpanitz/tedsarticles/coopdefintion.htm

Panitz, T. (1999). Using cooperative learning 100% of the time in mathematics classes establishes a student-centered, interactive learning environment. *Cooperative Learning and College Teaching,* 9(2), p13-14. [Electronic document], Retrieved March 2, 2005 from http://home.capecod.net/~tpanitz/tedsarticles/coopmath.htm

Panitz, T., & Panitz, P. (2004). 'Encouraging the use of collaborative learning in higher education, [Electronic document], Retrieved July 24, 2006 from http://home.capecod.net/~tpanitz/tedsarticles/encouragingcl.htm

Parker, T. (2007). Ending college remediation: Consequences for access and opportunity. *Policy Brief, Ashe/Lumina Fellows Series*. Issue 2. [Electronic document], Retrieved October 17, 2007 from http://www.elps.hs.iastate.edu/ASHE-Lumina/document/Parker%20Brief-Web.pdf

Patton, M. Q. (1997). *Utilization-focused evaluation, 3rd edition*, Sage Publications, Thousand Oaks, CA.

Payton, T. (2004). What is collaborative learning? Payton Education Consulting [Electronic document], Retrieved July 10, 2007 from http://www.tammypayton.net.courses/collab.what.shtml

Pease, J. (2000). Native ways of knowing and learning, Presentation to Crow Education Summit, Fall 2000.

Pease, J. (2005), *Introduction to the spirit of Indian women*. World Wisdom, Inc., [Electronic document], Retrieved September 24, 2009 from http://www.worldwisdom.com/uploads/pdfs/184.pdf

Pewewardy, C. & Hammer, P. (2003). *Culturally responsive teaching for American Indian student*s, ERIC ED 482325.

Pewewardy, C. (2002). Learning styles of American Indian/Alaska Native students' A review of the literature and implications for practice. *Journal of American Indian Education*, V41 N3, 2002.

Phoenix, C. (1990/1991). A four-strategy approach used to teach remedial mathematics in a freshman year program. *Community Review,* 11(1-2).

Peer-Led Team Learning (2003). Comparing the performance of groups of students with and without PLTL workshops. [Electronic document], Retrieved April 20, 2005 from http://www.sci.ccny.cuny.edu/~chemwksp/ResearchAndEvaluationComparisons.html

Radda, H., Iwanoto, D., & Patrick C. (1998). Collaboration, research, and change: Motivational influences on American Indian Students. *Journal of American Indian Education*. 37(2).

Rao, D. (2005). Learning communities: Promoting retention and persistence in college. Research to Practice Brief. National college Transition Network, *World Education,* Inc., I6.

Reglin, G., (1990). A model for education at-risk students, *T H E Journal (Technical Horizons in Education),*17(6).

Remedial/developmental education in the Kansas community colleges, Summer 1987-Spring 1988, KS. (ERIC Document Reproduction Service No. ED300078).

Reyes, R. (1998). A Native perspective on the school reform movement, A Hot Topics Paper. Northwest Regional Educational Laboratory, Portland, OR.

Reyes, R. (1991). *Indian values, attitudes, and behaviors, together with educational considerations.* The American Indian: yesterday, today, & tomorrow a handbook for educators (September, 1991), California Department of Education, Office of the Superintendent of Public Instruction (OSPI), Chapter 4, pages 21-32.

Reyhner, J. (1992). Teaching American Indian students. Norman: University of Oklahoma Press.

Reyhner, J. & Davison, D. (1992). Affective factors, *National Association for Bilingual Education, NABE News,* 16(1).

Reyhner, J. & Davison, D. (1992). Improving mathematics and science instruction for LEP middle and high school students through language activities. *Third National Research Symposia on Limited English Proficient Student issues: Focus on Middle and High school Issues*. Washington D.C. August 1992.

Rhodes, R. (1994). Nurturing learning in Native American students. Hotevilla, AZ: Sonwai Books.

Roderick, M., Nogoaka, J, & Coca, V. (2009). College readiness for all: The challenge for urban high schools. *Future of Children,* 19(1), p185-210. (ERIC Document Reproduction Service No. EJ 842068)

Roth, V., Goldstein, E., & Marcus, G. (2001) *Peer-led team learning: A handbook for team leaders.*, Prentice Hall, Upper Saddle River, NJ.

Roueche, J., & Roueche, S. (1999). *High stakes, high performance: Making remedial education work.* Washington D.C. Community College Press. (ERIC Document Reproduction Service No. ED 454939).

Rousey, A. & Longie, E. (2001). The tribal college as family support system. *American Behavioral Scientist*, 44(9), May 2001, Sage Publications.

Sarquis, J. L. & Detchon, J. C. (2004) The PLTL experience at Miami University, Volume IV: What works, what matters, what lasts, *Project Kaleidoscope.* [Electronic document], Retrieved January 12, 2006 from http://www.pkal.org/template2.cfm?c_id=1333

Sarquis, J. L., Dixon, L. J., Gosser, D. K. Kampmeier, J.A., Roth, V., Strozak, V. S., & Varma-Nelson, P. (2001) The workshop project: Peer-led team learning in chemistry. [Electronic document], Retrieved July 21, 2005 http://www.sci.ccny.cuny.edu/~chemwksp/pltl_chap.pdf

Schoenfled, A. (1992) *Handbook of research on mathematics teaching and learning.* New York, MacMillan.

School Improvement Research Series V, 1990-91 (1991). Oregon. (ERIC Document Reproduction Service No. ED347614).

Schuetz, P. (2002). Emerging challenges for community college, (ERIC Document Reproduction Service No. ED 477829).

Schmitz, J. (2006). Data Notes: Keeping informed about achieving the dream data, community colleges count, February 2006, V1N1. [Electronic document], Retrieved June 3, 2007 from http://www.achievingthedream.org/DATARESEARCH/DATANOTESNEWSLETTER/default.tp

Slavin, R. E. (1995). Research on cooperative learning and achievement: What we know, what we need to know. [Electronic document], Retrieved August 15, 2005 from http://scholar.google.com/scholar?hl=en&lr=&q=cache:P5K4_MuKUrUJ:www.aegean.gr/culturaltec/c_karagiannidis/2003-2004/collaborative/slavin1996.pdf+cooperative+slavin+madden

Slavin, R. E. (1990). Student team learning in mathematics. In N. Davidson (Ed.) *Cooperative learning in math: a handbook for teachers*. Boston: Allyn & Bacon, (pp 69-102).

Slusser, S. R., & Erickson, R. J. (2006). Group quizzes: An extension of the collaborative learning process. *Teaching Sociology*, 34(3).

Smith, B. L., & MacGregor J. T. (1992). *What is collaborative learning? collaborative learning: a source book for higher education*. National Center on Postsecondary Teaching, Learning and Assessment, Pennsylvania State University. [Electronic document], Retrieved December 4, 2006 from http://www.evergreen.edu/washcenter/natlc/pdf/collab.pdf

Soleste, H. R., & Tharp, R., (2002) *Theoretical perspectives, research findings, and classroom implications of the learning styles of American Indian and Alaska Native students.* (ERIC Document Reproduction Service No. ED 468000).

Springer, L., Stanne, M., & Donovan, S. (1999). Effects of small-group learning on undergraduate in science, mathematics, engineering, and technology: A Meta-analysis. *Review of Educational Research,* 69(1).

St. Phillips College, (1992). College solves problem of mandated remediation. *T H E Journal (Technical Horizons in Education),* 19(8).

Stern, S. (2001). Learning assistance centers: Helping students through. (ERIC Document Reproduction Service No. ED 455910).

Strijbos, J. W. (2000). A classification model for group-based learning. Educational technology expertise center (OTEC) Open University of the Netherlands, Heerlen, The Netherlands. [Electronic document], Retrieved July 10, 2007 fromhttp://www.eurodl.org/materials/contrib/2000/strijbos/strijbos.html

Strutchens, M. (1995). Multicultural mathematics: a more inclusive mathematics. (ERIC Document Reproduction Service No. ED 380295).

Suh, T., Fore, R. (2002). The national council of teacher quality: expanding the teacher quality discussion. (ERIC Document Reproduction Service No. ED 477730).

Sumner, P. (2001) JCCC drop study/attrition rates fall 2000, Office of Institutional Research, Overland Park Kansas.

Swisher, K. (1991). American Indian/Alaska Native learning styles: Research and practice. (ERIC Document Reproduction Service No. ED 335175).

Swisher, K. (1990). Cooperative learning and the education of American Indian/Alaska Native students: ArReview of the literature and suggestions for implementation. *Journal of American Indian Education,* 29(2).

Swisher, K., & Deyhle, D. (1989). The styles of learning are different, but he teaching is just the same: suggestions for teachers of American Indian youth. *Journal of American Indian Education,* special ed 1989.

Swisher, K., & Tippeconnic, J., (1999). Research to support improved practice in Indian education. (ERIC Document Reproduction Service No. ED 427915).

Tharp, R. & Yamauchi, (1994). Effective instructional conversation in Native American classrooms. National Center for Research on Cultural Diversity and Second Language Learning, Educational Practice Report 10. CREDE UC Berkeley.]Electronic document], Retrieved August 21, 2009 from http://escholarship.org/uc/item/1596250w

The Oxford Universal Dictionary, (1955). Oxford, England.

Thomas, P., & Higbee, J. (1996). Enhancing mathematics achievement through collaborative problem solving. The Learning Assistance Review, *The Journal of the Midwest College Learning Center Association*, 1(1), Chicago IL.

Tien, L. T., Roth, V., & Kampmeier, J.A. (2002). Implementation of a peer-led team learning instructional approach in an undergraduate organic chemistry course, *Journal of Research in Science Teaching*, 39(7), p. 167-177.

Tinto, V. (1998). Colleges as communities: taking research on student persistence seriously. *Review of Higher Education*, 21(2).

Tinto, V. (2003). Learning better together: The impact of learning communities on student success. In Promoting Student Success in College, Higher Education Monograph Series (pp. 1-8). Syracuse, NY: Syracuse University. [Electronic document], Retrieved September 22, 2009 from http://faculty.soe.syr.edu/vtinto/Files/Learning%20Better%20Together.pdf

Tinto, V. (1998). Learning communities: building gateways to student success,. *The national teaching & learning forum*, May V7, N4. [Electronic document], Retrieved August 21, 2009 from http://www.ntlf.com/html/lib/suppmat/74tinto.htm

Tinto, V., & Goodsell-Love, A. (1993). Building community, *Liberal Education*, Fall 93, 79(4).

