Effects of Cooperative Learning on Academic Outcomes in a Diverse Laboratory Science Undergraduate Course

Capstone Project

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Dedication

This thesis project is dedicated to my family, for their understanding and support during my graduate degree journey and in my life. This thesis project is also dedicated to all Medical Laboratory Scientists - students, coworkers and fellow peers. As MLS professionals, your dedication, caring, and search for new discoveries while caring deeply for the patients who will never know how your work has affected their lives. Your efforts and hard work does matter and makes a difference too many people every day - never stop caring and learning.

Abstract

The purpose of this study was to examine the addition of cooperative learning techniques in an undergraduate laboratory science course and determine if there would be any effect on academic outcomes and cooperative learning behaviors specifically comparing traditional and non-traditional students. The participants were a diverse group of traditional and non-traditional male and female students from a large Midwestern university. Quantitative methods were used to evaluate the effect cooperative learning educational methods had on academic outcomes in medical laboratory students. Additionally, the study examined if academic outcomes and cooperative learning behaviors exhibited would differ based on student status, traditional and non-traditional. Cooperative learning techniques were shown to significantly increase academic outcomes in all students, but no significant difference in academic outcomes were noted based on student status. The study showed more cooperative behaviors were exhibited by traditional than non-traditional students. The goal of implementing cooperative learning techniques was to increase academic outcomes and cooperative behaviors in all medical laboratory science students which was demonstrated in this study.

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Chapter One

Introduction

Students deserve an environment that provides a best case scenario for learning and creating knowledge. Students enrolled in advanced science curriculum courses in a Medical Laboratory Science (MLS) program are cognitively demanding, and they need to be supported by their teachers and staff, stimulated to seek knowledge and understanding of the curriculum, and provided with a safe environment to overcome obstacles in their learning to succeed. An enhanced learning environment can be provided for students when teachers implement cooperative learning exercises into curriculum (Johnson, Johnson, & Stanne, 2000). This study focused on the effects that cooperative learning techniques have in a medical laboratory science microbiology course, and how they may affect academic outcomes and cooperative behaviors in a diverse student body.

Purpose of the Study

The purpose of this study was to examine how cooperative learning (CL) techniques affect the academic learning outcomes in traditional and non-traditional students. Like many health professions' educational programs, academic outcomes in Medical Laboratory Science programs are monitored and reported to an external accreditation agency. Attrition rates and performance on national certification exams are reported to an accreditation agency for each graduating class. Because the quality of the education program is based on student outcomes, MLS programs strive to increase their students' academic outcomes for the mutual benefit of both the students and the program. In this study, student assessments or exam scores were measured three times during the semester. If this study provides research data which support academic benefits of the addition of cooperative learning activities into their coursework, then Medical Laboratory Science programs can add more cooperative learning activities into their programs and increase the retention rates of all students.

Background and Significance of the Study

Cooperative learning or active learning methods have been used for many years throughout all levels of education. Implementing these methods correctly can have a huge impact on the success of this methodology. As stated by Parr in 2007 when implementing CAR (collaborate, agree, and record) in his seventh grade classroom:

> However you decide to implement CAR, there are steps that will ensure success: establish guidelines and procedures before any activity or assignment; make sure that all group members understand the group's purpose; spend time in class discussing effective collaboration practices; model each step of CAR often; and closely monitor group discussions, encouraging participation of all members and assessing group responses. (p. 23)

Students work together collaboratively and cooperatively in small groups of 2-4 students in cooperative learning teaching methods. Cooperative learning methods have five key elements which need to be included by teachers to meet the criteria of a cooperative learning lesson. These include: positive interdependence between students, i.e. the students "sink or swim together"; face-to-face (F2F) interaction, which physically places the students in close proximity with each other for maximum interaction; individual accountability which means each person is responsible for knowing the material; social skills are chosen by the students and teacher to apply to a particular lesson, and its use is monitored by the teacher; and processing which provides each group member the opportunity to evaluate and reflect on their teamwork contributions, and how they can improve and apply these improvements to the next lesson (Johnson, Johnson, & Smith, 1998).

By applying these five key elements into cooperative learning lessons, the true effects can be reaped for the students. These effects are described in a quote by Parr (2007), "Cooperative learning can help develop appropriate social skills, increase retention of knowledge, improve self-esteem, foster motivation, and enhance the overall learning experience" (p. 21). By working together as a team towards a common goal and reaching that goal, the students learn the lesson material better together than they would have individually. This outcome builds the students' self-esteem and motivates them to want to learn more. When errors occur in the learning, it's a group learning opportunity rather than an individual error or competition between students. Therefore, errors become learning opportunities for the group, and this builds self-esteem and motivates the students to participate.

