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The effects of gender and ethnicity on students' perceptions of small-group learning in collegiate mathematics courses

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The Effects of Gender and Ethnicity on Students' Perceptions of Small-Group Learning in Collegiate Mathematics Courses

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Dedication

I would like to dedicate this thesis to the caring memory of Professor Barbara Leapard, who served as my original thesis adviser on this project. Although she passed away before the completion of this thesis, I will always remember her for her kind words, her structured support, and her constant encouragement, all of which helped make this endeavor towards obtaining my Master of Arts degree in mathematics possible.

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Abstract

Qualitative studies of students' perceptions on small-group work are limited, and few offer insights on the perceptions of women and minority students, for whom quantitative research suggests that small-group work is most beneficial. The aim of this research project is to conduct a qualitative analysis on the perceptions of women and minority students on their small-group learning experiences in collegiate mathematics courses. We conducted a Likert-scale survey of 114 Eastern Michigan University undergraduate students who were enrolled in a cross section of mathematics courses. The data were analyzed using statistical measures such as the frequency and modes of each response, as well as by utilizing a chi-squared test in MATLAB to test for statistical significance between the differences among students' responses with a 95% confidence interval. The survey analysis examines the roles gender and ethnicity play in how students feel about their experiences in small-group learning environments, the factors that shape these perceptions, and the resulting impacts on their perceived ability to understand the material. While students' perceptions of small-group work in collegiate mathematics courses were generally positive among all groups of students surveyed, some differences were found in their perceptions of group work based on gender and ethnicity.

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1 RATIONALE

Students' future professions will frequently require the ability to work effectively in group or team settings. However, working in groups or teams can be quite difficult, particularly when there are members of varying genders and ethnicities among these groups. As educators at the college level, it is important to adequately prepare our students for success in their future careers. Given the importance of mathematics courses in science, technology, engineering, and mathematics (STEM) fields found in many of today's occupations, it is essential to examine the roles that factors, such as gender and ethnicity, play within group dynamics in students' mathematics courses at the collegiate level.

Previous research suggests that small-group learning environments, whether they be cooperative or collaborative in nature, greatly improve students' understanding of mathematics material and performance in mathematics courses at all levels.[1–6] In particular, studies done by Uri Treisman and subsequent others, including Bonsangue, Fullilove, and Moreno, have revealed that women and minority students who enroll in collegiate mathematics courses that incorporate small-group learning methods show dramatic improvements in their mathematical performance.[7–11] However, much of the available research is limited to the quantitative nature in which this type of learning affects students' performances in their mathematics courses. Conducting research of a qualitative nature, which is considerably more limited, could potentially reveal a deeper understanding of why and/or how small-group learning environments, in contrast to more traditional lecture-oriented class settings, are seemingly more effective for women and

minority students.

Small-group learning environments are suggested, by some researchers, to more closely match the learning styles of women and minorities. In fact, Springer and Cabrera found that the highly competitive nature of traditional learning environments actually hinders the participation process for these students.[1,12] However, Colbeck and Rosser suggest that group conflicts cause many students, women in particular, to report negatively on their small-group learning experiences, especially when instructors fail to provide student groups with proper structure.[13,14] But what do women and minority students have to add to such conjectures? What do their thoughts and perceptions of small-group learning experiences tell us about the claims of the existing research, and in what ways do they feel small-group learning may or may not provide a learning environment more conducive to learning mathematics?

This research project conducts a qualitative analysis on how students' perceptions of small-group learning environments differ across gender and ethnicity. Thus, the perceptions of women and minority students on their small-group learning experiences in collegiate mathematics courses will be compared and contrasted to those of their non-minority male counterparts. To this end, a qualitative survey of Eastern Michigan University undergraduate students enrolled in a cross section of mathematics courses ranging from Pre-College Mathematical Concepts to Calculus II was conducted. The survey attempted to assess the roles gender and ethnicity play in how students feel about their experiences in small-group learning environments, the factors that shape these perceptions, and the impacts on their perceived ability to understand the material.

2 LITERATURE REVIEW

2.1 Introduction

The benefits of small-group learning environments in collegiate mathematics courses are highly controversial. Theories vary on how students should be grouped, the amount of structure and guidance that should be provided by the instructor, and even the degree to which group interdependence should be explicitly encouraged by providing specifically-assigned roles for students to adhere to during small-group work activities. The two main methodologies, cooperative learning and collaborative learning, as well as blended varieties thereof, are the predominant forms of small-group learning employed in college mathematics courses today. In examining students' perceptions of their small-group learning experiences, some researchers propose that certain aspects of these methods are, in fact, the sources of the positive or negative perceptions that women and minorities form about such learning experiences. These varying aspects are discussed in detail within the following sections.

2.2 To Cooperate or to Collaborate: That Is the Question...

Cooperative and collaborative learning are both firmly rooted in the notion that classroom small-group activities greatly enhance students' abilities to learn and understand course material while simultaneously honing the teamwork and communication skills desired by many employers.[13] However, these two approaches differ greatly in their underlying principles and methods.[15]

The fundamental differences between cooperative and collaborative learning stem

from the different age ranges of the students these approaches were designed to educate. As a result, the two approaches differ significantly in the recommended amount of group structure and guidance that should be provided by the instructor.[12,13] Thus, *cooperative learning*, which was originally developed for the education of children, emphasizes the importance of having instructors provide groups with the necessary structures to function properly. On the other hand, *collaborative learning*, which was designed to educate adolescents and adults, emphasizes the importance of not providing student groups with rigid structures that could potentially hinder the learning process.[12,15]

Springer et al. summarize the differences between cooperative and collaborative learning methods as follows: Cooperative learning incorporates numerous aspects that are essential to its success in the classroom. Aspects of cooperative learning include communicating mutual goals among group members, rewarding group members for accomplishing group oriented goals, and delegating roles and assignments to each individual within the group. Cooperative learning also involves incorporating accountability for each individual group member's own learning, specifying team-building activities, elaborating on the social skills necessary for productive group work, and getting students involved in the discussions of ways in which the group's work could be accomplished more efficiently. Alternatively, collaborative learning is described by more or less unstructured processes in which group members define goals, negotiate problems, build procedures, and develop socially acquired knowledge among members of these small groups.[12] Thus, as previously stated above, cooperative learning does emphasize the importance of group structures, whereas collaborative learning is less structured, and

allows students to develop their own process of learning.

Despite these distinctions, the existing research on both methodologies supports the more general claim that incorporation of small-group work into college courses positively influences students in numerous ways. According to Johnson et al.,[3] a *meta-analysis*, or a combination of the data from multiple but similar quantitative studies,[16] was used to analyze cooperative learning at the college-level. This meta-analysis revealed that, when contrasted against individualistic or competitive approaches, cooperative learning improves students' academic success, quality of relationships, psychological adjustment to college life, and overall attitude toward the college experience. In terms of academic success, cooperative learning results in numerous benefits. These include an increase of students' acquisition of knowledge, increased accuracy in knowlegde retention, better problem-solving creativity, and an increase in higher-level reasoning.[3] In addition, there is evidence to support claims that such learning methods also promote *metacognition*, or the ability to use prior knowledge and employ strategies to perform a learning assignment, problem solve, evaluate results, and modify problem solving approaches as needed.[17] Furthermore, cooperative learning increases students' willingness to take on difficult tasks, persistence in achieving goals despite difficulties, essential motivation, the ability to utilize learning from one situation to another, and also results in an increase in students' time spent focusing on the tasks at hand.[3]

According to Slavin, the types of group behaviors that contribute most to achievement of educational goals persistently demonstrate that students who provide explanations to others will have the most to gain from small-group learning situations, as

opposed to those students who simply receive explanations from others.[6] Hence, it is evident that the academic benefits of small-group learning, particularly the higher-level learning that takes place, are largely due to the discussions of the material and problem-solving approaches that occur within collaborative learning environments. Engaging in mathematical discourse forces students to communicate their understanding of the material to others, thereby encouraging the development of a much deeper understanding of the topic.

Much of the small-group learning that occurs in college-level mathematics courses is, in fact, a hybrid of cooperative and collaborative learning strategies in the sense that some group structure is provided (as in cooperative learning) but not so rigidly that the learning process could potentially be hindered (as in collaborative learning). Thus, many researchers have simply chosen to broaden their studies to encompass both cooperative and collaborative learning as well as any other forms of small-group learning in which students are asked to engage.[12,13,18] For example, a meta-analysis performed by Springer et al. revealed a significant and positive effect on the achievement, persistence, and attitudes of undergraduates in science, technology, engineering, and mathematics (STEM) courses that involve small-group learning, whether cooperative or collaborative in nature.[12] In addition, Springer states that college students tend not to distinguish between cooperative, collaborative, and small-group learning forms in the same way that researchers do, which makes surveying students in this regard ineffectual.[12] Thus, for the purposes of this research project, the survey will pertain to all forms of small-group learning in which students have participated during current or prior collegiate

mathematics courses.

2.3 Small-Group Learning: Effects on Women and Minorities

In the mid-1970's, research done by Uri Treisman at the University of California, Berkley, revealed that the high failure rates of women and minorities in mathematics courses were not due to factors such as lack of academic preparation or motivation, as many educators had originally presumed, but rather their failure was due to a lack of learning communities within which they could hone their mathematics skills.[8,11] In response to this unsettling revelation, in 1978 Treisman established calculus courses with workshop components in which students work together on solving unusually challenging problems and engage in discussions and critiques of each others' solutions.[8] The results were astounding due to the fact that, during the years between 1978 and 1984, there was a dramatic increase of both the academic success and program retention rates of women and minority students who participated in the workshops.[8,11]

Since then, dozens of major universities, and hundreds of smaller two-year and four-year universities around the country, have established comparable mathematics workshop programs. These programs are all very similar to the Emerging Scholars Program (ESP), as Treisman's workshops came to be known, in that the workshops are primarily aimed at providing women and minority students with the necessary skills, such as learning to communicate their ideas and their basis for solutions with one-another, in order to excel in their collegiate mathematics courses.[7,9] Based on descriptions of, and prior experience with ESP workshop formats, the ESP workshops would largely be

characterized as collaborative learning environments since the group structure within the workshop is limited to the criteria that group members work on problems and discuss their solutions in groups, and amongst the class as a whole.[7,8,10] Thus, workshop participants collaborate to define problems, outline the group's common goals, and produce the socially constructed knowledge through group inter-communication that Springer refers to, without employing the specific group structures, such as role and task assignments, which are characteristic of cooperative learning methods.[12]

While much of the research on ESP-type programs and other small-group learning methods is primarily quantitative in nature, several qualitative analyses of such learning methods have been performed. These qualitative analyses were performed either as the focus of various studies or as a side note within more quantitatively focused studies. In general, the existing research suggests that women and minorities prefer small-group learning environments; however, there is some debate as to why this may be the case, and if, in fact, it is.