Tribal College Catalog, (2007). *Little Big Horn College catalog 2007-2009*, Crow Agency, MT.

Tribal College AKIS Report, (2007). Little Big Horn College, Crow Agency, MT.

Trumbull, E., Nelson-Barber, S. & Mitchell, J. (2002). Enhancing mathematics instruction for indigenous American students. In J. E. Hankes & G. R. Fast (Eds.), *Changing the Faces of Mathematics: Perspectives on Indigenous People of North America* (1 ed., Vol. Ch.5, pp. 25- 35.). Reston, VA: National Council of Teachers of Mathematics.

TSET-2005 (2006). *Tribal college and universities program STEM education indicators and highlights*. 2005, Norwood MA, Systemic Research, Inc.

U.S. Dept. of Ed. Office of Research (1992). Office of Research Education, Consumer Guide, Number 1, June 1992. [Electronic document], Retrieved August 15, 2005 from http://www.ed.gov/pubs/OR/ConsumerGuides/cooplear.html

Uysal, F. (2007). A comparison of the success of vocational school students in basic mathematics based upon their method of placement in university. *Educational Sciences: Theory and Practice,* 7(2).

Vaughn, S., Linan-Thompsom, S., Pollard-Durodola, S. Mathes, P., & Cardenas H.E. (2006). Effective interventions for English language learners at risk for reading difficulties. In S. S. Newman & D. K. Dickinson (EDS.) *Handbook of early literacy research*. Vol 2, (pp 183-194). New York: Guilford Press.

Viadero, D. (2005). Math Emerges as Big Hurdle for Teenagers: High School Improvement Hinges on Critical Subject, Education week, 24(28), p1 (ERIC Document Reproduction Service No. EJ 75946).

Vogt, W. P. (1999). *Dictionary of Statistics & Methodology: A nontechnical guide for the social sciences, 2nd edition*, Sage Publications, Thousand Oaks, CA.

Wauters, J., Bruce, J., Black, D., & Hocker, P. (1989). Learning styles: A study of Alaska Native and non-Native students. *Journal of American Indian Education.* Special Edition, 1989.

Waycaster, P. (2001). Community college collaborative on developmental mathematics. Presented at NADE 25th annual conference. Louisville KY, 2001.

Waycaster, P. (2001). Factors impacting success in community college developmental mathematics courses and subsequent courses. *Journal of Research and Prac*tice, V25.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge, United Kingdom: Cambridge University Press.

Wenglinsky, H. (2000). How teaching matters: Bring the classroom back in discussions of teacher quality. Milken Family Foundation & Educational Testing Service. A Policy Information Center Report, October 2000, Princeton, New Jersey.

Winograd, P. (2007). Ready for College 2007: A Report on New Mexico high school Graduates who take remedial classes in New Mexico colleges and universities.

Office of Educational Accountability, Department of Finance and Administration, Santa Fe New Mexico. June 28, 2007

Young, K. (2002). Retaining under prepared students enrolled in remedial courses at the community college. (ERIC Document Reproduction Service No. ED 467850).

APPENDICES

APPENDIX A:

STUDENT PARTICIPATION FORM. BEGINNING OF SEMESTER.

SUBJECT CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH AT MONTANA STATE UNIVERSITY

Project: Implementing small peer led collaborative learning groups in developmental mathematics course at a Tribal Community College.

You are being asked to participate in a research study on the implementation of small peer led collaborative learning groups in developmental mathematics courses at a Tribal Community College. This study will help educators understand how the use of small peer led collaborative group learning effects the learning of the students involved in the groups. You have been chosen because of your interest in tutoring and mathematical background.

If you agree to participate, you are agreeing to the following obligations:

1. You will conduct weekly 1-2 hour workshops sessions as scheduled for groups of 6-8 developmental mathematics students.
2. You will attend weekly 1-2 hour workshop training sessions with the mathematics instructors. During these sessions we will discuss many things such as group dynamics, how to encourage participation, mathematics concepts, and work through weekly activities.
3. It will be necessary for you to prepare for weekly workshop sessions by reading through the work shop materials, bringing them to the scheduled sessions, and keep a weekly journal (leader log) of your group's interactions and experiences.
4. You will informally evaluate the progress of individual group members via leader logs, 1-3 page journal reports containing your experiences during the workshop with your groups of students. The journal reports will make it possible to follow your progress as a leader and your student's progress throughout the semester.
5. It is necessary to maintain attendance records for the workshop sessions so there is record of who was present and participating.
6. You will participate in debriefing sessions and discussions about the workshops via journal, this will be combined with the 1-2 hour sessions with the instructors.
7. Journal entries will be used to help follow changes throughout the semester.

We want you to know that:

1. Your participation is confidential and voluntary.
2. You may choose not to participate without penalty.
3. You will be compensated financially for this study at the same rate per hour as other tutors at LBHC. Participating in this study may have some general benefits in that you will be contributing to the improvement of student learning. Participating in this study may also provide you with new ideas about working with others, how to better facilitate a discussion, small group dynamics, better understanding of

mathematical concepts, increase in confidence, satisfaction, interest in teaching, career change, and gratification.,

4. The risks for participating in this study are minimal. This may include risks such as feeling uncomfortable leading groups and discussing your experiences.
5. Your decision to participate/not to participate in this study will have no effect on your scholastic record at Little Big Horn College.
6. All data collected from you and personal information will be kept confidential and secured in locked offices or in password protected computers. No one outside the principal investigator and approved research staff will have access to your information. Your privacy will be protected to the maximum extent allowable by law.
7. In research papers or other public presentations resulting from this study, your name will not be used and any identifying characteristics or personal information that could be used to identify you will be deleted or masked. It is highly unlikely that anyone would be able to identify you from any published report, although it is slightly possible that another LBHC employee might read a report based on this study and recognize your remarks. Your privacy will be protected to the maximum extent allowable by law.
8. If you have any questions or concerns regarding your participation in this study you can contact me at:
   Dianna Hooker, Mathematics Instructor/Department Head, Office room number 111, Seven Stars Learning Center, Little Big Horn College, Crow Agency, MT 59022 406-638-3142
   If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Institutional Review Board Chair, 960 Technology Blvd., Room 127, Bozeman, MT 59717. For information and assistance, call 406-994-6783.

Your signature below indicates your voluntary agreement to participate in this study.

===

Participant's Signature ________________________________ Date _____________

APPENDIX B:

STUDENT PARTICIPANTS AT MIDTERM AND END OF SEMESTER SURVEY.

Student Survey

Peer-Led Team Learning **Institution______________________**
Course Name_______________ **Instructor_____________________**

For each item circle the number that corresponds to your response: 1 – Strongly disagree; 2 = disagree; 3 = neutral (no opinion); 4 agree; 5 strongly agree.

1. The Workshops are closely related to the material taught in the lectures. 1 2 3 4 5

2. Workshops help me do better in tests. 1 2 3 4 5

3. Interacting with the Workshop leader increases my understanding. 1 2 3 4 5

4. The Workshop materials are helpful preparation for exams. 1 2 3 4 5

5. The Workshop materials are more challenging than most textbook problems. 1 2 3 4 5

6. I believe that the Workshops are improving my grade. 1 2 3 4 5

7. I regularly explain problems to other students in the Workshops. 1 2 3 4 5

8. Interacting with other group members increase my understanding. 1 2 3 4 5

9. I would recommend Workshop courses to other students. 1 2 3 4 5

10. In understanding the Workshops I am comfortable asking questions when I do not understand something. 1 2 3 4 5

11. The instructor encourages us to participate in the workshops. 1 2 3 4 5

12. The Workshops are often dominated by one or two students. 1 2 3 4 5

13. Noise or other distractions make it difficult to benefit from the Workshops. 1 2 3 4 5

14. Students who are uninterested or unmotivated make it difficult for others to benefit from the Workshops. 1 2 3 4 5

15. I feel comfortable with the Workshop leader. 1 2 3 4 5

16. The Workshop leader is well prepared. 1 2 3 4 5

17. I am uncomfortable asking questions in the lecture. 1 2 3 4 5

18. The Workshops are a big help in solving problems.	1 2 3 4 5
19. I would like to be a Workshop leader in the future.	1 2 3 4 5
20. In the Workshops I enjoy interacting with the other students.	1 2 3 4 5
21. The workshop experience led me to join formal or informal study groups related to other courses.	1 2 3 4 5

Circle the appropriate response on the 1-5 scale, as specified in the following questions.

22. On average, I spend the following number of hours per week studying (in addition to time spent at lectures and workshops):

1. 0-2 hours 2. 2-4 hours 3. 4-6 hours 4. 6-8 hours 5. 8-10 hours

This next item is about the materials used in the workshops.
Use the following scale: 1 = materials do not meet this objective at all; 2 = materials somewhat meet the objective; 3 = materials meet the objective rather well; 4 = materials meet this objective very well; 5 = materials are excellent for meeting this objective:

The materials are:

23. well connected with lectures	1	2	3	4	5
24. challenging	1	2	3	4	5
25. developed to review fundamentals	1	2	3	4	5
26. useful for group work	1	2	3	4	5
27. motivational	1	2	3	4	5
28. helpful for individual study	1	2	3	4	5
29. Useful for reinforcing concepts.	1	2	3	4	5

Rate each of the following activities according to the amount of Workshop time devoted to the specified activity.
Use the following scale: 1 = almost no time; 2 = 2 a small amount of time; 3 = a moderate amount of time, 4 = a large amount of time; 5 = most of the time.

30. The workshop leader presents ideas and methods.	1	2	3	4	5
31. The leader responds to student questions.	1	2	3	4	5
32. Students work on problems in pairs or small groups.	1	2	3	4	5
33. Students work on problems alone.	1	2	3	4	5
34. Students present solutions.	1	2	3	4	5
35. Hands-on activities.	1	2	3	4	5
36. Technology and computer simulations.	1	2	3	4	5

Thank you for your participation

Modified from the Peer-Led Team Learning: A guidebook.

APPENDIX C:

INTERVIEW QUESTIONS FOR SMALL PEER-LED COLLABORATIVE LEARNING GROUPS.

END OF SEMESTER QUESTIONS.

Interview questions:

1. Describe the participation in your small peer-led team learning group. Talk about how each member of the group participated and the role of the leader. What were the best contributions and what were the worst distractions. Suggest how we can improve this for the next semester.