Cooperative learning lends to better social interactions and quality of life as described in the 1999 article by Carpenter, Bloom, and Boat. Their research was conducted in special education classrooms using cooperative learning methods.

As stated by Carpenter, Bloom and Boat (1999):

> The ability to contribute meaningfully to one's own success, support the success of others, and have sense of belonging are important variables in the promotion of self-esteem in school settings; thus the role of cooperative learning activities in fostering and sustaining self-esteem is apparent. The basis of cooperative learning is that each group member plays a vital role in the group process. (p. 147)

These positive outcomes apply regardless of the student's ability levels when cooperative learning strategies are correctly integrated into the curriculum.

DuVal (2008) found similar results in her research with self-esteem and achievement outcomes in her fifth grade classes' recorder musical instrument sessions. While working on her Master's degree, she wanted to determine if working collaboratively the students' musical accomplishments would exceed working individually. Her findings showed increased achievement for the students who learned the music recorder in cooperative learning groups over individual learning. The students' self-esteem was positively affected also due to better musicians and lower level musicians working together to improve their skills. Another key learning component was for herself "As an educator, it is rewarding to help students comprehend that collaboration, teamwork, and problem solving are invaluable skills in and out of the classroom" (DuVal, 2008, p. 58). Cooperative learning extends beyond the confines of a physical classroom and benefits students in society.

Non-Traditional students are: independent, attend college later in their lives, come from a lower socioeconomic background, non-English language learners, attend college part-time and work, or are parents. Traditional students typically begin school right after completing post-secondary school, attend college fulltime and are usually a dependent. The academic outcomes for these students can vary depending on many factors. According to Hoyert and O'Dell (2009) "It has been commonly noted that older, nontraditional aged college students consistently maintain higher grade point averages (GPA) than their traditional aged peers (Leavitt, 1998; Eppler & Harju, 1997; Spitzer, 2000; Justice & Dornan, 2001; Morris, Brooks, & May, 2003; Dupeyrat & Marine, 2005)" (p. 1052). However, not all non-traditional students earn higher grades than traditional students and can have varying academic outcomes (Markle, 2015). Horn and Carroll (1996) found that fewer non-traditional students than traditional students earned their degrees. Since there is little research on the implementation of cooperative learning methods in a medical laboratory science program with a diverse student body, there is a true need to conduct this research.

The quantitative research questions for this study are as follows: (1) Do cooperative learning activities affect academic outcomes in medical laboratory science students?; (2) Does the effect of cooperative learning differ by student status, which is traditional or non-traditional students?; and (3) Does the amount of cooperative learning behaviors differ by student status, which is traditional and non-traditional students? The hypotheses are as follows: (1) Students in the cooperative learning group will have higher academic outcomes than students in traditional learning classroom; (2) Traditional students will have higher academic outcomes than non-traditional students in cooperative learning classroom; and (3) Traditional students will demonstrate more cooperative learning behaviors than non-traditional students.

Setting

The setting for this study was a university-based undergraduate medical laboratory science program enrolled in a core curriculum microbiology course in the Midwestern United States of America. The participants were enrolled in two sections of the same course taught by the same instructor. Participants were both traditional and non-traditional students, and were a diverse student body including African American, Caucasian and international students. In 2014, forty-seven participants were measured in their academic outcomes through three exams and observed in a cooperative learning activity during the microbiology course. The comparison group consisted of sixty-four students during the fall 2013 academic semester at the same university. The class parameters were the same for the comparison group as they were for the experimental group except only traditional teaching methods without cooperative learning activities were used in the group.

Assumptions

The literature shows that academic outcomes are typically increased when cooperative learning methods are clearly defined and implemented in small, heterogeneous groups of students. However, if these methods are unclear to the students or poorly planned by the instructors, then academic outcomes may not show any improvement and the students may be frustrated with the process. The primary researcher who was a teaching specialist and instructor who taught the course were both new to cooperative learning methods. However, the researchers and the course instructor made their best efforts to implement the cooperative learning with high fidelity using the protocol (Appendix A). The researcher also believes in cooperative learning which may cause a bias if the design of study is qualitative in which subjectivity could be seen in data collection and interpretation: thus, this study adopted quantitative approach.