Some researchers suggest that women's and minorities' preferences towards small-group learning stem from a difference in their learning styles in which emphasis is placed on connected knowing, cooperative problem solving, and socially constructed knowledge.[1,12] In contrast, non-minority males allegedly prefer the more traditional, competitive, and individualistic styles of learning.[1,12] However, many studies have shown that small-group learning environments are not only just as effective for non-minority males as they are for women and minorities, but that non-minority males are just as likely to prefer such learning methods. For example, research done by Cabrera et al. revealed

no support for the differential learning style hypothesis suggested by some researchers and, in fact, revealed that non-minority males were just as likely to prefer collaborative learning styles as were women and minorities.[1] In addition, research done by Fullilove, Moreno et al., and Treisman revealed that non-minority males also performed better in ESP workshops than did their non-ESP counterparts and that they even preferred the collaborative nature of ESP workshops.[8–11] Thus, while many researchers suggest that women and minorities generally experience greater positive effects of and demonstrate a distinct preference towards small-group learning (as opposed to the traditional, lecture-oriented and often competitive learning methods), it is important to note that this same research also suggests that non-minority males also perform better in small-group learning environments despite frustrations with leader-slacker tensions.[12]

Some research suggests that women and minority students often report negative perceptions of the effectiveness of small-group learning environments. Many researchers propose that such negative perceptions are primarily due to a lack of proper structure within collaborative learning environments.[13,14] For example, women and minorities frequently report feeling that their ideas, suggestions, and contributions are often ignored and undervalued by majority group members, especially when women and minorities were isolated as the sole person of a minority gender or ethnicity within their assigned group.[12–14] In addition, frustrations among women and minorities can also arise as instructors often fail to intervene when conflicts stemming from personal or power differences arise within groups, or when specific roles, which foster an equitable distribution of responsibilities, are not assigned to the group.[13,14,18] Thus, while

Springer's research does suggest that small-group learning environments provide women and minorities with an increase in their opportunities to be heard by the group, and also an increased ability to learn by participating withing the group,[12] factors such as poorly-assigned and/or poorly-sized groups,[14] lack of clear roles for group members to prevent leader-slacker tensions from surfacing,[13,18] and lack of appropriate forms of instructor intervention when conflicts arise[19] can all negatively affect the perceived benefits of group work.

As a preventive measure, cooperative learning theorists suggest the inclusion of various structural components geared at fostering the group interdependence that collaborative learning methods are devoid of. According to Kluge,[4] the characteristic components of effective cooperative learning methods should include the following:

- positive interdependence of goals, rewards, roles and resources among group members;
- heterogeneous groups of two to four members;
- individual accountability among group members;
- teaching of necessary social skills to facilitate group interactions;
- distributed leadership among group members;
- group autonomy from instructor;
- group processing or performance self-reflection; and
- promotion of face-to-face interaction or close proximity.

The inclusion of these structural characteristics in cooperative learning methods is largely based on the premise of *social interdependence theory*, which states that the way in which social interdependence is defined for groups of individuals greatly determines how they will interact, which in turn significantly affects group outcomes.[3] Further, many adolescents and adults are lacking the necessary social skills to interact cooperatively, contrary to the assumption of collaborative learning theorists. Thus, cooperative learning theorists believe that, despite their age maturity, college students still need imposed structures to function effectively in small-groups.[3,15] Hence, Springer et al. summarize that when instructors define group problems, provide specific group procedures, and designate roles to individual group members, this can result in more efficient group interactions, which are characterized by in-depth discussions that ultimately lead to greater understanding of the concepts at hand.[12]

2.4 Research Summary

Existing research overwhelmingly suggests that the use of small-group learning in college mathematics courses, whether cooperative, collaborative, or a mix of the two, greatly improves students' academic performance. Small-group learning is also known to increase students' ability to acquire knowledge, to accurately retain information, and to improve problem-solving creativity and higher-level reasoning.[3]

In an attempt to better understand why women and minority college students seemingly benefit more from small-group learning environments in their mathematics courses, as opposed to individualistic or competitive environments, we are performing a

qualitative survey that assesses students' perceptions of their collaborative learning experiences, while considering the role that gender and ethnicity may play in these perceptions. Due to the fact that some research shows that negative perceptions of small-group work are rooted in lack of appropriate group structures, we also intend to examine any roles that group structuring may play in students' formation of such perceptions through a thorough review of the open response questions of the survey.

3 RESEARCH QUESTIONNAIRE

In order to assess students' perceptions of their small-group learning experiences in collegiate mathematics courses, we developed a questionnaire based largely on a qualitative survey utilized by MacBean et al. in conducting their research on college students' attitudes towards group work.[18] In addition to course and biographical information, including age, gender and ethnicity, the resulting survey asks students to indicate on a five-point Likert-scale of 1 (strongly disagree) to 5 (strongly agree) the extent of their agreement to a bank of 14 statements, some of which are phrased to present group work in a positive way, while the others are phrased to present a negative view of group work.[18] A final section of the survey, in the form of three open-ended questions, provides students with an opportunity to note additional information regarding the reasoning behind their positive and/or negative perceptions of group work. A complete copy of the survey is available in Appendices A and B with the HSRC Permission Letter available in Appendix C.

3.1 Mathematics Course Information

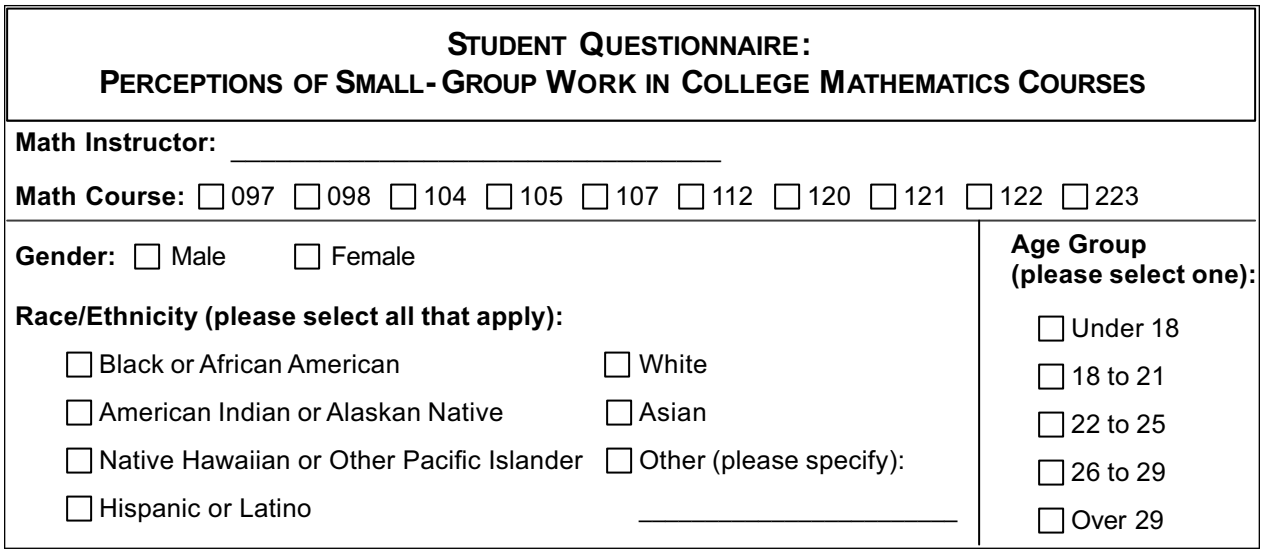
The initial section of the questionnaire (see Figure 1) serves to identify the mathematics course in which the student is registered and with which instructor. This will enable matching of the students' responses with the math course level they are enrolled in so as to assess any potential relationship between the two should the need arise in future research. The actual course numbers and names that we surveyed are as follows:

- Math (097): Pre-College Mathematical Concepts,
- Math (104): Intermediate Algebra,
- Math (105): College Algebra,
- Math (107): Plane Trigonometry,
- Math (112): Topics in Precalculus Mathematics,
- Math (120): Calculus I,
- Math (121): Calculus II, and
- Math (122): Elementary Linear Algebra.

3.2 Biographical Information

In this portion of the survey (see Figure 1), students were asked to report their age, gender, and ethnicity. In addition to specifying their gender as either male or female, students were asked to specify their age by selecting one of the five age groups that appear on the survey biographical information section as well. This enabled us to provide

an analysis on whether age has any effect on students' perceptions of small-group learning experiences should that need arise in future research of this nature.



STUDENT QUESTIONNAIRE:
PERCEPTIONS OF SMALL-GROUP WORK IN COLLEGE MATHEMATICS COURSES

Math Instructor: _____

Math Course: ☐ 097 ☐ 098 ☐ 104 ☐ 105 ☐ 107 ☐ 112 ☐ 120 ☐ 121 ☐ 122 ☐ 223

Gender: ☐ Male ☐ Female

Race/Ethnicity (please select all that apply):

☐ Black or African American
☐ American Indian or Alaskan Native
☐ Native Hawaiian or Other Pacific Islander
☐ Hispanic or Latino
☐ White
☐ Asian
☐ Other (please specify): _____

Age Group (please select one):

☐ Under 18
☐ 18 to 21
☐ 22 to 25
☐ 26 to 29
☐ Over 29

Figure 1. Student math course and biographical data section of the survey.

Also in the biographical section of the survey, students were asked to select the ethnicity(ies) with which they identify themselves from the ethnic categories utilized by the National Science Foundation (NSF) (see Figure 1).[20] Based on the NSF reporting standards, students who selected any of the first four categories on the left side of Figure 1 were considered among the totals for minority students, as were any students who specified one of those same four ethnicities in the "other" section of the biographical data portion of the survey.[21] The students who selected either White or Asian, as well as any other non-minority ethnicities in the "other" section, were classified as "non-minority students" for the purpose of data analysis on this survey.