2. The content of the Workshop activities was designed to compliment your regular class work and help you better understand how the concept being presented plays a role in real life. Do you think that the Workshop materials were beneficial to your learning and applying the concepts? Give an example or two of how the workshops helped you better understand the mathematics content. Which Workshop was the most helpful and why? Which Workshop was the least helpful and why?

3. Compare the small peer led learning group experience with your other experiences both in and out of school. Does the interaction with others in the small peer led group change the way you view or feel about learning? What type of learning situations work best for you? How do you think this type of learning might be helpful in others areas study?

APPENDIX D:

PEER-LEADER TRAINING. BEGINNING OF SEMESTER.

Training for Peer Group Leaders.

Peer Leaders are hand picked students who have completed the course successfully with a grade of A or B not more than three or four semesters before now. They are not tutors who explain how to do each problem or additional teachers who are expected re-teach the material covered in class, but peer-leaders to help guide other students through a learning process. The peer leaders are support for the members of their group, their purpose is to encourage, motivate, mediate, and offer ideas and suggestions to the group to help them learn. Training is necessary in two parts: initial and on-going. The initial training is necessary to help the peer-leaders learn what their role is and how they can best perform it. The on-going training will be done in one hour sessions each week through out the semester. Initial training topics are listed below. On-going training sessions are three-fold; first to discuss any issues that may have arisen in the groups the previous week and brainstorm ways to overcome them should they present themselves again. Secondly, to familiarize the peer group leaders with the material to be covered each week during the group sessions and give them a chance to practice it and become acquainted with any difficulties and problems that might arise. Third, time will be allotted to discuss any of the ideas brought up during the initial training sessions that is of further interest or needed more discussion.

Topics for the initial Training Sessions:

1. The role of the group leader.
2. The basics of group dynamics.
3. Basic theory.
4. Listening skills and questioning techniques.
5. Learning Styles.
6. Reflective teaching.
7. Teaching tools.
8. Race, class, and gender issues.
9. Disability issues.

It would be nice to touch on all these topics at least in passing before the first actual group meeting. Then more detail can be given to the topics as needed. Each is presented in a more detail below along with several references that might be useful in addressing various topics. This training needs to be separate from the tutor training. Tutors are not peer-leaders, which is one point that must be included in the peer-leader training.

1. The role of the group leader.

This session will begin with discussion of how a peer-leader differs from that of a tutor, teaching assistant or instructor. How does the peer leader make this fact known to his or her group members? The next issue is boundaries and availability. The peer leader needs to decide when they will be available for their groups and when is off limits. There is also an issue of confidentiality between the peer group leader and the group members so it is not advisable to get too personal with them. These boundaries need to be discussed. Being prepared for these issues before they come up makes the role of the group peer leader much easier.

2. The basics of group dynamics.
This includes many topics such as motivation, personality, attitude, size of group, etc., many things can discussed. Also discussed is the use of ice breakers to help get the group to interact. Collaborative learning concepts.

3. Basic theory.
This is a short lesson on how college student learn and develop both personally and intellectually. Several models have been proposed, Perry, Vygotsky, Gagne, for example. It is important to provide to provide several examples of how this development can help or hinder success in college.

4. Listening skills and questioning techniques.
This is a very important aspect of successful peer learning, being a good listener. It is a skill that must be taught to most people. Techniques to help understand the questions being asked or to clarify the problem. Listening to what is being said, watching the group dynamics and body language are all part of this topic.

5. Learning Styles.
This area of discussion is very large and often well understood by the group leaders. It is helpful to review the different type so learning styles and possibly even have the peer group leaders take a test to determine what kinds of learners they are. Seeing the diversity between each other and talking about what works best for each of them provides insight into the students they will be working with.

6. Reflective teaching.
This is a discussion about how to help the group leaders be better leaders next week or next time. Explain how to reflect on what happened in each group session and let the group leaders provide suggestions on how each might have handled a situation differently. This should naturally come up in the journals each group leader will be keeping for the group sessions.

7. Teaching tools.
a. Drawing pictures, or modeling. This often helps clarify what the problems are about and offer ideas on what might help to solve the problem.
b. Concept Mapping. Diagram that demonstrate how connect various concepts are related often provide ideas that help solve problems. They might suggest similar concepts

that have known solutions or identify related concepts that help connect the understanding.
c. Smaller group problem solving. If the whole group is not functioning well, it is sometimes helpful to break into smaller groups. Pairs of learners help give everyone a chance to contribute either as a listener or speaker.

8. Race, class, and gender issues.
In our college gender is probably the biggest issue here. There are also cultural concerns that need to be addressed. These issues should be discussed so our group leaders are not caught unaware when these issues arise.

9. Disability issues.
In the case of disability issues we need to attempt to accommodate all our students learning needs. The most common of these might be hearing or visual disabilities. This is often tied to learning styles and may need to be individually addressed when the situation comes up.

Progressions: Peer-Led Team Learning. The Workshop Project Newsletter, has many helpful articles that can be used as a starting point in the peer leadership training. A list of the articles I have chosen to be used follows:

A. Stages of Group Dynamics by Linda Dixon, Vol. 1, Issue 4.

B. Relational Leadership and Its Usefulness to the Workshop Model by Cheryl Rice, Vol. 1, Issue 4.

C. Building an Emotional bond: Part of a peer Leader’s Role by Arleeann Santoro, Vol 4, Issue 1 & 2.

D. Motivation in the Workshop: How can Leaders Use This Knowledge? By Chris Richard, Vol. 2, Issue 3.

E. Training Leaders at Portland State University by Gwen Shusterman and Carl Wamser, Vol. 3, Issue 1.

F. Vygotsky’s Zone of Proximal Development: A theory base for peer-led team learning, by Mark Cracolice, Vol. 1, Issue 2.

Copies of these articles are attached.

References:

Gosser, D.K.; Cracolice, M.S.; Kampmeier, J.A.; Roth, V.; Strozak, V.S.; Varma-Nelson, P. 2001, Peer-Led Team Learning A Guidebook.

Gold Stein, E., Progressions: Peer-Led Team Learning. The Workshop Project Newsletter. Peer Leader Training, V2. N2. Winter 2001. www.pltl.org

Progressions: Peer-Led Team Learning. The Workshop Project Newsletter. www.pltl.org

APPENDIX E:

GROUP LEADER SURVEY MIDTERM AND END OF SEMESTER.

Self Rating Checklist

Please rate your leadership and your Workshop sessions according to the following questions. Feel free to make additional comments and observations at any point. Note that you are not being asked to put your name on this form so please be candid in your replies.

	Very Seldom	Some Times	Often	Almost Always
1. I understand the goals of the Workshop program.	1	2	3	4
2. I understand the professor's goals for the modules and for the course as a whole.	1	2	3	4
3. I prepare well for the workshops	1	2	3	4
4. I can get the workshops sessions started easily.	1	2	3	4
5. I am happy with the amount of control I have in the Workshop (not too much, not too little).	1	2	3	4
6. I am patient.	1	2	3	4
7. All the students participate on a regular basis.	1	2	3	4
8. I am adept at keeping the conversation going among the students.	1	2	3	4
9. I am good at asking questions that help students approach the problems.	1	2	3	4
10. My students look to me for help the appropriate amount of time (not too often, not too seldom).	1	2	3	4
11. The Workshop students talk easily with one another.	1	2	3	4
12. I am able to tell people they are incorrect in a constructive way.	1	2	3	4
13. I am confident about my explaining the material when it is appropriate for me to do so.	1	2	3	4
14. I know how to handle it when someone asks me a question I can't answer.	1	2	3	4

15. My Workshop stays on task the right amount of time each week.	1	2	3	4
16. I can get the students back on track when they get distracted.	1	2	3	4
17. I am able to break the tension when needed: I can keep the stress within the group at a manageable level.	1	2	3	4
18. I help students see connections between old and new material.	1	2	3	4
19. I take different learning styles into account when I plan a workshop session.	1	2	3	4
20. I treat all students fairly.	1	2	3	4
21. I keep tabs on individual student's progress with the workshops problems.	1	2	3	4
22. I know how to make referrals to other campus resources when necessary.	1	2	3	4
23. I think about the possible impact of race, class, and gender issues on students learning.	1	2	3	4
24. If I had a student with a disability in my Workshop, I would know how to plan for support for him/her in my Work shop sessions.	1	2	3	4
25. I maintain a positive attitude.	1	2	3	4

Other comments:

Modified from the Peer-Led Team Learning: A guidebook.

APPENDIX F:

PEER LEADER SURVEY. END OF SEMESTER.

Leader Survey

Peer-Led Team Learning **Institution______________________**
Course Name____________ **Instructor_________________**

1. How often do Workshops meet?__________
2. What is the scheduled length of a Workshop meeting?_____________
3. On average, How long do you usually meet?____________
4. How many students are enrolled in your workshop?_______________
5. On average, how many students usually attend a Workshop?___________
6. What do you think is the best number of students for a workshop? ____________
7. Attendance at the workshop (is , is not) a course requirement?
8. About how much of your time per week is taken by workshop preparation and activities, not including the workshop itself? _______________________
9. Please describe the activities as they take place in a typical workshop?

Rate each of the following activities according to the amount of Workshop time devoted to it.
Use the following scale: 1 = almost no time; 2 = 2 a small amount of time; 3 = a moderate amount of time, 4 = a large amount of time; 5 = most of the time.

10. The workshop leader presents ideas and methods.	1	2	3	4	5
11. The leader responds to student questions.	1	2	3	4	5
12. Students work on problems in pairs or small groups.	1	2	3	4	5
13. Students work on problems alone.	1	2	3	4	5
14. Students present solutions.	1	2	3	4	5
15. Hands-on activities.	1	2	3	4	5
16. Technology and computer simulations.	1	2	3	4	5

17. Are Workshop problems good preparation for tests? Please describe.

18. Do Workshop materials include challenging problems? Please describe.

19. Were the Workshop materials too difficult or too easy for students in your group? If so, what did you do?

This next item is about the materials used in the Workshops.

Use the scale from 1 to 5 according to how well they meet each objective: 1 = materials do not meet this objective at all; 2 = materials somewhat meet the objective; 3 = materials meet the objective rather well; 4 = materials meet this objective very well; 5 = materials are excellent for meeting this objective:

The materials are:

20. well connected with lectures	1	2	3	4	5
21. challenging	1	2	3	4	5
22. developed to review fundamentals	1	2	3	4	5
23. useful for group work	1	2	3	4	5
24. motivational	1	2	3	4	5
25. helpful for individual study	1	2	3	4	5
26. Useful for reinforcing concepts.	1	2	3	4	5

27. What methods are used to get students working together?

28. What do you do for students having difficulty?

29. Did students sometimes discuss personal problems with you? If so how did you respond to them?

30. What training and support are provided to leaders in how to run Workshops, for example in group dynamics or instructional processes?