Scope and Limitations of the Study

This study was conducted on a small group of medical laboratory science students attending a Midwest university. Although the student group has a diverse student population, it does not represent all possible student situations described as non-traditional or include all ethnicities. Additional research could be conducted in different geographical areas where medical laboratory science students are located to achieve a more broad scope of data. Another limitation was this research only took place for two CL activities in a microbiology class within a medical laboratory science curriculum. Other medical laboratory science courses, such as chemistry, hematology and body fluids, molecular diagnostics, coagulation, transfusion medicine, or laboratory management courses could have different data results.

Definitions

- Cooperative Learning – activity which rewards individuals for group efforts and involves students working together to accomplish goals while helping each other reach their own and each other's highest potential in learning
- Positive interdependence – the goal is that everyone must work together; sink or swim
- Face-to-Face (F2F) interaction – each team is located in close proximity to each other to encourage maximum interaction; eye-to-eye and knee-to-knee
- Individual accountability – each person is responsible for knowing the materials
- Social skills – each student must work on implementing the social skill (encouragement, summarizer) and the instructor monitors if the social skills are used
- Processing – students reflect on how well they worked together as a team and individually to reflect on how they can contribute more or improve next time
- Traditional student – student who follows the traditional pathway of education starting college right out of high school, attends college fulltime and earns a degree within four to five years, English is native language, and usually a dependent
- Non-traditional student - a student who delayed starting college right of high school due to various reasons, attends part time only, works full time, independent, lower socioeconomic class, non-English language learner or a parent

Summary

The purpose of this study was to determine if the addition of cooperative learning activities will increase academic outcomes in medical laboratory science students in a microbiology classroom. The academic outcomes were further analyzed to determine if there were assessment scores differences between traditional and non-traditional students. Finally, cooperative learning behaviors displayed were evaluated and compared between traditional and non-traditional students. The goal of implementing cooperative learning was to improve academic outcomes and increase cooperative learning social behaviors of all medical laboratory students.

Chapter Two

Literature Review

Numerous research studies have been conducted on incorporating different cooperative learning techniques such as problem based or team based learning methods in undergraduate science courses and comparing these outcomes to traditional (lecture-based) learning technique based outcomes. This chapter will compare and contrast several of these research articles covering various cooperative learning (CL) techniques applied in a variety of classrooms, diverse students, retention rates, student engagement, computer enrichment, and communication and their effects on student outcomes. The different areas researched to determine what potential effects CL could have include: problem based learning, student engagement, computer enrichment, social skills and communication, and assessment outcomes. The combination of CL techniques while considering these other factors has not been researched in medical laboratory science undergraduate courses, so other science-based undergraduate courses were reviewed.

Problem Based Learning

Problem based learning (PBL) involves a student working towards a solution to a problem but not necessarily in a group setting. In the article by Bahar-ÖzvariŞ, Cetin, Turan, and Peters' (2006), problem based learning had variable student learning outcomes compared to traditional learning methods so they added a team based cooperative learning method and group assessment to the training of mental health physician students. The principle of these added cooperative learning elements were: team rewards, individual accountability, and equal opportunities for every student's success. Per Bahar-ÖzvariŞ et al. (2006) the students were just as responsible for their own learning as well as their team's learning outcomes. Angawi (2014) also started using problem based cooperative learning methods in his undergraduate chemistry course to determine if it would help students comprehend highly complex and difficult spectra interpretations of organic compounds. The cooperative learning activity had the students work together in groups of three or four, and solve complex problems through group discussion (Angawi, 2014). Per Angawi (2014) the CL method helped promote more communication among the students, increased their motivation to learn the highly complex subject matter, and decreased the number of data interpretation errors. Creating real-life like scenarios are difficult to do in a chemistry lab, but Giancarlo (2004) accomplished this feat by having his undergraduate chemistry students utilize CL methods while problem solving and using critical thinking skills to determine if a metal object ingested by a dog was toxic in a mock situation which was based on a real-life event! Through group discussion and team work, students qualitatively and semi quantitatively determined the composition of the metal object, and its toxicity potential towards the dog (Giancarlo, 2004). This CL activity was challenging for the students, but allowed them to be creative while also discussing the advantages and disadvantages of different analytical methods used in the laboratory.