3.3 Survey of Student Attitudes Toward Small-Group Learning

The assessment of students' attitudes towards group work was performed by recording students' responses to the following survey as measured on a five-point Likert-scale (see Figure 2). Statements (2) through (5), (7), and (9) were drawn directly from the survey utilized by MacBean et al. and were geared towards students' general attitudes towards participating in group work in mathematics courses.[18] Due to the fact that their survey was conducted in the United Kingdom, slight rephrasing of the statements was occasionally necessary. Statements (1), (6), (8), and (10) through (14) were devised to answer more specific questions that arose during the research phase of this project and pertain specifically to students' perceptions about valuation of their ideas, prior group work experience, leader-slacker tensions, and group heterogeneity. Some of the questions employed positive phrasing toward group work, while the others employed negative phrasing toward group work. The survey questions are outlined in Figure 2.

3.4 Open Response Questions

Lastly, students were given an opportunity to provide supplementary feedback on the open-ended questions that appear in Figure 3. These questions were geared towards understanding which aspects of small-group work students enjoy, which aspects they do not enjoy, and an additional space was provided to allow them to add any further comments regarding their perceptions of small-group work in their collegiate mathematics courses.

Please indicate your level of agreement to each of the following statements (circle only one for each):					
SD = Strongly Disagree D = Disagree N = Neutral A = Agree SA = Strongly Agree					
1. I have participated in group work in a college mathematics course before.	SD	D	N	A	SA
2. I only discuss a math problem with others once I fully understand it myself.	SD	D	N	A	SA
3. I enjoy working with other people on math problems.	SD	D	N	A	SA
4. I find that I understand a mathematical concept better once I have discussed it with other people.	SD	D	N	A	SA
5. I'm not confident enough with my math knowledge to discuss specific problems with others.	SD	D	N	A	SA
6. I would rather work in groups with people of my same gender.	SD	D	N	A	SA
7. I do not enjoy working on mathematics problems with others --math is a more solitary exercise.	SD	D	N	A	SA
8. I prefer working in groups that have both male and female members.	SD	D	N	A	SA
9. When I have no idea how to start a math problem, I find it useful to discuss possible approaches with others.	SD	D	N	A	SA
10. I feel that my ideas on how to solve a problem are valued by other group members.	SD	D	N	A	SA
11. I have never participated in group work in a college mathematics course before.	SD	D	N	A	SA
12. I find that each group member generally contributes equally to the work that needs to be done.	SD	D	N	A	SA
13. I often feel that my ideas on how to solve a problem are not valued by my group members.	SD	D	N	A	SA
14. When working in groups, I find that some people tend to do all the work while others do very little.	SD	D	N	A	SA

Figure 2. Statements pertaining toward small-group learning section of survey.

Please provide a response to the following questions:

1. What things do you enjoy most about doing group work in this math course?

2. What things do you enjoy least about doing group work in this math course?

3. Please provide any additional information and/or comments you would like to share in the space below.

Figure 3. Open response section of student survey.

3.5 Questionnaire Summary

The data obtained from the questionnaire were evaluated using statistical methods to examine the frequencies and modes of the students' responses, and to test for any association between a students' gender and/or ethnicity and their overall perceptions of small-group learning environments. To this end, we compared the frequency distributions given in both the raw numbers as well as the percentages of each group of students along with the modes of students' Likert-scale responses to each question. Further evaluation was performed by utilizing a chi-squared test to examine the gender and ethnicity variables for any association with the responses given for each survey statement. Responses were compared both with and without grouping on the gender and ethnicity variables. Lastly, the information obtained from the open-ended responses were analyzed for any significant findings.

4 SURVEY RESULTS

The data was analyzed using Microsoft Excel to obtain the frequency distributions and modes (highlighted in color) of the Likert-scale score of the students' responses by group to each question so as to provide a sense of where students' responses generally fell along the Likert continuum from "strongly disagree" to "strongly agree." Ultimately, MATLAB was used to test for any association (using a 95% confidence interval) between the students' responses and the gender and ethnicity variables. Based on the demographic data collected, further tests for any relationship between the age group and math course variables were certainly possible but were omitted, as they are not the

current emphasis of this research project.

4.1 Mathematics Course Background Information

The survey was completed by a total of 164 undergraduate students registered for a cross section of math courses offered at Eastern Michigan University (EMU) during April of 2010. However, due to the fact that 50 records were incomplete and missing one or more survey responses, those records were omitted from the research study leaving 114 records to be analyzed. The mathematics content of the courses varied widely as the courses ranged from Pre-College Mathematical Concepts to Calculus II.

The instructors of the surveyed courses did not require group work during class time, but students were generally permitted to work together outside of class on homework assignments should they choose. Based on this information, the type of small-group learning that these students might possibly engage in would be best classified as collaborative learning, and does not incorporate the more rigid group structures characteristic of cooperative learning.

4.2 Summary of Biographical Information

In the first section of the survey, we obtained data pertaining to the biographical information, including gender, ethnicity, and age group of the students. The recorded data are summarized in Table 1, and follow the National Science Foundation (NSF) standards for determining minority status for the students.[20] As was stated in the "Research Questionnaire: Biographical Information" section of this paper, students were asked to select the ethnicity(ies) with which they identify themselves from the ethnic

categories utilized by the NSF.[20]

Table 1. Summary of all students, their minority status, and age by gender.

	Male	Female	Survey Total
All Students	62	52	114
	54.4%	45.6%	100.0%
Non-Minority	52	37	89
	58.4%	41.6%	78.1%
Minority	10	15	25
	8.8%	13.2%	21.9%
Under 18	5	2	7
	4.4%	1.8%	6.1%
18 to 21	29	35	64
	25.4%	30.7%	56.1%
22 to 25	18	7	25
	15.8%	6.1%	21.9%
26 to 29	3	2	5
	2.6%	1.8%	4.4%
Over 29	7	6	13
	6.1%	5.3%	11.4%

Overall, Table 1 shows that the sample of students was predominantly comprised of male students (54.4% male versus 45.6% female) and non-minority students (78.1% non-minority versus only 21.9% of students that reported being of minority descent). It is worth noting that the students who reported being of "other" descent were manually categorized as either "non-minority" or "minority" based on the ethnicity they specified in the space provided on the survey biographical information section (see Figure 1. The "Survey Total" column is comprised of the total number of responses in each category from the entire survey data set, regardless of gender. Also worth noting is the fact that

the largest age group was the "18 to 21" group at 56.1%, followed by the "22 to 25" group at 21.9%, then by the "Over 29" group at 11.4%, the "Under 18" group at 6.1%, and finally, the "26 to 29" group at 4.4%.

4.3 Summary of Student Attitudes Towards Small-Group Learning

In the second section of the survey, the students were asked to indicate their level of agreement to a bank of 14 statements. The statements are often referred to as "Statements" 1 through 14 (or Statements #1 through #14). Several of the statements were centered around students' overall attitudes toward group work, some of which were phrased to present a positive view of group work, while others were phrased to present a negative view towards group work. The remaining statements were geared towards establishing potential reasons behind students' attitudes towards group work by addressing issues such as students' preferences towards group diversity, leader-slacker tensions, and self-confidence. Again, some of these statements were phrased positively while the others were phrased negatively to help more accurately assess students' true perceptions of the statements. The results of the survey are summarized by the frequency distributions of their responses to each survey statement in Tables 3 through 16.

The Likert-scale analysis applied in this study utilizes measures of central tendency suitable for discrete data, such as Likert-scale responses, which only take on values of 1 through 5 and which technically represent an ordinal response, rather than numerical values. Thus, although the responses are given numerical values for the purpose of simplifying the process of analyzing the data, taking the mean average or the standard

deviation of multiple students' responses to a question, such as "strongly disagree" and "agree," is generally not utilized for this type of data in statistics.

The appropriate measures of central tendency to be utilized included the frequency distributions, including the number and percentage of the students' responses, as well as the mode of each question response, wherein the *mode* of each statement is the response that occurs most frequently and is highlighted in color on each statement table.[22] In addition to using the frequency distributions and modes of the various groups and subgroups of the students surveyed, we also conducted a chi-squared test for comparison with one degree of freedom using MATLAB to evaluate whether students' responses were related to their gender or ethnicity with a statistically significant difference indicated by p-values of $p \leq 0.050$. By definition, a *p-value* is the level of significance given in a statistical hypothesis test (a chi-squared test in this instance) that represents the probability of a given event. The smaller the p-value, the stronger the evidence is in support of the alternative hypothesis, namely in our case that there is a significant relationship between a student's subgrouping and their given response.[23] Thus, by specifying a level of significance of $p \leq 0.050$, we can say with 95% certainty that when such a p-value does occur, it appears in red on the statement tables and in Appendix D, and there is a statistically significant difference in the way a student responded based on their group in a comparison among the following five groups of students surveyed:

1. males vs. females,

2. non-minorities vs. minorities,

3. non-minority males vs. non-minority females,

4. non-minority males vs. minority males, and

5. non-minority males vs. minority females.

Results that fell within $0.050 < p \leq 0.100$ were referred to as marginally significant, and appear in green on the statement tables and in Appendix D.

In Tables 3 through 16, the frequency distributions and modes of all of the students' responses to each of the statements are as shown below. For example, Table 3 displays all students' responses to Statement #1, Table 4 displays all students' responses to Statement #2, and Table 5 displays all students' responses to Statement #3, and so on for each of the 14 statements on the survey.

From these tables, we can see how the modes, or most frequent responses, vary depending on the particular subsets of the data grouped by gender and ethnicity based on the number and percentage of responses in each category of strongly disagree, disagree, neutral, agree, and strongly agree. Furthermore, Appendix D displays the results of the chi-squared tests that were performed in MATLAB on the data. For the purpose of simplification, the p-values are labeled based on the groups that are being compared, namely,

1. p_1: males vs. females,

2. p_2: non-minorities vs. minorities,

3. p_3: non-minority males vs. non-minority females,

4. p_4: non-minority males vs. minority males, and

5. p_5: non-minority males vs. minority females.