31. What training and support are provided to the Workshop leaders in the knowledge of the discipline?

32. What training and support are provided to the Workshop leaders in theories of learning and related methods of teaching?

33. What parts of student leader training have been most useful? What do you need more of?

34. How do you interact with the instructor teaching the Workshop course?

Modified from the Peer-Led Team Learning A guidebook.

Peer-Leader focus group interview questions. End of semester.

What has being a peer leader taught you about the teaching processes?

What were problems/challenges you faced as a peer leader?

How has being a peer leader influenced your learning style?

What do you think your strengths are as a leader?

When did you feel the most successful/most helpful and why?

When you did you feel the least successful/frustrated and why?

What were the most difficult sessions for you?

What are the most significant or important abilities/skills that you have developed by being a peer tutor?

Describe an event where you used one of the abilities or skills you listed above during a workshop session.

Do you think these abilities or skills will be useful in your future and how?

Has being a peer leader changed the way you study for your own classes? If so how?

Did you notice any changes in your relationships with students in your group as the semester progressed both in school and out of school?

Have your academic interests changed as a result of being a peer leader?

How would you describe your experience a peer leader to other potential future peer leaders?

What would you say was the best thing about being a peer leader? What was the worst thing?

Has your peer leader experience allowed you consider teaching as a career option?

APPENDIX G:

WORKSHOP ACTIVITIES # 1-14

PreAlgebra Lab #1 Name ____

Please work on this with the group of students from your class. Also list the other students who are working on it with you on the back of this page.

We are studying integers in class. We use integers in many ways and often exact answers are not needed so we estimate the answers. The first problems you will do have two parts, an estimate and an exact answer. Read the problems carefully so you know when to estimate and when an exact answer is wanted.

Some examples of estimates:

A. The average drop in temperature from July to January is 56 degrees. We would round this to 60 degrees.

B. Kathy lost $135 gambling (playing poker on line). This would be rounded to $100 or $150. Explain these two possible ways to round Kathy's loss.

C. According to the latest US census, there will be 300,118,000 people in the United States by the year 2010. The most likely way we would round this number would be to 300 million.

Often estimates are very helpful and much easier than exact answers.

Try these problems. Write an expression to show how you get your answers.

1. Leslie has a monthly take home pay of $1674.39. She wants to establish a budget so she knows she will be able to pay her bills and put the rest into a savings plan. She will spend $525.00 for rent, $ 400 for food, $300 for child care, $197.00 for transportation costs, $150 for miscellaneous expenditures. How much does she have left to put into her savings plan?

Estimate:

Exact:

2. A club has had several plate sales to raise money for a trip. The first plate sale made $235.00, the second made $117.00, the third made $482.00 and the fourth made $311.00 How much money does the club still need to raise to meet their goal of $2475.00 for the trip?

Estimate:

Exact:

3. A truck loaded with firewood weighed 8763 pounds. If the firewood weighed 2498 pounds, how much does the empty truck weigh?

Estimate:

Exact:

4. The temperature outside began at 42 degrees at six o'clock in the morning. The temperature has risen 25 degrees by noon, and then it rose another 13 degree by two o'clock in the afternoon when it began to cool off. It cooled down 3 degrees by dinner time and another 18 degrees by bedtime. What was the temperature at bedtime?

Estimate:

Exact:

5. The highest point in Montana is Granite Peak at 12,799 feet above sea level. The lowest point in Montana is where the Kootenai River leaves the state at 1,800 feet above sea level. What is the difference in elevation in Montana between the highest point and the lowest point?

Estimate:

Exact:

6. If the temperature drops from -3° F to -21° F, how many degrees did the temperature drop?

Estimate:

Exact:

7. Pythagoras was a Greek philosopher who made important developments in mathematics, astronomy, and the theory of music. He was born in about 569 B.C. and lived till 475 B. C. How old was Pythagoras when he died?

Estimate:

Exact:

8. Students are always checking books out of our library. The following is a table of the transactions that have taken place this week:

Day	Checked out	Returned
Monday	15	22
Tuesday	6	3
Wednesday	37	15
Thursday	12	7
Friday	16	21

What is the net change in the number of books the library has for this week?

Estimate:

Exact:

9. Jon earned $48 on Saturday. On Sunday he spent $21, and then made $17 more by mowing a lawn. How much does he have left?

Estimate:

Exact:

10. An elevator went up 3 floors, down 7 floors, down 13 more floors, down 18 floors and up 8 floors. It stopped on the 35th floor. On what floor did it start?

Estimate:

Exact:

Now some quick problems to end up with.

A. How many years from 11 B.C. to 32 A.D.?

B. Using the Fahrenheit scale for temperature, water boils at 212° F and it freezes at 32° F. What is the temperature halfway between boiling and freezing?

C. Your child has a temperature of 102°F. Normal body temperature is 98.6° F. The doctor told you to call if the temperature was more than 5 ° above normal. Do you need to call the doctor?

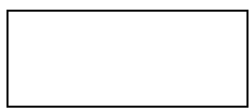
D. A march through town drew participants as they walked along. At the beginning of the march there were 42 people walking, after one block 11 more had joined the walk. At the end of the second block 15 more joined, but 3 quit. After the third block 20 more started walking, but 7 quit. The next block had a drinking fountain so 25 stopped for a drink and no on new started. How many people were still walking after they passed the drinking fountain?

Workshop #2 Pre-Algebra Name________________________________

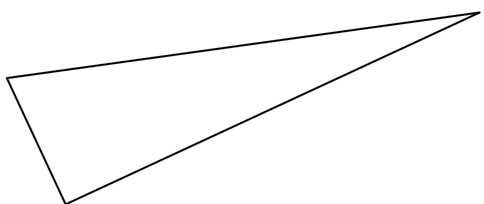
Perimeters and Areas

The perimeter is the distance around an object. It does not matter what shape you have, you measure the distance around the outside. If the shape is a polygon, just add up the lengths of the sides and you have the perimeter.

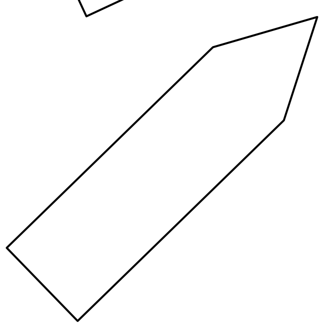
Examples:



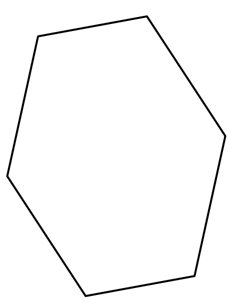
The perimeter of this rectangle is the sum of all four sides. Add them together and you get:
3 + 5 + 3 + 5 = 16
Perimeter is length. It represents the distance around so you must label it using length measurements such as inches, centimeters, feet, etc.



The perimeter of this triangle is the sum of all three sides. Add them together and you get:
5 + 12 + 13 = 30



This polygon has five sides so it is called a pentagon, to get the perimeter; you add the lengths of all the sides:
4x + 7y + 3 + 3 + 7y = 4x + 14y + 6



How many sides does this polygon have?
The perimeter is found by adding the lengths of all the sides, the same as for the other shapes.
The perimeter of this hexagon is:
5a +5a + 3 + 5a + 5a + 3 = 20a + 6

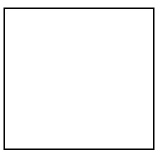
Perimeters are used when we talk about how long a piece of fence is needed to enclose a yard, or how long is the line around the football field. We walk the perimeter of a garden instead of walking through the middle of it.

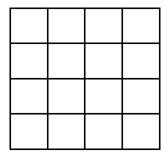
The area of a rectangle is found by multiplying the base and the height. This formula works for any shape that can be classified as a rectangle. What is a rectangle?

Is a square a rectangle?

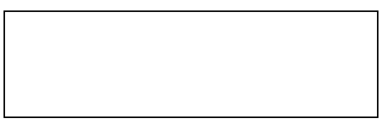
Here are a couple examples of area:

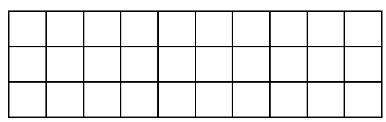
Notice that because the sides of the first square are both 4 units in length, when you draw in the square units you end up with 16 square units. If each side was 4 inches, we would multiply 4 inches x 4 inches and get 16 square inches, sometimes written as 16 inches squared or 16 inches^2.



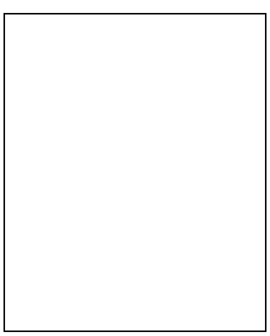


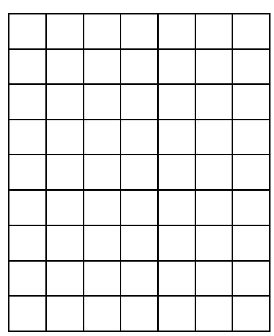
This time the dimensions are 3 units by 10 units so when you draw in the square units there are now 30 of them. It is important to report your answer to area using square units, such as square inches, square meters, or square miles, etc. In this case pretend they represent city blocks, we would multiply 3 city blocks by 10 city blocks and get 30 square city blocks.





Here is a rectangle that has a base with length of 7 and a height of 9. To get area we multiply 7 x 9, so the area is 63 square units. My paper is 7 centimeters by 9 centimeters so the area is 63 square centimeters.





Now try some problems, be careful to decide if the problem is asking for perimeter or area. Label your answers with the correct label. If you do not have a picture please draw one before you solve the problem.

1. Find the perimeter of the following figure:

2. Find the perimeter of a rectangle with sides 1 foot by 3 feet.

3. A family room is in the shape of a rectangle with dimensions 12 feet by 17 feet. There is one 3 foot wide door into the room. The family needs to measure the perimeter so they can put up a kick board along the bottom of each wall. How many feet of kick board do they need to buy? If the kick board costs 26 cents per linear foot, how much will this cost?