Student Engagement

The student interactions during CL group discussions and activities rely on a high level of student engagement, interaction, and preparation before class time. Active and equal participation from all students is crucial to successful CL methods during their group discussions. Obenland, Kincaid, and Hutchinson (2014) wanted to determine if the addition of a student-centered discussion at the end of each general chemistry lab would increase student engagement, their level of understanding, and meet the course learning objectives. Students voluntarily completed pre and post-test on-line surveys which assessed their understanding of the course and also participated in interviews to assess their chemistry experiences, past and present.

The findings showed that the students felt the student-centered discussions were more frequent and worthwhile, increased their understanding of the chemistry concepts, and helped them correlate the lecture and lab content (Obenlund, Kincaid, & Hutchinson, 2014).

Another way to increase student engagement is to add a constructive competitive component to cooperative learning activities. This competitive element was utilized by Rosol (2013) as a “kudos” system which rewards student groups for desired CL behaviors and/or outcomes; conversely, these kudos can also be lost by the student group if undesirable CL behaviors and/or outcomes are exhibited. Groups compete for the highest kudo points based on specific and clear criteria, which rewards the entire group with extra credit points which could raise their overall course grade. The implementation of the kudos CL system effectively increased student participation, exam scores, performance, and decreased student absenteeism (Rosol, 2013). In contrast, Herrmann (2013) concentrated his research on active participation and social interdependence between students in their political theory undergraduate course. Students are too passive in their learning and do not engage with their classmates or instructors enough per Hermann (2013). Hermann (2013) was interested in understanding to “What extent does cooperative learning increase student engagement in tutorials?” (p. 5). The tutorials were a set of four questions which were completed by the students individually before class, and then students discussed their responses in a small CL group setting. The students synthesized new answers to the questions utilizing all group members’ input until they were all in agreement on one new group answer which were then presented to the entire class. The findings from Herrmann’s (2013) research did not support the positive effects typically found using CL – students did not score higher and most students regarded CL methods negatively, although higher student engagement levels were noted.

Computer Enrichment

Another challenge undergraduate instructors have is teaching difficult chemistry concepts. The addition of computer animation combined with CL-like discussion teaching methods used by Karacop and Doymus (2013) helped students comprehend the difficult and abstract concept of chemical bonding. Computer enhanced learning applications are enriching CL teaching techniques while also increasing student achievement outcomes (Karacop & Doymus, 2013). Similarly, the research by Herron and Nurrenbern (1999) shows how computer animations help students connect macroscopic chemistry principles to the atomic level principles. The use of CL along with computer animation will enhance learning outcomes and problem solving capabilities in chemistry (Herron & Nurrenbern, 1999).

CL teaching techniques can be feasible for students in an on-line learning environment also. This was explored by Roseth, Akcaoglu, and Zellner (2013) in their research for a hybrid doctoral program. The virtual classroom environment is not an ideal setting for cooperative learning, yet they wanted to maintain some face to face small group options in regard to formatting their online course. The decision to use a hybrid blended model of synchronous and asynchronous cooperative learning activities required some new technologies to be implemented to achieve this. WordPress, "an open source website publishing application" (Roseth, Akcaoglu, & Zellner, 2013, p. 56), was used due to its ability to support small group synchronous activities occurring simultaneously. It's a website in which multiple online tools can be housed for user ease, likeability, and adaptability. Google Hangouts was used to maintain a face to face experience, Etherpads for collaborative writing assignments, Google forms for monitoring student progress and providing feedback, and Piazza was used for student question and answer sessions. The implementation of these computer enrichment tools proved to be effective in maintaining an online environment while reaping the positive effects of CL teaching activities (Roseth, Akcaoglu, & Zellner, 2013). Kahil, Kirkley, and Kibble (2013) also used an adaptive online computer enriched CL teaching method to enhance student learning and provide more feedback to their students. This was accomplished by creating an online hematology manual used in conjunction with virtual online microscopy that met the needs of histology doctoral students utilizing technology while reducing contact hours with staff. A majority of the students responded favorably to using the electronic manual, found it reinforced classroom content, provided feedback and active CL opportunities, facilitated their learning, and the students' testing scores indicated the learning objectives were met (Kahil, Kirkley, & Kibble, 2013).