For the purposes of computing the chi-squared test statistic and corresponding p-values for each of the five groups that were compared for the chi-squared statistical analysis, the Likert-scale responses for strongly disagree, disagree, and neutral were grouped together into one category labeled "disagree," and the Likert-scale responses for agree and strongly agree were grouped together into one category labeled "agree." It is worth noting that the neutral responses were grouped with the "disagree" category due to the fact that these responses were not strong enough in agreement with the statements to fall into the "agree" category.

Table 2. Chi-squared analysis example.

CHI-SQUARED ANALYSIS EXAMPLE:	(SD & D & N)	(A & SA)		
Statement #1:	**DISAGREE**	**AGREE**	**TOTAL**	**PERCENTAGE**
NON-MINORITY MALE	22	30	**52**	58.43%
NON-MINORITY FEMALE	16	21	**37**	41.57%
TOTAL	**38**	**51**	**89**	

A table illustrating these groupings and the basis of how the chi-squared test statistic was computed for the comparison between non-minority males and non-minority females on Statement #1 is shown in Table 2. This table was utilized as the basis to compute the observed and expected values for each of the five groups of students being compared, and was then used to calculate the chi-squared test statistic and corresponding p-values for each of the five comparisons. Ultimately, all comparisons and p-values were

computed using MATLAB based on this type of chi-squared analysis for each of the 14 statements.

Beginning with Statement #1, "I have participated in group work in a college mathematics course before," we see in Table 3 that the mode for all students was agree (at 34 or 29.8%), for male students the mode was also agree (at 18 or 29.0%), for female students the mode was agree (at 16 or 30.8%), and the same applies for non-minority students with mode of agree (at 27 or 30.3%). Male and female non-minority students also generally agreed with the statement having modes in the agree response category at 16 (or 30.8%) and 11 (or 29.7%), respectively.

We see that for minority students, the mode drops to disagree (at 10 or 40.0%) with agree at a close second of 28.0%, while male minority students were neutral (at 4 or 40.0%), and for female minority students the mode was disagree (at 7 or 46.7%) with agree at another close second at 33.3%. Therefore, based on the modes alone, we might be inclined to conclude that fewer minority students agreed that they have participated in small-group work in their mathematics courses when it is not a specific requirement for the course. Whereas, their non-minority male and female counterparts were more likely to have participated in group work in their collegiate mathematics courses despite the fact that it was not necessarily a requirement for the course. In support of this conclusion, when the chi-squared test for comparison was performed on Statement #1 between non-minority and minority students' responses, we found that the value for p_2, which compares non-minority students to minority students, was marginally significant at 0.059. Thus, we would conclude from the chi-squared test that minority students are

slightly less likely to have participated in small-group work in collegiate mathematics courses before, as was indicated by the slight differences we saw in the modes of minority students' responses.

It is worth noting that a similar analysis was performed on each of the following survey statements, and for the sake of brevity, we omitted the actual numbers and percentages from the discussion, leaving them to be found in the tables themselves, unless it becomes necessary for emphasis. Additionally, any statistically insignificant p-values were omitted and left to be found in Appendix D unless there were significant or marginally significant findings on a particular statement. In the cases that significant or marginally significant findings were found, the p-values were listed under the subgroups they corresponded to on the statement tables. More specifically, Tables 3 through 16 contain the statistically significant and marginally significant p-values from Appendix D for any of the five groups listed above where applicable. The complete data analysis follows, along with the tables and figures mentioned above.

4.4 Survey Data Analysis

Table 3. Number and percentage of students' responses to Statement #1 by group.

Survey Statement #1 I have participated in group work in a college mathematics course before.	**Number & Percentage of Students' Responses by Group**				
	SD	**D**	**N**	**A**	**SA**
All Students (114 Total)	13 11.4%	23 20.2%	18 15.8%	34 29.8%	26 22.8%
Male Students (62 Total)	7 11.3%	8 12.9%	14 22.6%	18 29.0%	15 24.2%
Female Students (52 Total)	6 11.5%	15 28.8%	4 7.7%	16 30.8%	11 21.2%
All Non-Minority Students (89 Total)	12 13.5%	13 14.6%	13 14.6%	27 30.3%	24 27.0%
Male Non-Minority Students (52 Total)	7 13.5%	5 9.6%	10 19.2%	16 30.8%	14 26.9%
Female Non-Minority Students (37 Total)	5 13.5%	8 21.6%	3 8.1%	11 29.7%	10 27.0%
All Minority Students (25 Total) p_2=0.059 (vs. Non-Minority Students)	1 4.0%	10 40.0%	5 20.0%	7 28.0%	2 8.0%
Male Minority Students (10 Total)	0 0.0%	3 30.0%	4 40.0%	2 20.0%	1 10.0%
Female Minority Students (15 Total)	1 6.7%	7 46.7%	1 6.7%	5 33.3%	1 6.7%

For Statement #2, we see in Table 4 that, while All students, male students, female students, non-minority, and non-minority male and female students consistently disagreed with the statement "I only discuss a math problem with others once I fully understand it myself," overall, minority students (including both male and female minorities) were more likely to feel neutral towards or to agree with the statement. Thus, we would be inclined to conclude that minority students prefer to discuss a math problem only once they fully understand it themselves, whereas their non-minority counterparts are more comfortable discussing math problems with others before the problems are fully understood by these students. When the chi-squared test was performed on Statement #2, we found marginally significant differences in the way that both minority students and female minority students responded to this question as compared to non-minority students and non-minority male students respectively. For minority students as compared to non-minority students, we found a p-value of $p_2 = 0.075$. For female minority students as compared to non-minority male students, we found a p-value of $p_5 = 0.063$. Thus, there is a marginally significant difference in the way minority and female minority students feel about discussing math problems with others before they fully understand the problems themselves. To be more specific, based on the responses in Table 4, we would conclude that these two groups of students feel less confident in discussing math problems with others before they fully understand the problem themselves, as these two groups tended to either feel neutral or agree with Statement #2.

Table 4. Number and percentage of students' responses to Statement #2 by group.

Survey Statement #2	**Number & Percentage of Students' Responses by Group**				
I only discuss a math problem with others once I fully understand it myself.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	15 13.2%	48 42.1%	25 21.9%	22 19.3%	4 3.5%
Male Students (62 Total)	9 14.5%	28 45.2%	13 21.0%	10 16.1%	2 3.2%
Female Students (52 Total)	6 11.5%	20 38.5%	12 23.1%	12 23.1%	2 3.8%
All Non-Minority Students (89 Total)	15 16.9%	42 47.2%	15 16.9%	13 14.6%	4 4.5%
Male Non-Minority Students (52 Total)	9 17.3%	25 48.1%	9 17.3%	7 13.5%	2 3.8%
Female Non-Minority Students (37 Total)	6 16.2%	17 45.9%	6 16.2%	6 16.2%	2 5.4%
All Minority Students (25 Total) p_2=0.075 (vs. Non-Minority Students)	0 0.0%	6 24.0%	10 40.0%	9 36.0%	0 0.0%
Male Minority Students (10 Total)	0 0.0%	3 30.0%	4 40.0%	3 30.0%	0 0.0%
Female Minority Students (15 Total) p_5=0.063 (vs. Non-Minority Male Students)	0 0.0%	3 20.0%	6 40.0%	6 40.0%	0 0.0%

On Statement #3, "I enjoy working with other people on math problems," we see in Table 5 that all groups of students, with the exception of minority females, tended to predominantly agree with the statement. Minority females, however, were slightly more likely (at 40.0%) to disagree with the statement, leading us to believe that minority females are more likely to prefer to work alone on math problems. It is worth noting that, of the female minorities, the next most frequent response was agree at 26.7%; thus, some female minority students do feel comfortable working with others on math problems. In this case, when we performed the chi-squared test, we found that female minority students answers differed with marginal significance as compared to non-minority male students with a p-value of $p_5 = 0.077$. Thus, based on frequency of female minority students' responses in Table 5, we see that they are marginally more likely to disagree with the statement, and therefore feel that they do not enjoy working with other people on math problems.

Table 5. Number and percentage of students' responses to Statement #3 by group.

Survey Statement #3	**Number & Percentage of Students' Responses by Group**				
I enjoy working with other people on math problems.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	5 4.4%	14 12.3%	25 21.9%	41 36.0%	29 25.4%
Male Students (62 Total)	1 1.6%	5 8.1%	14 22.6%	26 41.9%	16 25.8%
Female Students (52 Total)	4 7.7%	9 17.3%	11 21.2%	15 28.8%	13 25.0%
All Non-Minority Students (89 Total)	4 4.5%	8 9.0%	21 23.6%	31 34.8%	25 28.1%
Male Non-Minority Students (52 Total)	1 1.9%	5 9.6%	12 23.1%	20 38.5%	14 26.9%
Female Non-Minority Students (37 Total)	3 9.7%	3 9.7%	9 29.0%	11 35.5%	11 35.5%
All Minority Students (25 Total)	1 4.0%	6 24.0%	4 16.0%	10 40.0%	4 16.0%
Male Minority Students (10 Total)	0 0.0%	0 0.0%	2 20.0%	6 60.0%	2 20.0%
Female Minority Students (15 Total) p_5=0.077 (vs. Non-Minority Male Students)	1 6.7%	6 40.0%	2 13.3%	4 26.7%	2 13.3%

For Statement #4, "I find that I understand a mathematical concept better once I have discussed it with other people," we see in Table 6 that all groups of students predominately agreed with the statement. Furthermore, when the chi-squared test was performed for Statement #4, there were no statistically significant findings in any of the subgroups. However, when non-minority male students were compared with minority Male students, we did find marginally significant differences between these two groups with $p_4 = 0.100$. Thus, we can conclude that while all groups of students generally agree with the statement, minority male students were actually slightly more likely to agree with the statement given that they had no responses in the strongly disagree or disagree categories and only one response in the neutral category, unlike non-minority male students, who had numerous responses in these three categories in comparison. Hence, all groups of students were more likely to feel that engaging in mathematical discourse helps them to understand the problem more fully, and male minority students were slightly more likely than non-minority male students to agree with the statement.

Table 6. Number and percentage of students' responses to Statement #4 by group.