4. Charlie just joined a baseball team and was wondering how far it was to run all the way all around the bases in the case of a home run. He knows it is 90 feet between bases and the baseball diamond is really square turned sideways. How far will Charlie run if he hits a home run?

5. A neighborhood wants to make the area safer for their children; they have built a playground on a rectangular lot that is 18 yards long by 24 yards wide. The final touch is to put a nice fence around the playground. How much fence is needed? If the fence costs$6.89 per yard, how much will it cost?

6. Jill would like to put new carpet in her living room. The room measures 11 feet by 13 feet. How much carpet does she need?

7. Kelly has to stay after school as wash the boards at school. There are 4 white boards in the classroom and each measure 4 feet by 8 feet. What is the total area of white boards that Kelly must wash?

8. An official basketball court 28 yards long by 15.25 yards wide. A regulation volleyball court is 18 meters by 9 meters. Which court is bigger, and by how much?

9. Soccer and football teams often have to share the same practice field. Soccer fields are 110 yards long and 80 yards wide. Football fields are 120 yards long (including the goalposts) and 53 feet wide. Which sport uses the field with the largest area?

10. What will it cost to buy a rectangular lot if the length is 1320 ft and the width is 528 feet if one acre of ground sells for $5250? Hint: 43560 square feet = 1 acre)

PreAlgebra MA 071 Workshop #3 Name ________________________________

Pick a number between 1 and 10.
Multiply it by 2.
Add 6.
Divide by 2.
Subtract the number you started with.
The result will always the same.

What is the result?

Try this with several different numbers:

Number started with	Result

Why do you always get the same number?

Does this work if you start with a negative number? Try it a couple times.

Number started with	Result

There are lots of variations on this type of mathematics puzzle.

Pick a number between 1 and 10.
Multiply it by 4.
Subtract 8.
Divide by 2.
Subtract the number you started with, twice.
The result is 4.

Do you need to pick a number between 1 and 10 or would any number work?

Order of operations problems: These are classic problems on most standardized tests.

These are tough so be careful!!!!!!!!!!!!!

Remember:

( ) parenthesis

Exponents

x / in order from left to right

+ - in order from left to right.

1. $2 + 4 \cdot 3 \div 2 + 5 =$

2. $5 + 5 \cdot 5 – 5 \div 5 =$

3. $50 – 8 \cdot 5 + 6 \div 3 =$

4. $24 – 8 – 6 \cdot 2 \div 4 =$

5. $24 – 8 \div 4 \cdot 2 + (3)4 =$

6. $-3 - -2 \cdot 2 - -2 \div -2 =$

7. $-3 – (-2 – 4 \cdot -5) =$

8. $-4(b – 3) – 2(b + 1) =$

9. $3x – 2(5x – 4) =$

10. $-6 (2x – y) + 3(-3y – x) =$

11. $4 – 3(4x – 3y) -3(-2x +3y) =$

Evaluate for the value given: (simplify first then substitute in the values)

12. $-5a^2 + 6 + 8a^2 – 7$ for $a = -1$

13. $-4(2a^2 –b) – 5(b-a^2)$ for $a = -2$ and $b = -1$

14. $6(2x – 3) – 5(3x -2)$ for $x = 3$

PreAlgebra Workshop #4 Name ___________________________________

Solving equations has a lot of applications to real life.   First we have to be able to convert our sentences into mathematical symbols. Once that is done it is not hard to solve the equations and find solutions.

Let's first figure out some vocabulary:

If we talk about a number but do not know what value it is, that is the *unknown*, often this gets named *x* in the problem.

When we use terms like *times, multiplied by, twice as much*, etc., they mean to *multiply*.

Greater than, longer than, more than, taller than, plus, all mean to *add.*

Subtract, less than, shorter than, smaller than, all mean to *subtract.*

Is nearly always means *equal*.

This should help you get started.

If you have a number and add 5 the answer is 24.

x   +   5   =   24 Easy to solve from here. Solve it.

If you multiply a number by three and subtract four the answer is fourteen.

3x   -   4   =   14   Now solve it.

Twice a number is seven greater than the number itself.

2x   =   7   +   x   Solve it.

A class had 23 students enrolled. The instructor wants to divide the class into 3 groups to work on problems together. The problem is that 2 students often miss class so they can not be counted on as part of the group. How many people should be in each group? (Write an equation for this first then solve and see the answer matches what you think it should)

A club is going to have a plate sale chili, and frybread. Since Grandma is making the fry bread and everyone loves Grandma's frybread they need twice as many pieces of frybread as they need bowls of chili. They plan to put chili in one bowl and each piece of frybread in a separate bowl, how many pieces of frybread do they need if they have 156 bowls?

The rodeo team has held a number of events to raise money for two members to attend a rodeo. They have $450.00 to split between the two members. It has been decided by the team that Mark should get $75.00 more than John because Mark is driving the truck. How much money does each individual get?

Steven has 540 feet of fencing. He needs to enclose a rectangle for his dogs that is twice as long as it is wide. What dimensions should he make this fence?

The custodian at the college had 11 packages of light bulbs on hand. He replaced 29 burned out light bulbs in the hallways and 7 in offices. There were eight bulbs left. How many were in each package?

The bookstore had ordered 6 boxes of red pens. The store sold 32 red pens last week and 35 red pens this week. Five red pens were still on the shelf. How many pens were in each box?

There were eighteen donuts on the table in the lounge at 10:00 am registration day. While no one was looking some students came by and ate some of them. The registrar noticed the donuts were nearly gone so at 10:30 he added three dozen more. Now there were 49 donuts on the table. How many were eaten by the students when no one was watching?

With Halloween coming we all try to anticipate how many children will stop up at our door. It is better to have candy left over than to run out. Last year I brought 5 bags of candy to my office for the children who come by trick or treating. Altogether I had 38 children stop at my office. I handed out 2 pieces to each child and had forty-four left over for faculty and staff. How many pieces of candy were in each bag?

Workshop Activitiy#5   Name ____

Jack and Jill are twins who happen to be in the same mathematics class. This is very helpful because they often use each other to check the answers they get. Often they do not check answers till the problems get hard. Each one works the problems out the best they can. When they get done they check answers. This is a super way to see if they understand the mathematics concepts. If their answers do not match exactly they try to figure out why. See if you can help them figure out why some do not match.

Jack and Jill are working on simplifying a problem.

Jack solved his problem this way:	Jill solved the same problem like this:
8(2x + y) - (7x + 3) = 16x + 8y - 7x + 3 = 23x + 8y + 3	8(2x + y) - (7x + 3) = 16x + 8y - 7x - 3 = 23x + 8y - 3

Because they got different answers for the same problem, some one must have made a mistake. Who was it? What did they do wrong?

A little later Jack and Jill were solving a problem.

Jack solved his problem this way:	Jill solved the same problem like this:
5 + 2 (3 - 4x) = 27 2 (3 - 4x) = 22 6 - 8x = 22 -8x = 16 x = -2	5 + 2 (3 - 4x) = 27 5 + 6 - 8x = 27 11 - 8x = 27 -8x = 16 x = -2

They did get the same answer this time, but they do not do the problems the same way. Can they both be correct? Please explain why or why not.

Jack solved his problem this way:	Jill solved the same problem like this:
3(2x - 1) - (x - 7) = -15 6x - 3 -1x - 7 = -15 5x - 10 = -15 5x = -25 x = 5	3(2x - 1) - (x - 7) = -15 3x - 1 - x + 7 = -15 2x + 6 = -15 2x = -21 x = -10.5

This time Jill says to Jack that he must be right because she does not think that she should be getting a decimal answer. Is Jack right, did Jill make a mistake? Explain what you think. Follow each step closely. This one has both Jack and Jill confused.

Because they got lost on the last problem they decide to go back and try some easy ones. Here are the first 5 problems they each did at the beginning of the assignment. You should try each one and compare what you did with what they did.

Jack solved his problems this way:	Jill solved the same problems like this:
1. 4x - 5 = 19 4x = 24 x = 6	1. 4x - 5 = 19 4x = 24 x = 6
2. 7 + 2x = -3 2x = -10 x = -5	2. 7 + 2x = -3 2x = -10 x = -5
3. 3(2x - 5) = 13 6x -15 = 28 6x = 12 x = 2	3. 3(2x - 5) = 13 6x - 5 = 13 6x = 18 x = 3
4. 16 = -4(3x + 2) 16 = -12x + 8 24 = -12x -2 = x	4. 16 = -4(3x + 2) 16 = -12x + 2 14 = -12x 14 /-12 = x

5. 5 - (x - 6) = 11 5 - x - 6 = 11 11 - x = 11 x = 1	5. 5 - (x - 6) = 11 5 - x + 6 = 11 11 - x = 11 x = 1

Do these problems help you figure out why Jack and Jill have different answers?

Look at the mistakes that Jack has made on the problems. Do you notice a pattern in what he does? Explain to him what you see and how he can correct the problems.

Look at the mistakes Jill has made on her problems. Is there a pattern for them? How can you explain what she is doing wrong?

Workshop #6 PreAlgebra Name ____

Polynomials are mathematical expressions that are used to represent many things in real life. We use them to explain the motion of objects and the cost of goods.

Before we can do much with polynomials we need to have a common language to talk about them. We need to define some vocabulary.

First, what is a polynomial? One definition is "A polynomial is a mathematical expression involving a sum of powers in one or more variables multiplied by coefficients." [1] This is not much help if you don't define some of the vocabulary in the definition and give a few examples.

Examples of polynomials:

$5x^2 + 3x – 8$

$x + 4$

-18

$x^3 + y^4 – 7x^2 + 8y^3 – 5x + 2$

Do they look familiar? In book 2 we learned how to add, subtract, and multiply them together. We just never really named them.

Back to our definition: The "sum"of powers in one or more variables is the part that has + or – signs between different parts of the polynomial. The different parts connected by the + or – signs are called terms.

$5x^2 + 3x – 8$ has 3 terms, $5x^2$, $3x$, and $– 8$

$x + 4$ has 2 terms, x and 4

-18 has only one term, -18

$x^3 + y^4 – 7x^2 + 8y^3 – 5x + 2$ has 6 terms, x^3, y^4, $– 7x^2$, $8y^3$,$– 5x$, and 2

The "powers" in one of more variables are the exponents for each variable. We talk about the power or degree of each term and for the whole polynomial. Each term of $5x^2 + 3x – 8$ has its own degree. The degree of $5x^2$ is 2 because the exponent is 2. The degree of $3x$ is 1 because $x = x^1$, this would make the power 1. And the degree for the last term of -8 is 0, because $x^0 = 1$. The power is 0.