Social Skills and Communication

Students' achievements are very important, but how can CL methods impact students' social interactions? "What are the effects of working in a cooperative group on your behavior, interaction, and learning achievement?" (Acar & Tarhan, 2007, p. 354). The research results of Acar and Tarhan (2007) in their undergraduate electrochemistry course yielded a significantly increased mean score by 35.9 % in the experimental group which utilized CL teaching methods compared to an increase of 4.4% in the control group post-test scores, quiet and shy students became more engaged with their peers over the duration of the course, and their ability to work cooperatively increased throughout the semester in the experimental CL groups. Similarly, student learning, motivation, and satisfaction were higher when CL methods were used compared to traditional learning methods (Jafari, 2014). The research conducted by Iguchi, Suenaga, Hosono, Nishiyam, Umezawa, and Akaho (2000) is unique because CL methods provided increased outcomes in drug information experiences for pharmacy students through the utilization of a valuable pseudo clinical experience between students and licensed pharmacists.

Due to a reduction of pharmacy affiliates with pharmacy schools, the students have decreased opportunities for an on-site pharmacy experience. Through the use of CL teaching methods and telephone communication with practicing pharmacists, these students were able to still have a realistic disease management decision-making experience (Iguchi, Suenaga, Hosono, Nishiyam, Umezawa, & Akaho, 2000).

Another desirable outcome per instructors is increased communication between students during group discussions and with their instructors. Trees (2013) stated that international students provide invaluable input into discussions and cultural knowledge for everyone in class; life experiences shared by students can be learning opportunities for the entire class, including the instructors. Group interactions within a diverse student group allow English language skills to become stronger for non-ELL students. Per Herron and Nurrenbern (1999), “Qualitative research strategies led to the conclusion that the CL experience moved students away from rote memorization toward meaningful learning and developed students’ interpersonal and communication skills” (p. 1357). Effective communication between students and instructors is conducive to increased understanding and the creation of new knowledge in the classroom. Young and Talanquer’s (2013) research focused on how different types of small-group activities in a chemistry course affected the student’s conversations and engagements with each other. Ideally, instructors want the students to stay on task during activities and focus on the content rather than diverge to non-related topics. Their research found that having a facilitator present during small group activities the entire time positively affects the level of group discussions and leads towards deeper group understanding due to more in-depth exploration and conversation of the course content (Young & Talanquer, 2013). The different activities the students participated in were brainstorming, hands-on activities, demonstrations, opinion sharing, calculations, data analysis, and text analysis which are similar to the activities performed in medical laboratory science courses (Young & Talanquer, 2013). The presence of a facilitator the entire time may not be feasible during most courses, but having instructors periodically monitor the group activities and discussions could be just as beneficial.

There is a lack of diversity and multicultural influences in science course teachers. Ferguson (2008) notes that student populations are becoming more diverse with time, but the teachers' diversity is not changing compared to the students. This is a disservice to the students the instructors are instructing unless the instructors become more aware of the diversity gap. Ferguson (2008) developed six standards to cross this gap: "dialogic conversations, authentic activities, transformative skills, committed practice, reflexivity, and knowing self, others, and epistemology" (p. 10). He acknowledged that different cultures provide different approaches and perspectives to science education which enhances all students' overall learning experience (Ferguson, 2008). By preparing future science teachers using these six multicultural standards, the communication and interactions between students and instructors will be enhanced and more meaningful, and the instructors will be more aware of themselves and their students socially and culturally (Ferguson, 2008).

Assessments and Outcomes

Another challenge for many instructors is the development of learning outcomes assessment methods. This can be even more challenging when CL methods are used in an education course. Arunita (2011) compared existing assessment tools with newly developed CL assessment tools which measure both quantitative and qualitative data. The CL categories in which the students were asked to evaluate the effect CL had for them were: acquisition, application, and integration of knowledge; research, critical thinking, problem-solving, interpersonal, and communication skills; cooperative behaviors, teamwork, personal and group leadership skills, creativity, and their desire for further learning (Arunita, 2011). The research group which was provided with revised learning outcomes, CL support strategies, and assessment tools which directly correlated with peer assessments, rubrics, and student portfolios were more responsive than the control research group which was not provided with these support materials. The outcome of this research study shows that the better the CL assessment tools are, the better the students are able to self-evaluate their own learning skills through the analysis of the feedback which is provided to them, and they can work towards improving their outcomes (Arunita, 2011). Student's taking accountability of their own learning is a desirable outcome from most instructors' perspective.