Survey Statement #4	**Number & Percentage of Students' Responses by Group**				
I find that I understand a mathematical concept better once I have discussed it with other people.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	3 2.6%	14 12.3%	27 23.7%	45 39.5%	25 21.9%
Male Students (62 Total)	2 3.2%	6 9.7%	12 19.4%	28 45.2%	14 22.6%
Female Students (52 Total)	1 1.9%	8 15.4%	15 28.8%	17 32.7%	11 21.2%
All Non-Minority Students (89 Total)	3 3.4%	11 12.4%	22 24.7%	33 37.1%	20 22.5%
Male Non-Minority Students (52 Total)	2 3.8%	6 11.5%	11 21.2%	21 40.4%	12 23.1%
Female Non-Minority Students (37 Total)	1 2.7%	5 13.5%	11 29.7%	12 32.4%	8 21.6%
All Minority Students (25 Total)	0 0.0%	3 12.0%	5 20.0%	12 48.0%	5 20.0%
Male Minority Students (10 Total) p_4=0.100 (vs. Non-Minority Male Students)	0 0.0%	0 0.0%	1 10.0%	7 70.0%	2 20.0%
Female Minority Students (15 Total)	0 0.0%	3 20.0%	4 26.7%	5 33.3%	3 0.0%

On Statement #5, "I'm not confident enough with my math knowledge to discuss specific problems with others," Table 7 shows that most groups of students were more likely to disagree with the statement, with the exception of minority students, whose modes were split equally between disagree and neutral, while male minority students had modes that were split equally between strongly disagree and neutral. Furthermore, when the chi-squared test was performed for Statement #5, there were no statistically significant or marginally significant findings in any of the subgroup comparisons. This leads us to conclude that the majority of students report feeling confident enough with their math knowledge to discuss specific problems with others.

Table 7. Number and percentage of students' responses to Statement #5 by group.

Survey Statement #5 I'm not confident enough with my math knowledge to discuss specific problems with others.	**Number & Percentage of Students' Responses by Group**				
	SD	**D**	**N**	**A**	**SA**
All Students (114 Total)	25 21.9%	55 48.2%	17 14.9%	14 12.3%	3 2.6%
Male Students (62 Total)	15 24.2%	31 50.0%	7 11.3%	8 12.9%	1 1.6%
Female Students (52 Total)	10 19.2%	24 46.2%	10 19.2%	6 11.5%	2 3.8%
All Non-Minority Students (89 Total)	20 22.5%	46 51.7%	8 9.0%	12 13.5%	3 3.4%
Male Non-Minority Students (52 Total)	11 21.2%	29 55.8%	3 5.8%	8 15.4%	1 1.9%
Female Non-Minority Students (37 Total)	9 24.3%	17 45.9%	5 13.5%	4 10.8%	2 5.4%
All Minority Students (25 Total)	5 20.0%	9 36.0%	9 36.0%	2 8.0%	0 0.0%
Male Minority Students (10 Total)	4 40.0%	2 20.0%	4 40.0%	0 0.0%	0 0.0%
Female Minority Students (15 Total)	1 6.7%	7 46.7%	5 33.3%	2 13.3%	0 0.0%

The results of Statement #6, "I would rather work in groups with people of my same gender," shown in Table 8, illustrates that most groups of students, with the exception of female students and non-minority male and female students, tended to disagree with the statement. The modes for female students were split evenly between disagree and neutral, while the modes for non-minority students and non-minority male and female students were predominantly neutral at 39.3%, 38.5%, and 40.5%, respectively, with the mode for disagree at a close second with 31.5% for non-minority students as a whole. When the chi-squared test was performed on this statement, we found no statistically significant or marginally significant differences in the way the students in the various subgroups responded. These findings suggest that most students would not necessarily prefer to work in groups comprised of their same gender and, ultimately, that the majority of all groups of students were open to working with people of either gender.

Table 8. Number and percentage of students' responses to Statement #6 by group.

Survey Statement #6	**Number & Percentage of Students' Responses by Group**				
I would rather work in groups with people of my same gender.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	27 23.7%	41 36.0%	39 34.2%	5 4.4%	2 1.8%
Male Students (62 Total)	14 22.6%	23 37.1%	21 33.9%	2 3.2%	2 3.2%
Female Students (52 Total)	13 25.0%	18 34.6%	18 34.6%	3 5.8%	0 0.0%
All Non-Minority Students (89 Total)	21 23.6%	28 31.5%	35 39.3%	3 3.4%	2 2.2%
Male Non-Minority Students (52 Total)	11 21.2%	18 34.6%	20 38.5%	1 1.9%	2 3.8%
Female Non-Minority Students (37 Total)	10 27.0%	10 27.0%	15 40.5%	2 5.4%	0 0.0%
All Minority Students (25 Total)	6 24.0%	13 52.0%	4 16.0%	2 8.0%	0 0.0%
Male Minority Students (10 Total)	3 30.0%	5 50.0%	1 10.0%	1 10.0%	0 0.0%
Female Minority Students (15 Total)	3 20.0%	8 53.3%	3 20.0%	1 6.7%	0 0.0%

For Statement #7, "I do not enjoy working on mathematics problems with others—math is a more solitary exercise," we see in Table 9 that the majority of groups of students disagreed with the statement, with the exception of female non-minority students, whose modes were split evenly between disagree and neutral at 27.0%, and male minority students, who reported mostly neutral responses at 40.0% with the frequencies of disagree and strongly disagree tied at a close second of 30.0% each. The results of the chi-squared test on this statement reveal no statistically significant or marginally significant differences among the various subgroups of students. Thus, the majority of students surveyed felt that math is not necessarily a more solitary exercise and that they actually enjoyed working with others on math problems.

Table 9. Number and percentage of students' responses to Statement #7 by group.

Survey Statement #7	**Number & Percentage of Students' Responses by Group**				
I do not enjoy working on mathematics problems with others--math is a more solitary exercise.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	25 21.9%	38 33.3%	29 25.4%	19 16.7%	3 2.6%
Male Students (62 Total)	15 24.2%	21 33.9%	17 27.4%	8 12.9%	1 1.6%
Female Students (52 Total)	10 19.2%	17 32.7%	12 23.1%	11 21.2%	2 3.8%
All Non-Minority Students (89 Total)	21 23.6%	28 31.5%	23 25.8%	15 16.9%	2 2.2%
Male Non-Minority Students (52 Total)	12 23.1%	18 34.6%	13 25.0%	8 15.4%	1 1.9%
Female Non-Minority Students (37 Total)	9 24.3%	10 27.0%	10 27.0%	7 18.9%	1 2.7%
All Minority Students (25 Total)	4 16.0%	10 40.0%	6 24.0%	4 16.0%	1 4.0%
Male Minority Students (10 Total)	3 30.0%	3 30.0%	4 40.0%	0 0.0%	0 0.0%
Female Minority Students (15 Total)	1 6.7%	7 46.7%	2 13.3%	4 26.7%	1 6.7%

On Statement #8, "I prefer working in groups that have both male and female members," we see in Table 10 that the following groups felt mostly neutral about the statement: all students (42.1%), female students (48.1%), non-minority students (43.8%), male and female non-minority students (at 38.5% and 51.4%, respectively), and female minority students (40.0%). Male students, minority students, and male minority students all had modes displaying general agreement with the statement, while male non-minority students had a mode split equally at 38.5% between neutral and agree. It is worth noting that, as a whole, all groups of students had modes that were either neutral or in agreement with the statement and that for those groups who were neutral on the statement, the second highest frequency was to agree with the statement. Furthermore, when we performed the chi-squared test on this statement, we found no statistically significant or marginally significant differences among the way each subgroup responded. Thus, we conclude that all groups of students generally preferred or felt neutral toward working in groups that have both male and female members, which supports the earlier tendency of students to disagree with Statement #6, "I would rather work in groups with people of my same gender."

Table 10. Number and percentage of students' responses to Statement #8 by group.

Survey Statement #8	**Number & Percentage of Students' Responses by Group**				
I prefer working in groups that have both male and female members.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	1 0.9%	4 3.5%	48 42.1%	41 36.0%	20 17.5%
Male Students (62 Total)	1 1.6%	1 1.6%	23 37.1%	25 40.3%	12 19.4%
Female Students (52 Total)	0 0.0%	3 5.8%	25 48.1%	16 30.8%	8 15.4%
All Non-Minority Students (89 Total)	1 1.1%	3 3.4%	39 43.8%	31 34.8%	15 16.9%
Male Non-Minority Students (52 Total)	1 1.9%	1 1.9%	20 38.5%	20 38.5%	10 19.2%
Female Non-Minority Students (37 Total)	0 0.0%	2 5.4%	19 51.4%	11 29.7%	5 13.5%
All Minority Students (25 Total)	0 0.0%	1 4.0%	9 36.0%	10 40.0%	5 20.0%
Male Minority Students (10 Total)	0 0.0%	0 0.0%	3 30.0%	5 50.0%	2 20.0%
Female Minority Students (15 Total)	0 0.0%	1 6.7%	6 40.0%	5 33.3%	3 20.0%

The results of Statement #9, "When I have no idea how to start a math problem, I find it useful to discuss possible approaches with others," shown in Table 11, were unanimous in agreement across the board among all groups of students. The results of performing the chi-squared test also support that conclusion as there were no statistically significant differences among the way that the various subgroups responded, except for a marginally significant difference when non-minority male students were compared to non-minority female students with a p-value of $p_3 = 0.080$. Thus, we would conclude that all groups and subgroups of students tend to agree with this statement, and non-minority female students were slightly more likely to agree with the statement than non-minority male students. This result supports the general disagreement by most groups to Statement #2, "I only discuss a math problem with others once I fully understand it myself," with the exception of the marginally significant differences found among minority and female minority students to Statement #2. The best explanation between the differences in minority and female minority students responses among these two questions is the slight difference in phrasing of the two questions in which Statement #2 implies that these students will first try to understand a math problem before discussing it with others, while Statement #9 implies that students have tried to first understand the problem but were unable to figure out where to begin, in which case they then find it useful to discuss the problem with others.

Table 11. Number and percentage of students' responses to Statement #9 by group.