Now you find the degree for each term of: $x^3 + y^4 – 7x^2 + 8y^3 – 5x + 2$

Once we have determined the degree of each term we use the biggest one to determine the degree of the entire polynomial. So for $5x^2 + 3x – 8$, the degree of the polynomial is 2, and for $x^3 + y^4 – 7x^2 + 8y^3 – 5x + 2$, the degree of the polynomial is 4.

The last word that we use quite often when talking about polynomials is the coefficient. The coefficient is the number in front of each variable for each term. Since $5x^2 + 3x – 8$ has 3 terms of $5x^2$, 3x, and – 8; each has a coefficient. The coefficient of $5x^2$ is 5, the coefficient of 3x is 3 and the coefficient of – 8 is -8.

Without having common words to use it is very hard to be sure we are talking about the same things. Much the same as if you are dropped in any specialty world. Consider someone who has no knowledge of basket ball but you throw them into the game and expect them to play on your team. They do not even know that the basic object of the game is to get the ball into basket. They don't know ground rules like you can't kick the ball or run with the ball. Before you can play you have to explain a few things. That is what we so with mathematics as well.

Different plays in basketball have different names, so do different polynomials. A polynomial with only 1 term is called a monomial. If it has 2 terms than we call it a binomial and one with 3 terms is called a trinomial.

Here are some examples of polynomials and a short description of what they tell us:

a. $-16t^2 + 80t + 5$ this trinomial could provide us with the height of an arrow shot out of a bow at the speed of 80 feet per second from a grown man's arms about 5 feet above the ground. The variable t stands for the time in seconds since the arrow was released.

b. $-16t^2 + 24t + 7$ is a trinomial that would give us the height of a basketball shot from the players reach of about 7 feet up at the speed of 24 feet per second. Again, t represents the time the ball has been in the air since it was released.

c. $x^2/20 + x$ is a binomial that gives the stopping distance of a moving vehicle in feet. The variable x is the speed of the vehicle in miles per hour and the answer to the binomial is how many feet it will take that vehicle to stop on a dry paved road.

If you are in a car traveling 25 miles per hour how far does it take to stop?

If you are in a car traveling 75 miles per hour how far does it take you to stop?

Based on this information, how close should you be to the car in front of you?

Do you think the stopping distance would be the same on a dirt road? Explain.

Do you think the stopping distance would be the same on winter roads? Explain.

d. $x^2/2 – x/2$ is a binomial that is used when tournaments are scheduled. This expression tells you how many games need to be played based on the number of teams or players, x for a round robin tournament. A round robin tournament is where each team plays every other team.

How many games need to be played in a round robin 3 on 3 basketball tournament if 7 teams want to enter?

How many games if 25 teams are entered?

How is this different from the way tournaments are laid out for hand games?

1. Weisstein, Eric W. "Polynomial." From *MathWorld*--A Wolfram Web Resource. http://mathworld.wolfram.com/Polynomial.html

Workshop #7 PreAlgebra Name ____

At the beginning of the semester the first thing we did was to identify prime numbers and then we factored whole numbers into their prime factorization. This was very helpful for reducing fractions.

Remember these factor trees:

Since then we have moved past integers and on to polynomials. These we also like to have factored into the smallest parts, which are lower degree polynomials, polynomials with fewer terms or just smaller coefficients.

The first thing we try to do with factoring is look for a common factor in each term. This might be an integer, a variable or a combination of both.

Here are a couple examples:

$6x + 9$ is a polynomial with a common factor in both terms. The integer that is common to both is 3. So we factor out the 3, and $6x + 9$ becomes $3(2x + 3)$.

$10x^2 – 35x + 20$ has a common factor. What is it? ______ (what number can you divide each term by?)

Factor it out. _____ $(2x^2 – 7x + 4)$

$3x^2 + 7x$ also has a common factor, but it is not an integer. If not an integer it must be a variable. What variable is common to both terms of $3x^2$ and $7x$?

So when $3x^2 + 7x$ is factored it becomes $x(3x + 7)$.

Often common factors contain both integers and variables.
$8x^3 + 10x^2 – 14x$ is factored into $2x\,(4x^2 + 5x – 7)$

$35y^4 – 42y^3 = 7y^3(5y + 6)$

Here are a few for you to try:

$8a + 10$	$6b^2 + 15$
$13f^2 + 20f$	$3x^2 + 12x + 3$
$2xy + 5x$	$8x^2 – 11x$
$9x^3 + 12x^2 – 6x$	$24x^5 – 18x^3 + 30x^2$

We also have other types of factoring that are used very frequently with polynomials. Many polynomials do not have common factors, but can still be factored.

For instance you have had a lot of practice multiplying binomials together and ending up with a trinomial.

$(x + 2) (x + 5) = x^2 + 7x + 10$ and $(x – 3) (x + 1) = x^2 – 2x – 3$

This means there are a lot of trinomials that can factored into the product of two binomials.
$x^2 + 7x + 10$ factors into $(x + 2) (x + 5)$ and $x^2 – 2x – 3$ factors into $(x – 3) (x + 1)$.

These are a little different, but you have the knowledge and tools to be able to factor them. Think of it as just multiplying backwards. Lots of thing in life you can do forward and backward: getting dressed in the morning and undressed at night, going to the store then coming home, making your bed and unmaking it to wash the linens.

So let's try backwards step by step.

$x^2 + 10x +21$ = What two numbers multiply together to get 21?
(x + 3) (x + ____) they also need to add together to get 10.

ALWAYS check your answer, takes about 10-15 seconds, multiply your factors back together $(x + 3)(x + 7) = x^2 + 7x + 3x + 21 = x^2 + 10x + 21$, exactly what we started with.

$x^2 + 7x + 6$ = What two numbers multiply together to get 6 and add together to get 7?
(x + ____) (x + ____)

ALWAYS check your answer, multiply the factors back together and make sure it was what you started with! (x + ____) (x + ____) =

The more you do the easier it gets. Just like tying your shoes. It was really hard when you learned how at 4 or 5 years old, but now you can even do it in the dark! You have had lots of practice. You can even do it with big fat rope or tiny thin thread. The basic principle does not change, same with factoring polynomials.

$x^2 - 11x + 40$	$x^2 - 7x + 10$
$x^2 - 2x + 1$	$x^2 - 3x - 40$
$x^2 - 6x + 18$	$x^2 + 7x - 8$
$x^2 + x - 30$	$x^2 + 5x - 14$
$x^2 - 9x - 22$	$x^2 + 13x + 40$
$x^2 - 10x - 24$	$x^2 - 6x + 9$
$x^2 + 4x - 21$	$x^2 + 8x + 15$
$x^2 - 4$	$x^2 - 49$

Workshop #8 Pre Algebra Name ________________________________

Three brothers were trying to multiply some polynomials. They each did 5 problems then decided to stop and check their answers.

Here is what each did:

A	B	C
$3x(x+4)$ $= 3x^2 + 4$	$3x(x+4)$ $= 3x^2 + 24$	$3x(x+4)$ $= 3x^2 + 12x$
$(x+2)(x+3)$ $= x^2 + 6$	$(x+2)(x+3)$ $= x^2 + 3x + 2x + 6$ $= x^2 + 5x + 6$	$(x+2)(x+3)$ $= x^2 + 6 + 2x + 3x$ $= x^2 + 6 + 5x$
$(x-1)(x+4)$ $= x^2 - 4$	$(x-1)(x+4)$ $= x^2 + 4x - 1x - 4$ $= x^2 + 5x - 4$	$(x-1)(x+4)$ $= x^2 - 4 + 4x - 1x$ $= x^2 - 4 + 3x$
$(x-5)(x-7)$ $= x^2 + 35$	$(x-5)(x-7)$ $x^2 - 7x - 5x + 35$ $x^2 + 12x + 35$	$(x-5)(x-7)$ $= x^2 + 35 - 7x + 5x$ $= x^2 + 35 - 12x$
$(2x-5)(2x+5)$ $= 4x^2 - 25$	$(2x-5)(2x+5)$ $= 4x^2 + 10x - 10x - 25$ $= 4x^2 - 25$	$(2x-5)(2x+5)$ $= 4x^2 - 25 - 10x + 10x$ $= 4x^2 - 25$

Look carefully at what each brother did. Do you see a pattern for how A multiplied his binomials? What did he do? Is it correct? Explain. (Brother A thinks that Brothers B and C are too slow)

How did Brother B do? Do you see a pattern in what he was doing? Is it correct? Explain.

Brother C had similar answers to Brother B. What is pattern? Is it correct? Explain.

Once they got the got multiplication figured out, they switched to factoring and gave that a try. Look through the way they factored and see how the Brothers did.

A	B	C
$2x + 6$ $= 2(x + 3)$	$2x + 6$ $= 2(x + 6)$	$2x + 6$ $= 2x + 3$
$4y - 4$ $= 4(y - 1)$	$4y - 4$ $= 4(y - 4)$	$4y - 4$ $= 4y$
$12x - 28y$ $= 4(3x - 7y)$	$12x - 28y$ $= 2(6x - 14y)$	$12x - 28y$ $= 4x\ 3 - 7y$
$16x^2 + 72x + 16$ $= 4(4x^2 + 18x + 4)$	$16x^2 + 72x + 16$ $= 8(2x^2 + 72x + 2)$	$16x^2 + 72x + 16$ $= 16x^2 + 5x$
$x^2 + 3x + 2$ $= (x + 2)(x + 1)$	$x^2 + 3x + 2$ $=(x + 1)(x + 3)$	$x^2 + 3x + 2$ $= (x + 2)(x + 2)$
$x^2 + 9x + 20$ $= (x + 4)(x + 5)$	$x^2 + 9x + 20$ $=(x + 9)(x + 11)$	$x^2 + 9x + 20$ $= (x + 20)(x + 9)$
$x^2 - 7x + 12$ $= (x + 3)(x + 4)$	$x^2 - 7x + 12$ $=(x - 3)(x + 4)$	$x^2 - 7x + 12$ $= (x - 7)(x + 12)$
$x^2 + 2x - 24$ $= (x + 6)(x - 4)$	$x^2 + 2x - 24$ $= (x + 8)(x - 5)$	$x^2 + 2x - 24$ $= (x + 2)(x - 12)$

How did Brother A do? Is there a pattern that you see in how he factored the polynomials? Explain.