Colleges and universities are striving to meet the needs of all students to ensure they earn their degree. Academic success for all students is highly sought for the betterment of students, higher learning institutions and society. According to the National Center for Educational Statistics (2015), "The 2013 6-year graduation rate for first-time, full-time undergraduate students who began their pursuit of a bachelor's degree at a 4-year degree-granting institution in fall 2007 was 59 percent" (2015-144). Per Hoyert and O'Dell (2009) and Donahoe and Wong (1997), non-traditional students typically have higher academic outcomes than traditional students. These higher academic outcomes do not always lead to earning a diploma in non-traditional students. Per Horn and Carroll (1996), non-traditional students enrolled in undergraduate programs were less likely than traditional students to earn their degree or stay enrolled after five years. The effectiveness in increasing achievement performance and knowledge retention for all students, traditional and non-traditional, by using small group cooperative learning has been reported by Johnson and Johnson (2009).

Risk factors. Instructors can also help their students who may be at risk for adverse academic events and/or outcomes. Per Johnson, Johnson, McKee, and Kim (2009), there is a higher loss of "at risk" undergraduate students enrolled in allied health science programs which causes financial loss for these health science programs, loss in future employees in allied healthcare fields, and decrease in minority students graduating from these programs. "At risk" students include minority students, older (non-traditional) students, students who are parents (non-traditional), first generation, females, or students in which English is not their primary language (Johnson, Johnson, McKee, & Kim, 2009). They developed a personal background and preparation survey (PBPS) to use in their research which was voluntarily completed by students from the following allied health science professional schools: dentistry, medicine, nursing, and biomedical sciences. The outcome showed the PBPS can consistently predict at risk students, and their degree of risk in both minority student and non-minority student groups. This study could successfully predict 70 to 76% of first year and second year students who were at risk for adverse academic status events and therefore, failing or dropping out of these allied health science schools. The goal of the research was to intervene and help these at risk students sooner with counseling, advising, and mentorship, and decrease their attrition rates (Johnson et al., 2009).

Competitiveness in allied health science programs is another situation that at risk students have to deal with in their coursework. Wilson and Kittleson (2013) address this in their research on first generation, low income female students enrolled in STEM fields, and the extra challenges they face towards reaching their goal of completing their undergraduate degree and applying for medical school.

Instructors can set up CL groups with more diversity to benefit at risk students. The best learning environment for students in CL groups is to have randomly selected heterogeneous student groups based on gender, ability levels, race, and international students in which English is their second language (Forrester & Hutson, 2014). Teachers should consider student diversity strengths and differences in the creation of CL activities to facilitate interaction between diverse students during group work (Trees, 2013). "Students' needs which need to be met include: socio-economic variations, international and non-English native speakers, age and gender variations, reading literacy variations, and physical or emotional needs" (Trees, 2013, p. 235). Other considerations Trees (2013) recommends when instructors establish diverse student groups are public speaking concerns, self-identity, communication difficulties, and working together concerns these students may have. "Effectively teaching diverse student groups requires being critically reflective, adaptable, able to respond to varying needs and implement strategies for facilitating students learning from each other" (Trees, 2013, p. 235). Heterogeneous groups provide a more dynamic learning opportunity for all students, even though most students typically want to be in groups where they had fewer differences and more similarities with their group members (Trees, 2013).

Summary

There is a gap in research literature regarding faculty within MLS programs and courses utilizing cooperative learning techniques. There are numerous other allied health science programs and science courses which have been researched, but the lack of research in laboratory science courses needs to be addressed. This study researched the addition of two cooperative learning activities in an undergraduate medical laboratory microbiology applications course, to determine if they will increase students' understanding and the academic outcomes expected in an undergraduate professional program. An academic achievement gap exists between traditional and nontraditional students, and this study researched the effects that CL methods could contribute to closing this gap. The medical laboratory science professional program has a diverse student body composed of traditional and non-traditional students including differences based upon: gender, socio-economic, first generation, non-native English speaking, and international students. All of these variables provide an interesting student dynamic for this research.

Chapter Three

Methodology

The purpose of this study was to examine how the addition of cooperative learning techniques affected the academic learning outcomes in students in an allied health undergraduate clinical microbiology course in a Medical Laboratory Science program. A secondary purpose for this research was to determine if there were any differences between traditional and non-traditional students' academic outcomes and demonstration of cooperative learning behaviors. The relationship between the cognitive outcomes from using cooperative learning techniques in the course and traditional versus non-traditional student outcomes were of particular interest in this research. This chapter will describe the steps taken in the research methodology to determine if cooperative learning had an impact on the academic outcomes, and if these outcomes varied based on student status of traditional compared to non-traditional. The research design will be described first in this chapter. The participants and setting for the research will then be described, followed by the measures used, and processes utilized for data collection and, finally, the analysis of the results.