Survey Statement #9 When I have no idea how to start a math problem, I find it useful to discuss possible approaches with others.	**Number & Percentage of Students' Responses by Group**				
	SD	**D**	**N**	**A**	**SA**
All Students (114 Total)	1 0.9%	12 10.5%	18 15.8%	51 44.7%	32 28.1%
Male Students (62 Total)	1 1.6%	6 9.7%	12 19.4%	25 40.3%	18 29.0%
Female Students (52 Total)	0 0.0%	6 11.5%	6 11.5%	26 50.0%	14 26.9%
All Non-Minority Students (89 Total)	1 1.1%	9 10.1%	13 14.6%	39 43.8%	27 30.3%
Male Non-Minority Students (52 Total)	1 1.9%	6 11.5%	10 19.2%	19 36.5%	16 30.8%
Female Non-Minority Students (37 Total) p_3=0.080 (vs. Non-Minority Male Students)	0 0.0%	3 8.1%	3 8.1%	20 54.1%	11 29.7%
All Minority Students (25 Total)	0 0.0%	3 12.0%	5 20.0%	12 48.0%	5 20.0%
Male Minority Students (10 Total)	0 0.0%	0 0.0%	2 20.0%	6 60.0%	2 20.0%
Female Minority Students (15 Total)	0 0.0%	3 20.0%	3 20.0%	6 40.0%	3 20.0%

For Statement #10, "I feel that my ideas on how to solve a problem are valued by other group members," we see in Table 12 that all groups of students were generally in agreement with the statement, with the exception of minority females for whom the mode was tied between neutral and agree at 46.7%. When the chi-squared test was conducted, we found that there was a statistically significant difference in the way that both female students and non-minority female students responded to this statement when compared to male students and non-minority male students, respectively. When male students were compared against female students, we found a p-value of $p_1 = 0.014$, and when non-minority male students were compared against non-minority female students, we found a p-value of $p_3 = 0.021$. Thus, we conclude that the majority of students felt like their ideas were valued among their group members, with the exception of female students and non-minority female students. While these two groups of students had modes that were in general agreement with the statement, they had additional frequent responses in the neutral and both disagreement categories of the survey. Hence, we would also conclude that female students and non-minority female students were more likely to feel neutral, disagree or strongly disagree with the statement and therefore feel that their ideas on how to solve math problems were not generally valued by other group members when compared to male students and non-minority male students.

Table 12. Number and percentage of students' responses to Statement #10 by group.

Survey Statement #10	**Number & Percentage of Students' Responses by Group**				
I feel that my ideas on how to solve a problem are valued by other group members.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	2 1.8%	5 4.4%	34 29.8%	57 50.0%	16 14.0%
Male Students (62 Total)	0 0.0%	1 1.6%	15 24.2%	36 58.1%	10 16.1%
Female Students (52 Total) p_1=0.014 (vs. Male Students)	2 3.8%	4 7.7%	19 36.5%	21 40.4%	6 11.5%
All Non-Minority Students (89 Total)	2 2.2%	5 5.6%	24 27.0%	44 49.4%	14 15.7%
Male Non-Minority Students (52 Total)	0 0.0%	1 1.9%	12 23.1%	30 57.7%	9 17.3%
Female Non-Minority Students (37 Total) p_3=0.021 (vs. Non-Minority Male Students)	2 5.4%	4 10.8%	12 32.4%	14 37.8%	5 13.5%
All Minority Students (25 Total)	0 0.0%	0 0.0%	10 19.2%	13 25.0%	2 3.8%
Male Minority Students (10 Total)	0 0.0%	0 0.0%	3 8.1%	6 16.2%	1 2.7%
Female Minority Students (15 Total)	0 0.0%	0 0.0%	7 46.7%	7 46.7%	1 6.7%

On Statement #11, "I have never participated in group work in a college mathematics course before," Table 13 shows that for All students, male students, female students, non-minority students, non-minority male, and non-minority female students, the mode was generally either to strongly disagree or disagree with the statement. For minority students (including both male and female minority students), the mode was generally either neutral or to agree. It is worth noting that for minority students and female minority students, the second highest number of responses was to strongly disagree. When the chi-squared test was performed, we found marginally significant differences in the way that female students responded to this question as compared to male students with a p-value of $p_1 = 0.100$. Thus, based on female students responses, we see that they had a higher percentage of responses in the agree categories than male students and were slightly more likely to state that they had never participated in group work in a college mathematics course before. We also found a marginally significant difference in the way that female minority students responded when compared against non-minority males with a p-value of $p_5 = 0.074$. Based on female minority students responses, we see that they had a higher percentage of responses in the two agreement categories than non-minority male students. Therefore, female minority students were slightly more likely to agree with the statement and were slightly more likely to have never participated in group work in a college mathematics course before. Thus, we would conclude that most students have indeed participated in small-group work in their college mathematics courses before, with the exception of female and minority female students. It is worth noting that while female students were significantly more likely to report

having never engaged in group work in a college math course before on Statement #11, this was not evident in the counter Statement #1. Perhaps the difference was the result of the use of the word "never" in Statement #11 and the combination of the neutral responses into the disagreement category of the chi-squared comparison table.

Table 13. Number and percentage of students' responses to Statement #11 by group.

Survey Statement #11	**Number & Percentage of Students' Responses by Group**				
I have never participated in group work in a college mathematics course before.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	35 30.7%	31 27.2%	13 11.4%	23 20.2%	12 10.5%
Male Students (62 Total)	21 33.9%	16 25.8%	10 16.1%	9 14.5%	6 9.7%
Female Students (52 Total) p_1=0.100 (vs. Male Students)	14 26.9%	15 28.8%	3 5.8%	14 26.9%	6 11.5%
All Non-Minority Students (89 Total)	29 32.6%	27 30.3%	8 9.0%	16 18.0%	9 10.1%
Male Non-Minority Students (52 Total)	19 36.5%	15 28.8%	6 11.5%	7 13.5%	5 9.6%
Female Non-Minority Students (37 Total)	10 27.0%	12 32.4%	2 5.4%	9 24.3%	4 10.8%
All Minority Students (25 Total)	6 24.0%	4 16.0%	5 20.0%	7 28.0%	3 12.0%
Male Minority Students (10 Total)	2 20.0%	1 10.0%	4 40.0%	2 20.0%	1 10.0%
Female Minority Students (15 Total) p_5=0.074 (vs. Non-Minority Male Students)	4 26.7%	3 20.0%	1 6.7%	5 33.3%	2 13.3%

The results of Statement #12, "I find that each group member generally contributes equally to the work that needs to be done," shown in Table 14 reveal that for male students, non-minority students, and both male and female non-minority students, the mode was to disagree with the statement, whereas for all remaining groups, the mode was generally neutral. When the chi-squared test was performed, we found statistically significant differences when the subgroups of minority students were compared against non-minority students, and male minority students were compared against non-minority male students with p-values of $p_2 = 0.023$ and $p_4 = 0.007$, respectively. Based on this analysis and the modes from Table 14, we see that minority students and male minority students generally felt more neutral or tended to agree with the statement, allowing us to conclude that, while most students tended not to feel that each group member generally contributes to the work that needs to be done, minority students and male minority students tended to feel that most students contribute equally to the work that needs to be done. Thus, minorities perspectives on this statement differ significantly from that of non-minority students as a whole as well as from that of their non-minority male counterparts. In short, based simply on the modes of students' responses, minority students, including both male and female minorities, generally felt that each group member contributed equally to the work and were also more likely to agree with the statement, whereas leader-slacker tensions were higher among non-minority students. The chi-squared test revealed these differences in students' perceptions to be significantly different among minorities as a whole and among male minority students as well.

Table 14. Number and percentage of students' responses to Statement #12 by group.

Survey Statement #12 I find that each group member generally contributes equally to the work that needs to be done.	**Number & Percentage of Students' Responses by Group**				
	SD	**D**	**N**	**A**	**SA**
All Students (114 Total)	18 15.8%	32 28.1%	34 29.8%	25 21.9%	5 4.4%
Male Students (62 Total)	11 17.7%	18 29.0%	17 27.4%	12 19.4%	4 6.5%
Female Students (52 Total)	7 13.5%	14 26.9%	17 32.7%	13 25.0%	1 1.9%
All Non-Minority Students (89 Total)	16 18.0%	31 34.8%	23 25.8%	18 20.2%	1 1.1%
Male Non-Minority Students (52 Total)	11 21.2%	18 34.6%	13 25.0%	9 17.3%	1 1.9%
Female Non-Minority Students (37 Total)	5 13.5%	13 35.1%	10 27.0%	9 24.3%	0 0.0%
All Minority Students (25 Total) p_2=0.023 (vs. Non-Minority Students)	2 8.0%	1 4.0%	11 44.0%	7 28.0%	4 16.0%
Male Minority Students (10 Total) p_4=0.007 (vs. Non-Minority Male Students)	0 0.0%	0 0.0%	4 40.0%	3 30.0%	3 30.0%
Female Minority Students (15 Total)	2 13.3%	1 6.7%	7 46.7%	4 26.7%	1 6.7%

For Statement #13, "I often feel that my ideas on how to solve a problem are not valued by my group members," we see in Table 15 that the modes were to disagree across all groups of students. Hence, this would generally support the conclusions drawn for the contrasting Statement #10, "I feel that my ideas on how to solve a problem are valued by other group members," in which the mode was agreement across the board, except for the fact that the chi-squared test revealed significant differences in the ways that both female and female non-minority students responded to Statement #10. In this instance, i.e., for Statement #13, there were no significant differences found among the ways any of the subgroups of students responded to this statement. Thus, in this case, all groups of students generally felt that their ideas were indeed valued by their group members when it was phrased in this manner, and these results were supported by the chi-squared test on this question. Perhaps the operative word yielding a slight difference here was "often," whereas Statement #10 did not utilize that word in its opposite phrasing of the statement.

Table 15. Number and percentage of students' responses to Statement #13 by group.