Brother B got different answers than Brother A, what did he do? Can you find what he is doing wrong; is it the same in each problem? Explain.

Brother C got done first this time. For some reason they seem to think everything is a race and the first one done always wins. Explain what Brother C was doing and then write him a note about how to get the correct answers.

Workshop #9 PreAlgebra Name ____

Rational numbers are any numbers that can be written in the form of a fraction. Most of the numbers you use everyday are rational numbers. ½ , ¾, 5 = 5/1, 0.5 = ½, etc.

We also use rational expressions, these are polynomials divided by other polynomials. Before we get started with the rational expressions there are a couple concepts that we should review. In solving these problems you will have reviewed some of the concepts necessary for success with rational expressions.

Write down how you get each answer not just the answer. Show your work!

A. Since pies are an all time favorite, Sally made sure there were lots at the feed. Each one was cut into 8 pieces. After everyone left and they were cleaning up there were still 2 pieces of apple pie, 1 piece of banana cream pie and 3 pieces of pumpkin pie left over. If the leftovers were all put together, would you have more or less than a whole pie? Write the fraction that represents the amount of pie left over.

B. Mary needs three yards of material to make her daughter a dress. She has 1 ¾ yards of the blue material she needs. Her sister bought a few yards of the same material at the same time and has agreed to give her some. How much does Mary's sister need to give her so Mary has enough to make the dress?

C. Some kids were playing in the yard and drew a big round circle in the dirt. This was their teepee. With some imagination the adults could picture the poles and canvas, but to the children it was real. There were 4 children, but not all the same age. The oldest claimed half the area for himself. The next oldest child said she got 1/4 of the area. The third in line said she wanted1/5 of the area since she was 5 years old. How much of the total area did the youngest child get?

D. George's mother is ½ Crow and his father is 1/4 Crow, how much Crow is George?

Possible interest:
Many Indian tribes continue to employ blood quantum in their own current Tribal laws to determine who is eligible for membership in the tribe. These often require a minimum degree of blood relationship and often an ancestor listed in a specific Tribal census from the late 1800s or early 1900s. The Eastern Band of Cherokee Indians of North Carolina, for example, require an ancestor listed in the 1924 Baker census and a minimum of 1/32 Cherokee blood inherited from their ancestor(s) on that roll. Meanwhile the Western Cherokee require applicants to descend from an ancestor in the 1906 Dawes roll (direct lineal ancestry), but impose no minimum blood quantum requirement. The Ute require a 5/8 blood quantum, the highest requirement of any U.S. tribe, while the Miccosukee of Florida, the Mississippi Choctaw and the St. Croix Chippewa of Wisconsin all require 1/2 "Tribal blood quantum". At the other end of the scale, the Mashantucket Pequot of Connecticut and the Sac and Fox of Oklahoma both require 1/16, whereas the Confederated Tribes of the Grand Ronde Community of Oregon require a combined minimum of 1/16 from any of a list of several Oregon indigenous peoples. A 1/4 blood requirement is by far the most common, along with requirements of "Lineal descendency" which do not specify any minimum Tribal ancestry.[1]
1. Wikipedia® is a registered trademark of the Wikimedia Foundation, Inc.

E. If half of my algebra class has already finished the test and 2/5 of the remaining students will be done in the next 3 minutes, what fraction of the students will still be working on the test?

F. John was riding out to check his fence. The first stretch was 2 ¾ miles long, the second side was 3 1/8 miles long and the last side was 2 ½ miles long. John did not have to worry about riding the last side of the fence because his land bordered the highway and he can see that from the road. How far did John ride if he followed the fence out and back?

G. The commute to the college is 13 ½ miles from my house. In one week, Monday – Friday, how far do I drive in just commuting miles?

H. If you spend ¼ of your day working, 1/8 of your day eating, 3/16 of your day at school, what fraction of your day is left? Out of that fraction what part of your day do you spend sleeping?

I. Write out a short review, to give to a friend who was not here today, that explains how you add, subtract, multiply and divide fractions.

Workshop #10 PreAlgebra Name ____

Simplifying rational numbers is very similar to simplifying fractions. The big difference is that the expressions not integers so when you factor them you have polynomials to cancel out not just integers.

A & B did the following problems. They were asked to reduce or simplify each problem. Check what they did and help them to it correctly next time.

A	B
$\frac{18}{30}$ $\frac{9}{15}$	$\frac{18}{30}$ $\frac{3}{10}$
$\frac{6x^2y}{15xy^5}$ $\frac{2x}{3y^4}$	$\frac{6x^2y}{15xy^5}$ $\frac{2x}{3y^6}$
$\frac{36a^2b^3}{20ab^4}$ $\frac{18a}{10b}$	$\frac{36a^2b^3}{20ab^4}$ $\frac{9a}{5b}$
$\frac{2x+8}{4}$ $\frac{2x+4}{2}$	$\frac{2x+8}{4}$ $\frac{2(x+4)}{4}$ $\frac{x+4}{2}$

$\dfrac{x^2+3x-40}{x^2-25}$	$\dfrac{x^2+3x-40}{x^2-25}$
$\dfrac{3x-40}{-25}$	$\dfrac{(x+8)(x-5)}{(x-5)(x+5)}$
	$\dfrac{(x+8)}{(x-5)}$

$\dfrac{x^2-x-12}{x+3}$	$\dfrac{x^2-x-12}{x+3}$
$x2 - 4$	$\dfrac{(x-4)(x+3)}{(x+3)}$
	$(x-4)$

Is either of them simplifying correctly? What would you say to the one who is having trouble, how could you explain things to help that person understand better?

Workshop #11 PreAlgebra Name ____

Inequalities

Work together to solve the following problems:

A. David has two possible job opportunities. The first offers him $8.00/hour. The second job pays $6.50/hour for hours between 8am and 5pm, but $10.00/hour for hours after 5pm. Which job would be best for David? Explain.

B. I have a piece of string 200 inches long. What is the longest piece I can cut off and still be able to make two pieces at least 32 inches long? Explain.

C. If you want to earn an A in this class you must earn at least 90% of the total number of points possible. If 800 points are possible how many points do you need to earn an A?

So far, you have received the following test scores: 82, 94, 92, 89, 71, 98, and 96. What score do you need on the final test in order to earn an A in this class?

D. You have a choice of two long distance phone companies. The first charges $0.30 for the first 5 minutes then $0.12 cents a minute after that for each call. The second charges $0.20 per minute. Which would be our best choice and why?

Is there a situation when both companies would charge the same amount? Explain.

E. List 5 situations where we use inequalities but do not specifically state the inequality. Such as highway signs that say “maximum speed 75, minimum speed 45.” We do not write speed limit $45 < x < 75$, but this what we mean.

1.

2.

3.

4.

5.

Workshop #12 PreAlgebra Name ____

The average driver drives about 12,000 miles each year. Most data for rural areas like this show rural drivers drive more miles. The average price of gasoline is $2.84. Let x represent the number of miles per gallon your car gets. Write an equation for the amount you spend on gasoline for one year.

Now write an equation for how much you will spend on gasoline if your car get 5 extra miles per gallon. (Can you name a few ways to get better gas mileage?)

If you currently get 25 miles per gallon and you increase your mileage by 5 miles per gallon, how much will you save in 1 year?

How much money would you save if you drove 20,000 miles per year?

Based on the info you calculated above, would it make sense to trade in your current car on one that got better gas mileage? Explain.

Workshop #13 PreAlgebra Name ____________________________________

At 8:00 John begins walking down a trail to the lake. He is walking at the rate of 8 yards per minute. His sister begins to walk 10 minutes later at the rate of 12 yards per minute. What time will it be when she catches her brother?

Proportions can be used to solve many problems. Here are a few you might try this with.

If you use 3 pieces of paper to take notes for one hour, how many pieces of paper will you need for 5 hours? Write an equation to solve this problem.

If one can of paint covers 180 square feet, how many cans are needed to cover three walls with a total area of 432 square feet?

It takes ¾ cup of brown sugar to make one batch of chocolate chip cookies. How much brown sugar is needed for a triple batch?

A television commercial says a product is “recommended by 4 out of 5 doctors”. If they did a poll of 360 doctors, how many would recommend the product?

Hot Wheels (the little metal cars that our kids play with) are 1:64 scale models of the real thing. If a Hot Wheel car is 2 ¼ inches long, how long is the "real thing"?

How tall would you make a model human that should go in that Hot Wheel car?

Some things in nature are very hard to measure just because they are hard to catch. A study was recently done on the Big Horn River that said the number of brown trout has dropped from 8000 per mile in 1998 to about 500 per mile in 2003. This huge drop in fish numbers is mainly due to the drought we have had. The less precipitation, the lower the water level in the river. Trout like lots of cool water and thrive with that environment, as the area gets less water; there is less water available for the river.

The question is; How do the scientists find out how many fish there are per mile? They can't catch them all! They can't shock them all! So how are they counted? The most common method is to catch some, mark them, and release them. For example, if I catch, mark, and release 37 fish on a one mile stretch of river this week. Then next week I can try again, I am only interested in counting the number of marked fish. How many did I catch this week that I caught a week ago and marked. Using this information I set up a ratio to calculate the total estimated number of fish per mile.

The first week I marked 37 out of N fish in the one mile stretch. The second week I caught say 5 marked fish out of the 37 marked fish in that stretch of river.

$$\frac{37}{N} = \frac{5}{37}$$

This equation will give you the estimated number of fish in that mile of river, about 274 in this example.

The same technique is used to count many types of wild animals.

You want to determine how many elk are on a 400 square mile plot of ground. You decide to trap and mark animals from a representative 2 square mile plot of ground. It was a successful day; you trapped 24 elk and tagged 7 of the animal. Several weeks later you go back to the same region and catch elk again. This time you find 3 of the elk were already tagged. How many elk would you estimate were living on the two square mile plot of ground? Then use that to estimate how many elk you expect to find on the entire 400 square mile range.

Workshop #14 Pre Algebra Name ____

"Never doubt that a small group of thoughtful committed citizens can change the world. Indeed, it is the only thing that ever has." Margaret Mead, Anthropologist.

"Alone we can do so little, together we can do so much." Helen Keller, advocate for the blind.