Research Design

The research performed was a quantitative quasi-experimental research design (Creswell, 2015). The quantitative method employed quasi-experimental design to compare the assessment scores between two groups as the primary research question: (1) experimental group which had participated in cooperative learning activities during the 2014 fall semester, and (2) the comparison group which was the previous year's class (2013) which experienced traditional learning methods only.

As stated by Creswell (2015), "Quasi experiments include assignment (but not random assignment) of participants to groups. This is because the experimenter cannot artificially create groups for the experiment" (p. 310-11). The small groups for the cooperative learning activities were the same as their lab table partners in the microbiology lab course. The lab table seating arrangements were randomly picked at the beginning of the semester. The addition of cooperative learning activities to the 2014 class (Appendix A) was the experimental addition in which the assessment outcomes were the primary variable of interest to the researcher when compared to the 2013 class which was taught using traditional learning methods.

Setting and Participants

The research occurred over one academic semester in 2014 with undergraduate students who attended a large state university in the Midwestern United States of America. Forty-nine male and female students were enrolled in the experimental group in which forty-one students agreed to participate in the study. The primary researcher was a teaching specialist assigned to instruction in the course. The students were a diverse group with twenty-six traditional and fifteen non-traditional students. The course was taught synchronously between two different campus locations using the same traditional and cooperative learning teaching techniques. The two locations were connected using Interactive Television (ITV) technology in which the two student groups could see each other's location and activities and communicate with the other group as needed.

Two cooperative learning activities were included during two separate laboratory components of the microbiology course for the experimental group: gram positive organisms (GPO) and antimicrobial sensitivity testing (AST). One unit location had 37 students taught by the course instructor while the other unit location had 12 students taught by the researcher with both student groups covering the same materials using the same cooperative learning teaching methods for the two cooperative learning activities. The sample sizes for both groups, experimental and comparison, are sufficient in numbers as stated by Creswell (2015), "Approximately 15 participants in each group in an experiment" are needed in educational research" (p. 145).

The comparison group consisted of sixty-four students enrolled in the same course during the fall 2013 academic semester delivered in the same format as the experimental group. The comparison group had thirty-four traditional and thirty non- traditional students. The class parameters were the same for the control group as they were for the experimental group except only traditional teaching methods were used in the comparison group. Traditional teaching methods consisted of lecture, face to face (F2F) activities, and laboratory sessions.

Table 1 presents the participant characteristics. The comparison group (n=64) and experimental group (n=41) were not significantly different in the proportions of gender, ethnicity, or traditional versus non-traditional student status and English language learner (ELL) versus non-English language learner status. Because there were no significant differences between the groups, traditional parametric statistical analyses could be applied.

Table 1
Participant Characteristics

Variable	Experimental Group		Comparison Group		Chi-square	*p* value
	n	%	n	%		
Gender					0.23	0.63
Male	16	39.02	28	43.75		
Female	25	60.98	36	56.25		
Ethnicity					1.32	0.52
Asian	4	9.76	4	6.25		
Black	9	21.95	20	31.25		
White	28	68.29	40	62.50		
Traditional or Non-Traditional					1.08	0.30
Traditional	26	63.41	34	53.13		
Non-Traditional	15	36.59	30	46.88		
ELL or Non-ELL					0.78	0.38
ELL	15	36.59	29	45.31		
Non-ELL	26	63.41	35	54.69		

At the beginning of the course, the experimental group of students was given a form requesting their voluntary permission to be included in the study which would be implemented to improve the teaching methods used in the Medical Laboratory Program during their course. Students had the choice to voluntarily sign the form granting permission to use their information in the research or to opt out and not be included in the research activities without any negative consequences. The participants were able to terminate their participation in the research at any time without repercussions (IRB Approval in Appendix F).

Measures

This study included two categories of measures: student test scores for both groups, and observations for the experimental (cooperative learning activity) group. One set of quantitative data collected was the assessment scores of the exact same test questions over the same units directly related to the cooperative learning activities within the experimental group compared to the assessment scores from the comparative group who were taught using traditional learning methods. The students in both groups had the same test questions pertaining to gram positive organism identification testing and antimicrobial sensitivity testing topics during the microbiology course. The assessment questions related to these topics were included in Exam 1, Exam 2 and the Final Exam throughout the course. There were seven test questions on Exam 1, six test questions on Exam 2, and twelve questions related to these two topics on the Final Exam which was a comprehensive final exam. The exam questions were multiple choice questions of various difficulty levels based on Bloom's taxonomy, such as: knowledge, application, comprehension, analysis, and evaluation. The test questions covered the topics of gram positive organism (GPO) identification testing and antimicrobial sensitivity testing (AST) on the exams because these topics were related to the cooperative learning activities on GPO and AST.