Survey Statement #13	**Number & Percentage of Students' Responses by Group**				
I often feel that my ideas on how to solve a problem are not valued by my group members.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	16 14.0%	55 48.2%	36 31.6%	7 6.1%	0 0.0%
Male Students (62 Total)	9 14.5%	29 46.8%	20 32.3%	4 6.5%	0 0.0%
Female Students (52 Total)	7 13.5%	26 50.0%	16 30.8%	3 5.8%	0 0.0%
All Non-Minority Students (89 Total)	14 15.7%	40 44.9%	29 32.6%	6 6.7%	0 0.0%
Male Non-Minority Students (52 Total)	8 15.4%	22 42.3%	18 34.6%	4 7.7%	0 0.0%
Female Non-Minority Students (37 Total)	6 16.2%	18 48.6%	11 29.7%	2 5.4%	0 0.0%
All Minority Students (25 Total)	2 8.0%	15 60.0%	7 28.0%	1 4.0%	0 0.0%
Male Minority Students (10 Total)	1 10.0%	7 70.0%	2 20.0%	0 0.0%	0 0.0%
Female Minority Students (15 Total)	1 6.7%	8 53.3%	5 33.3%	1 6.7%	0 0.0%

Lastly, for Statement #14, "When working in groups, I find that some people tend to do all the work while others do very little," we see in Table 16 that the modes for All students, male students, female students, non-minority students, both male and female non-minority students, and female minority students was to agree with the statement, whereas for minority students and male minority students, the mode was neutral. The chi-squared test revealed significant differences among the way that male minority students responded to this statement as compared to non-minority male students with a p-value of $p_4 = 0.004$. Hence, this statement suggests that when phrased this way (in contrast to the positive phrasing of Statement #12), leader-slacker tensions were more likely to be reported among most groups of students with the exception of male minority students, who were either neutral or in disagreement with this statement. Therefore, the chi-squared test revealed that male minority students were significantly more likely to feel that leader-slacker tensions are not a problem when working in groups, which was also supported by the chi-squared test on Statement #12.

Table 16. Number and percentage of students' responses to Statement #14 by group.

Survey Statement #14	**Number & Percentage of Students' Responses by Group**				
When working in groups, I find that some people tend to do all the work while others do very little.	**SD**	**D**	**N**	**A**	**SA**
All Students (114 Total)	1 0.9%	13 11.4%	39 34.2%	48 42.1%	13 11.4%
Male Students (62 Total)	1 1.6%	8 12.9%	21 33.9%	26 41.9%	6 9.7%
Female Students (52 Total)	0 0.0%	5 9.6%	18 34.6%	22 42.3%	7 13.5%
All Non-Minority Students (89 Total)	1 1.1%	10 11.2%	27 30.3%	40 44.9%	11 12.4%
Male Non-Minority Students (52 Total)	1 1.9%	5 9.6%	15 28.8%	25 48.1%	6 11.5%
Female Non-Minority Students (37 Total)	0 0.0%	5 13.5%	12 32.4%	15 40.5%	5 13.5%
All Minority Students (25 Total)	0 0.0%	3 12.0%	12 48.0%	8 32.0%	2 8.0%
Male Minority Students (10 Total) p_4=0.004 (vs. Non-Minority Male Students)	0 0.0%	3 30.0%	6 60.0%	1 10.0%	0 0.0%
Female Minority Students (15 Total)	0 0.0%	0 0.0%	6 40.0%	7 46.7%	2 13.3%

4.5 Review of Open Response Questions

In the third and final portion of the survey, students were asked to answer the following open response questions:

- What things do you enjoy most about doing group work in this math course?
- What things do you enjoy least about doing group work in this math course?
- Please provide any additional information and/or comments you would like to share in the space below.

Using Microsoft Excel to transcribe the data from these open response questions, and sorting and grouping the students and their responses based on their gender and ethnicity, we analyzed the responses to see if any significant findings were present. Overall, we had 30 (or 26.3%) null responses which were either irrelevant to the question asked, or in which the students' did not respond to the open response section of the survey at all. In total, there were 40 (or 35.1%) responses from non-minority males, 30 (or 26.3%) responses from non-minority females, 6 (or 5.3%) responses from minority males, and 8 (or 7.0%) responses from minority females. This set of numbers is inclusive of the entire survey set and totals the 114 student records that were fully completed on the front side of the survey questionnaire.

Beginning with non-minority males, we found numerous comments suggesting that these student's enjoyed the benefits of small-group work overall, but that they also felt that there were leader-slacker tensions that contributed to their frustrations with group work. Some even reported that despite the benefits of sharing ideas, getting to see other

peoples' perspectives on each problem, and getting to learn by explaining problems to those who were lacking an understanding of it, they felt that group work slowed them down because they felt that they understood the material well enough to move at a faster pace than being in a group allowed them to. For example, one non-minority male student reported that he felt that what he likes most about small-group work is that it leads to a better understanding of problems, and encourages discussions leading to more curiosity about the problems; however, he dislikes slackers or those who only want to do the bare minimum. Many similar comments were present among this group of students.

With respect to non-minority females, this group of students also reported many positive things that they enjoy about participating in small-group work in their mathematics courses, as well as some negative aspects that they do not enjoy. Overall, most students in this group reported enjoying being able to combine ideas to more fully understand the problem, and seeing different approaches to solving the problem at hand. However, this group of students also reported feeling like some people do all of the work while others do very little. In addition, non-minority females reported that sometimes people get left behind when the majority of the group reaches an understanding and moves on to the next problem. For example, one student from this group reported that it helps to share ideas on how to approach a problem with others, but she dislikes when some of the group members understand things more quickly than others and those other members get left behind. Thus, despite the clear benefits of group work, leader-slacker tensions and feeling that some group members get left behind were the predominant source of frustration with group work among non-minority females. This latter source of

frustration was not overly present among non-minority males, suggesting that non-minority females observed and were more concerned with the fact that some group members need more time to process and fully understand the problems.

The group of minority males was considerably smaller than either of the two groups discussed above; however, their responses were similar in some ways. Of the six students in this category who responded to the open response questions, five reported that they like the same positive aspects of doing group work, which include brainstorming on how to start and solve a problem, discussing ideas and procedures on how to solve a problem, and looking at all of the different ways a problem can be solved. One student even stated that he wished that they could do more group work in this course. In contrast, minority males' dislikes of small-group work were centered around debating, or even arguing, over which answers or approaches were the correct ones—a problem previously noted by Colbeck and Rosser that can lead to group tensions—as well as the leader-slacker tensions that frequently arise in small-group work.[13,14] One male minority student reported having never done any small-group work before. Thus, again, we see that this group of students predominantly sees and enjoys the benefits of small-group work in mathematics courses, but that they dislike group conflicts and leader-slacker tensions.

The final group of students that responded to the survey were minority females, which contained eight students. Overall, five minority females reported enjoying the benefits of sharing knowledge and discussing problems with others; however, among this group, there were three students that reported that they dislike having to work with other people on math problems altogether. One of the most informative responses was

centered around the fact that this particular student likes sharing ideas and learning from others and feels that explaining concepts to others helps her understand the material better; however, she dislikes slackers. This response was unique in that she mentioned the fact that explaining concepts to others actually helps reinforce students' understanding of the material at hand, which is also mentioned in some of the research, including that done by Slavin.[6]

Thus, overall, the open response questions reveal that the main four groups of students, non-minority males, non-minority females, minority males, and minority females, all felt that small-group work was beneficial given that engaging in open discourse on math problems helps students understand the material better and that seeing multiple approaches to solutions helped widen students' perspectives on how to solve problems. Problems associated with group work were centered around leader-slacker tensions among all groups, and some groups felt that arguing over different answers was detrimental to the group work process, as was the sense that some students tend to get left behind if they do not understand the material as quickly as the rest of the group. This leads us to believe that some of these problems could potentially be resolved by incorporating some of the slightly more rigid group structures characteristic of cooperative learning methods, such as assigning a group leader who is responsible for ensuring that everyone understands a problem before the group moves on to the next, or having the instructor intervene when group conflicts arise to help prevent heated debates and arguments over conflicting answers to problems. It is worth noting that some researchers, such as Slavin, would argue that engaging in heated debates is essential to

enhancing the group's learning process.[6] Otherwise, it appears that collaborative learning methods receive an overall positive view from the students who engage in them, despite numerous reports of leader-slacker tensions.

4.6 Survey Results Summary

In a sample of 164 college students who do not necessarily engage in small-group learning on a regular basis in their mathematics course, but who were permitted to work together in groups outside of class, we were able to analyze 114 fully completed survey records. This analysis revealed that, overall, students generally feel positive about the benefits of working in small-groups in their mathematics courses. Leader-slacker tensions were common complaints among all groups of students, as were concerns for those students that get left behind when they need more time to understand the problem at hand than the group allows.

There were three statements that yielded statistically significant results, and six statements that yielded marginally significant results among the five groups of students that we compared using the chi-squared test for proportionality. Beginning with males vs. females, we had statistically significant results on Statement #10, "I feel that my ideas on how to solve a problem are valued by other group members." Female students were more likely to disagree with Statement #10. We also found marginally significant results on Statement #11, "I have never participated in group work in a college mathematics course before," which female students were slightly more likely to agree with when compared to male students implying that female students are less likely to

work in groups when they are not required to by their instructor.

Next we compared non-minority students to minority students, which yielded marginally significant results on Statement #1, "I have participated in group work in a college mathematics course before," which minority students were slightly more likely to disagree with and which indicates that they too are less likely to work in groups when it is not a requirement for the course. On Statement #2, "I only discuss a math problem with others once I fully understand it myself," minority students were marginally more likely to agree with this statement, indicating that minority students prefer to understand a problem before going to others to discuss the solution. Finally, Statement #12, "I find that each group member generally contributes equally to the work that needs to be done," yielded statistically significant results for minority students, indicating that they were more likely to agree with this statement than were their non-minority counterparts and that minority students do not tend to perceive the existence of leader-slacker tensions that non-minority males are more likely to perceive.

In comparing non-minority male students with non-minority female students, we had one marginally significant statement and one statistically significant statement. Statement #9, "When I have no idea how to start a math problem, I find it useful to discuss possible approaches with others," yielded marginally significant results for non-minority females, as they tended to be slightly more likely to agree with this statement than non-minority males. Furthermore, Statement #10, "I feel that my ideas on how to solve a problem are valued by other group members," yielded statistically significant results when non-minority males were compared to non-minority females since

the female students were more likely to disagree with this statement than their non-minority male counterparts, indicating that non-minority females do not feel that their ideas are valued by other group members.

When non-minority males were compared to minority males, we found that there was marginal significance on one statement and statistically significant differences on two statements. For Statement #4, "I find that I understand a mathematical concept better once I have discussed it with other people," we found that minority males were slightly more likely to agree with the statement, implying that minority males find group work beneficial to understanding math problems better. For Statement #12, "I find that each group member generally contributes equally to the work that needs to be done," minority males were statistically more likely to agree with the statement than their non-minority male counterparts, and for Statement #14, "When working in groups, I find that some people tend to do all the work while others do very little," minority males were statistically more likely to disagree with the statement than their non-minority male counterparts—both of which imply that minority males do not perceive the same level of leader-slacker tensions that non-minority males do.