Carson p.487

Cow Pie bingo is type a fundraising activity that most of you are familiar with. Donators buy a square on the chance that the cow will choose that square for her pie. A cow is turned loose on a field marked off in squares and if she chooses "your" square for her first pie, you win. The squares are marked similar to the diagram below:

	A	B	C	D	E	F
1	A1	B1	C1	D1	E1	F1
2	A2	B2	C2	D2	E2	F2
3	A3	B3	C3	D3	E3	F3
4	A4	B4	C4	D4	E4	F4
5	A5	B5	C5	D5	E5	F5
6	A6	B6	C6	D6	E6	F6

The coordinates of the squares are given first by the horizontal coordinate, letter in this case and second by the vertical coordinate, the number in this case.

This is a good example of a rectangular graph. In mathematics we label the graph using all integers and identify several main items on the coordinates to make finding the points or locations easier.

This method also works well for bigger regions with more coordinates.

City blocks are often labels by coordinates in the same fashion. North/south roads are usually called avenues and east/west roads go by the name of streets. A corner would be identified as the corner of 5th Avenue North and 3th Street East.

Find this corner, the school is on this corner. Label this S for school.
The corner of 2nd Ave S and 1st St W is the church, label it C for church.
We live at the corner of 2nd Ave N and 4 St W, label it H for home.
The town store is located at the corner of Center and 3rd St E, label it IGA.

6th Ave N									
5th Ave N									
4th Ave N									
3rd Ave N									
2nd Ave N									
1st Ave N									
Center	4th ST W	3rd ST W	2nd St W	1st St W	Division	1st St E	2nd St E	3rd St E	4th St E
1st Ave S									
2nd Ave S									
3rd Ave S									
4th Ave S									
5th Ave S									

Using the map on the previous page, find the distance from the school to the store.

How far is it from our house to the school?

Which is closer the church and the store or the school and the church?

A friend of your child's lives on 4^{th} St E, but you do not have the exact address, you know the house is North of your house, how many blocks do you need to search?

The family dog often gets out of the fence. He is harmless, except for the fact he licks a lot. We know he has never ventured more than 2 blocks in any direction. You need to organize a search party to find the dog. What are the coordinates of the search area?

If you wanted to put mathematical labels on this town, where would the origin be?

Label the Church, School, Store and our House with mathematical coordinate labels.

APPENDIX H:

RUBRIC OF PRE ALGEBRA

Rubric for Pre-algebra

Concepts	**Novice**	**Nearing Proficiency**	**Proficient**	**Advanced**
Adding, subtracting, multiplying and dividing integers.	False starts, bad logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors	Right start, steps correct, leave out steps, apply
Adding, subtracting, multiplying and dividing variables, terms and expressions.	False starts, bad logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors	Right start, steps correct, leave out steps, apply
Solving simple linear equations.	False starts, bad logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors	Right start, steps correct, leave out steps, apply
Adding, subtracting, multiplying and factoring polynomials.	False starts, bad logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors	Right start, steps correct, leave out steps, apply
Adding, subtracting, multiplying and dividing rational expressions.	False starts, bad logic, time spent	Right start, trouble carrying out ideas, time spent	Right start, steps correct, a few errors	Right start, steps correct, leave out steps, apply

APPENDIX I:

COURSE SYLLABUS

Math 071: Pre-Algebra
Fall 2008

Instructor: Dianna Hooker
Office: Office 111, Driftwood Lodges Building
Office Hours: Posted on office door
Phone: 406-638-3142
Email: dianna@lbhc.cc.mt.us

Text: Key to Algebra Series, by Julie King and Peter Rasmussen
Other Required Materials: pencil, paper, eraser, folder

Class Time: 10:10-11:10 M T W T Or 2:10-3:10 M T W T

Prerequisite: Math 061, placement test, or consent of instructor

Course Description: This course is designed to teach students the fundamental mathematical concepts needed to be successful in college level mathematics courses. Topics covered include: a review of basic operations of arithmetic, with emphasis of properties basic to algebra, integers, and rational expressions – multiplying, dividing, adding, subtracting and factoring. Also covered are exponents, and linear equations, inequalities and graphing, polynomials and rational expressions.

Course Purpose: The purpose of this course is to provide students with a sufficient mathematical background to progress to the next level of mathematics. It is designed as a developmental course, to develop skills that are necessary but lacking in many students. An emphasis will be given to learning basic concepts that are the foundation or building blocks of all mathematical concepts. Writing and culture across the curriculum and the way answers are addressed by the types of situations in examples and the way answers are expected to be given.

Course Objectives: Upon completion of this course the student will:

- Be able to perform operations on integers
- Understand variables, terms and expressions
- Be able to work with equations
- Be prepared to manipulate polynomials
- Understand rational numbers: addition, subtraction, multiplication and division
- Be able to graph, using the Cartesian coordinate system
- Be ready to work with systems of equations, and
- Have a fundamental knowledge of square roots and quadratic equations.

General Information: It's **MY** job to come to class prepared, be available for answering questions and have grades prepared in a timely fashion. It's **YOUR** job to come to class on time, be prepared, and get the assignment(s) for any missed classes from me, another student, or the assignment sheet posted on the bulletin board in the classroom.

Attendance Policy: As quoted from the LBHC Catalog: "LBHC Faculty and Administration recognize that student attendance in class and academic performance are related: therefore, the established policy is:

- ✓ All instructors will keep and report daily attendance.

- ✓ If a student has not attended a course during the first four (4) instructional days he/she may be dropped by the instructor to make room for students on a waiting list.
- ✓ A student missing four (4) consecutive instructional hours of a class during the course of the semester, without prior notification, will be referred to the Dean of Students.
- ✓ A student missing six(6) consecutive days of a class during the course of the semester, without prior notification, will give the instructor the option to withdraw the student from the class: both the Dean of Students and the Registrar will be notified.
- ✓ The student may appeal through the office of the Dean of Academics.
- ✓ Some instructors have more detailed and rigorous attendance policies for their classes. It is the instructor's responsibility to have all specific attendance requirements listed in the class syllabus. It is the student's responsibility to be aware of and follow these requirements.

Daily attendance will be taken, and will count toward your overall grade. Be sure to autograph the sign-in sheet!

Attendance and participation are very important. Math is a lot like sports: the more you practice, the better you get. Some people are naturally more inclined, but <u>no one</u> is unable to learn math. It is generally accepted that ***students are expected to spend 2 hours of out-of-class time for every 1 hour in the classroom.*** This means that for a four-credit math class, you should be spending 4 hours in class + 8 hours out of class on that subject material, or a total of 12 hours per week on that subject material.

Grading/Evaluation: Course grade is based on seven(7) one-hour exams (100 points each) and homework or quizzes (15 @ 10 points each).

A:	90 - 100%	810 – 900 total points
B:	80 – 89%	720 – 809
C:	70 - 79%	630 – 719
D:	60 - 69%	540 – 629
F:	below 60%	less than 540

Homework assignments include workbook pages and other review materials. Assignments and due dates will be announced during class. Quizzes can occur at any time. Tests will be taken when scheduled, at the completion of each booklet: dates will be announced in class. NO make-up tests will be given unless the student has contacted the instructor before the test and made arrangements. Preferably, the test will be made-up in advance. . To receive full credit for each problem, you must have the correct answer and the correct procedure. Partial credit will be given for incorrect answers if you show your work.

Tutoring and working together on assignments are highly recommended. Asking questions and communicating information is a way of assimilating knowledge that is presented. You will often be given class time to work, and you are encouraged to form study partners. The Tuesday lab day is a day specifically scheduled for you to work together on math. You will meet in CL214 and work on a workshop activity in groups with your classmates. This activity will be available in CL214. Turning in your workshop assignment indicates you attended, participated, and contributed to your learning and to the learning of the entire group. For each scheduled workshop/lab activity you attend and turn in, you will earn 10 points that will be used as part of your daily grades.

Other sources for tutoring and mentoring assistance can be found by contacting:

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Title III Program:  Dionne Pretty On Top      638-3185
prettyontopd@lbhc.cc.mt.us

STEM Program:       Alda Good Luck            638-3183
goodlucka@lbhc.cc.mt.us

Trio Program:       Deborah Yarlott           638-3187
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deborahyarlott@lbhc.cc.mt.us

Changes in class selection: If you choose to *change* classes after registration, you **must** complete the appropriate paper work

Tentative schedule for MA 071: PreAlgebra is on the attached calendar.

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Try not to fall behind in your work.

Once this happens, it is almost impossible to catch up!!!

MA 071 PreAlgebra Tentative Schedule					
Fall Semester 2008 Calendar					
September					
Week	Monday	Tuesday	Wednesday	Thursday	Friday
1	1 Labor Day No classes	2 First day of classes Intro pgs 1-10	3 pgs 11-20	4 pgs 21-30	5
2	8 pgs 31-37	9 Workshop #1	10 Test, book 1	11 Book 2 pgs 1-11	12
3	15 Last day to register pgs 12, 14, 16-20	16 Workshop #2	17 pgs 21-28 and 29-33	18 pgs 34-37	19
4	22 Test, book 2	23 Workshop #3	24 Book 3 pgs 1-10	25 pgs 11-22	26
October					
5	29 pgs 23-30	30 Workshop #4	1 pgs 31-37	2 Test, book 3	3
6	6 Book 4 pgs 1-10	7 Workshop #5	8 pgs 11-20	9 pgs 21-29	10
7	13 pgs 30-34 and 35-37	14 Workshop #6	15 Book 5 pgs 1-9	16 Fall Mini Break, No Classes	17 Fall Mini Break, No Classes
8	20 pgs10-19	21 Workshop #7	22 pgs 20-23	23 pgs 33-34	24
9	27 Last Day to Withdraw pgs 35-37	28 Workshop #8	29 Book 6 pgs 1-8	30 pgs 9-17	31
November					

9	3 pgs 18-21, 24-29	4 Workshop #9	5 pgs 30-34	6 pgs 35-37	7
10	10 Test, book 6	11 Veterans Day Obs. No classes	12 Book 7, pgs 1-10	13 pgs 11-19	14
11	17 pgs 20-27	18 Workshop #10	19 pgs 28-31	20 pgs 35-37	21
12	24 Test, book 7	25 Workshop #11	26 Thanksgiving Break No classes	27 Thanksgiving Break No classes	28 Thanksgiving Break No classes
13	26 Book 8 pgs 1-9	27 Workshop #12	28 pgs 9-15	29 pgs 16-24	30
December					
14	1 pgs 25-30	2 Workshop #13	3 pgs 31-37	4 Test Book 8	5 Last day of classes
15	8 Review Day Preregistration	9 Review Day Preregistration	10 Finals	11 Finals	12 Finals