Finally, when non-minority males were compared to minority females, we found that there were three statements for which there were marginally significant differences in their answers. For Statement #2, "I only discuss a math problem with others once I fully understand it myself," female minorities were slightly more likely than their non-minority male counterparts to feel that they would prefer to understand a problem before discussing it with other people. For Statement #3, "I enjoy working with other people on

math problems," female minorities were slightly more likely to feel that they do not enjoy working with other people on math problems as compared to non-minority males. Finally, for Statement #11, "I have never participated in group work in a college mathematics course before," female minority students were slightly more likely to agree with the statement when compared against their non-minority male counterparts, implying that female minority students are less likely to engage in group work when it is not a requirement for the course as was found for non-minority females as well.

The review of the open response questions was enlightening in that we gained an opportunity to hear from the students first-hand on how they felt about engaging in small-group work. The students found small-group work helpful when students did not know how to begin a problem, and in helping them understand a problem, its solution, and the different possible approaches that can be used to solve a problem. In this section, students also reported feeling like some people do all of the work while others do very littl. They also noted the frustrations that arise when group conflicts lead to heated debates about which solution is the correct one when multiple answers arise. There were also responses that confirmed Slavin's research stating that those who learn most from small-group work are those that provide explanations to others, rather than those who just receive those explanations.[6]

5 CONCLUSION

In surveying 114 Eastern Michigan University Undergraduate students who were registered for a cross section of mathematics courses, we found that, by comparing the

frequencies and modes of students responses, as well as by comparing five groups of students using a chi-squared analysis, there were eight marginally significant and five statistically significant findings using a 5% significance level in the Likert-scale data that were reported by students regarding their small-group work experiences. The data gathered from the qualitative survey conducted here supports research that suggests that small-group learning, whether cooperative or collaborative in nature, improves students' understanding of mathematics material.[1–6] While our research suggests that the previous conclusion generally holds across gender and ethnicity, variations in the modes of the Likert-scale responses of students in the survey reveals that minority students feel slightly less favorable about engaging in small-group learning than their non-minority counterparts. In examining the potential reasons for this, our research revealed that minority students were more likely to report feeling less confident in discussing mathematical concepts with others, or preferring to develop their own understanding of a problem prior to discussing it with others. In addition, female and female non-minority students were also more likely to report feeling that a disparity often exists between group member contributions and that their work was not valued by other group members.

The results found here lend support to research done by cooperative and collaborative learning theorists that suggests that all groups of students, including non-minority males, women, and minorities, will report positively on their small-group learning experiences because of the perceived benefits found in sharing information and discussing math problems to find various routes to the proper solutions. Tensions arise among all groups, especially when group conflicts surface and/or proper group structures

fail to be implemented.[13,14] The type of small-group learning that the students within the sample engage in would be best classified as collaborative learning, which does not incorporate the more rigid group structures characteristic of cooperative learning methods. We acknowledge that the lack of group structures (and resulting lack of group interdependence) provided here could be the source of the leader-slacker tensions that were reported by many of the students as a negative aspect of their group work experiences. Overall, however, the observed differences among the frequency distributions, modes, and p-values were slight, and women and minority students still responded more favorably towards group work than not in the open response section of the survey.

In short, further research of a qualitative nature with improvements to the survey statements, including additional statements regarding group heterogeneity, and surveying a population of students who are more actively involved in small-group work in their mathematics courses could more accurately establish the effects of gender and ethnicity on students' perceptions of small-group work. Such additional research would need to survey a larger student sample comprised of a more diverse student population, which must also include more minorities to fully establish their perceptions of small-group work. In addition, such research should also include a wider array of collegiate mathematics courses taught (1) at different universities and (2) by multiple instructors who regularly incorporate small-group work into their mathematics courses. Furthermore, an examination of the varying group structures that are incorporated within the small-group learning that students engage in would also be important in understanding how these

structures enhance or inhibit students' ability to successfully engage in group work. Studies of this nature would thereby enable researchers to perform a more in-depth comparison of the roles played by such group structures in shaping the perceptions of women and minority students on their small-group learning experiences in collegiate mathematics courses.

Ultimately, our findings suggest that students would benefit from engaging in small-group work in their collegiate mathematics courses on a regular basis, as students reported feeling that small-group work improved their understanding of mathematical concepts and that engaging in mathematical discourse helped them strengthen their problem solving skills. Furthermore, experience with small-group work in mathematics courses at the collegiate level will help students prepare for the challenges involved in engaging in collaborative settings in their future careers and will benefit them immensely in preparing for careers in the science, technology, engineering, and mathematics (STEM) fields.

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APPENDICES

Appendix A: Sample Survey Form (Page 1)

STUDENT QUESTIONNAIRE:
PERCEPTIONS OF SMALL-GROUP WORK IN COLLEGE MATHEMATICS COURSES

Math Instructor: _____

Math Course: ☐ 097 ☐ 098 ☐ 104 ☐ 105 ☐ 107 ☐ 112 ☐ 120 ☐ 121 ☐ 122 ☐ 223

Gender: ☐ Male ☐ Female

Race/Ethnicity (please select all that apply):

☐ Black or African American
☐ American Indian or Alaskan Native
☐ Native Hawaiian or Other Pacific Islander
☐ Hispanic or Latino
☐ White
☐ Asian
☐ Other (please specify): _____

Age Group (please select one):

☐ Under 18
☐ 18 to 21
☐ 22 to 25
☐ 26 to 29
☐ Over 29

Please indicate your level of agreement to each of the following statements (circle only one for each):

SD = Strongly Disagree D = Disagree N = Neutral A = Agree SA = Strongly Agree

1. I have participated in group work in a college mathematics course before.	SD	D	N	A	SA
2. I only discuss a math problem with others once I fully understand it myself.	SD	D	N	A	SA
3. I enjoy working with other people on math problems.	SD	D	N	A	SA
4. I find that I understand a mathematical concept better once I have discussed it with other people.	SD	D	N	A	SA
5. I'm not confident enough with my math knowledge to discuss specific problems with others.	SD	D	N	A	SA
6. I would rather work in groups with people of my same gender.	SD	D	N	A	SA
7. I do not enjoy working on mathematics problems with others--math is a more solitary exercise.	SD	D	N	A	SA
8. I prefer working in groups that have both male and female members.	SD	D	N	A	SA
9. When I have no idea how to start a math problem, I find it useful to discuss possible approaches with others.	SD	D	N	A	SA
10. I feel that my ideas on how to solve a problem are valued by other group members.	SD	D	N	A	SA
11. I have never participated in group work in a college mathematics course before.	SD	D	N	A	SA
12. I find that each group member generally contributes equally to the work that needs to be done.	SD	D	N	A	SA
13. I often feel that my ideas on how to solve a problem are not valued by my group members.	SD	D	N	A	SA
14. When working in groups, I find that some people tend to do all the work while others do very little.	SD	D	N	A	SA

—PLEASE COMPLETE REVERSE SIDE—

Appendix B: Sample Survey Form (Page 2)

Please provide a response to the following questions:

1. What things do you enjoy most about doing group work in this math course?

2. What things do you enjoy least about doing group work in this math course?

3. Please provide any additional information and/or comments you would like to share in the space below.

Appendix C: HSRC Permission Letter

EASTERN MICHIGAN UNIVERSITY

Education First

January 28, 2010

Layla Potts
Department of Mathematics

Dear Layla:

The College of Arts and Sciences Human Subjects Review Committee (CAS HSRC) of Eastern Michigan University has reviewed and approved your proposal titled, "The Effects of Race and Gender on Students' Perceptions of Small-Group Learning in Collegiate Mathematics Courses." The CAS HSRC has determined that the rights and welfare of the individual subjects involved in this research are carefully guarded. Additionally, the methods used to obtain informed consent are appropriate, and the individuals participating in your study are not at risk.

You are reminded of your obligation to advise the HSRC of any change in the protocol that might alter your research in any manner that differs from that upon which this approval is based. Approval of this project applies for one year from the date of this letter. If your data collection continues beyond the one-year period, you must apply for a renewal. Please specify in your consent form that approval is from 1/28/2010 to 1/27/2011.

On behalf of the Human Subjects Committee, I wish you success in conducting your research.

Sincerely,

Alissa Huth-Bocks

Alissa Huth-Bocks, Ph.D.
CAS Human Subjects Review Committee Chair

Note: If project continues beyond the length of **one** year, please submit a continuation request form by 1/27/2011.

cc: Barbara Leapard, Ph.D.

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Appendix D: Chi-Squared p-Values with a 95% Confidence Interval

Label	Chi-Squared Comparison Groups	S1	S2	S3	S4	S5	S6	S7
p_1	Males vs. Females	0.890	0.337	0.129	0.129	0.897	0.880	0.158
p_2	Non-Minorities vs. Minorities	0.059	0.075	0.530	0.443	0.272	0.661	0.920
p_3	Non-Minority Males vs. Non-Minority Females	0.930	0.610	0.568	0.373	0.892	0.941	0.610
p_4	Non-Minority Males vs. Minority Males	0.108	0.352	0.365	0.100	0.155	0.618	0.155
p_5	Non-Minority Males vs. Minority Females	0.226	0.063	0.077	0.478	0.714	0.897	0.179

Label	Chi-Squared Comparison Groups	S8	S9	S10	S11	S12	S13	S14
p_1	Males vs. Females	0.149	0.366	0.014	0.100	0.893	0.880	0.658
p_2	Non-Minorities vs. Minorities	0.461	0.541	0.634	0.254	0.023	0.614	0.125
p_3	Non-Minority Males vs. Non-Minority Females	0.179	0.080	0.021	0.212	0.563	0.672	0.601
p_4	Non-Minority Males vs. Minority Males	0.468	0.425	0.741	0.640	0.007	0.365	0.004
p_5	Non-Minority Males vs. Minority Females	0.764	0.600	0.106	0.074	0.248	0.894	0.979

Statistically Significant Results:	0.000	to	0.050
Marginally Significant Results:	0.051	to	0.100