The observations of the experimental groups were conducted by the instructors and the students simultaneously. The instructors intermittently monitored the small groups for evidence of cooperative learning behaviors and roles and documented these observed behaviors on the instructor monitoring form (see Appendix B). The instructors were taught which behaviors and actions to notice and record by the researcher, who had taken a cooperative learning course taught by Johnson and Johnson (1983). Instructors also provided clarification, added or corrected the students as necessary during the CL activity. This monitoring data was narrative and qualitative, and not included in quantitative data analysis.

Students rotated the position of observer and tallied the assigned cooperative learning actions displayed within their small groups (see Appendix C). The actions were totaled both individually and as a group. The form was completed by all the research participants after completion of the cooperative learning activity. After group discussion and consensus, the small group participants self-evaluated and recorded their observations about their experiences in the cooperative learning activities. This participant form contained open-ended questions asking the participants to describe their experiences and reflections concerning the cooperative learning activities. The participant form allowed the voice of the participants who were impacted by the implementation of the cooperative learning to be heard by the researcher. This qualitative data will not be included in this research at this time.

The student observation forms and the assessment quantitative results were de-identified to maintain the student's anonymity. Independent t-test statistics were used in statistical software, the IBM SPSS version 23 (2015), to compare the means of the various types of quantitative data.

Data Gathering and Analysis

The cooperative learning activities occurred in the microbiology course for two instructional units on gram positive organism identification (GPO) testing and antimicrobial sensitivity testing (AST). These two units were selected due to the high level and complex thought processes and problem solving skills required from students to obtain understanding and knowledge on these topics. The cooperative learning lesson plan (see Appendix A) was similar for both CL activities.

The researcher introduced the concept of cooperative learning during pre-lab and provided the students with instructions and guided practice using cooperative learning behaviors. The students were given a Jigsaw assignment one week before the lab. Each student was given the task of becoming the expert on their randomly assigned test or topic for the unit, teaching it to their small group members, and exhibiting the five cooperative learning behaviors (social skills) selected by the researcher within their small group (see Appendices D and E). The small groups consisted of six students whom took turns role playing the following cooperative learning behaviors during the Jigsaw assignments: resource expert/teacher, encourager, checker, contributor, summarizer, and provider. The encourager's role was to ensure all group members were actively engaged with each other and participating; the checker's role was to ensure that all group members understood the teacher and documented the students' CL behaviors on the student observation form (see Appendix C); the contributor's role was to add ideas and ask questions; and the role of the summarizer was to restate and summarize what the teacher had taught using their own words.

Following the small group activities, the students, instructor and researcher discussed the outcomes of the CL activity and summarized the major points of the activity. Instructors provided feedback to the class regarding their observations from the monitoring form completed during the CL activities. The students reflected and noted what they could have done to contribute more to their small group and as an individual on the student observation forms (Appendix C). Finally, the students celebrated their successes in the CL activities.

Summary

In using the quasi-experimental quantitative research design, the quantitative data helped the researcher determine if the addition of cooperative learning techniques had any effect on the assessment outcomes from the experimental group of participants compared to the comparative group. The quantitative data was used to determine if any academic outcomes variations existed between traditional and non-traditional students and if there were differences between traditional and non-traditional students in exhibiting cooperative learning actions.   The results of the research are explained in the following chapter.

Chapter Four

Results and Discussion

The purpose of this study was to examine how cooperative learning techniques affect the academic learning outcomes in traditional and non-traditional students. Cooperative learning activities were implemented in two learning units in a Medical Laboratory Science microbiology course to determine if this teaching method would improve the academic outcomes of students. The research questions were interested in the effect CL would have on academic outcomes for the whole class and per student status (traditional or non-traditional), and if the number of cooperative learning behaviors exhibited would differ based on student status. The first part of this chapter will describe the results of the test scores and effects of student status on both test scores and cooperative learning behaviors, and then follow with a discussion of the results.

Results

Research question 1: The effect of cooperative learning activities on academic outcomes. The first research question was to investigate the extent that cooperative learning activities affect academic outcomes in medical laboratory science students. This question was investigated by comparing two exam or assessment scores for the experimental cooperative learning activities group (n=41), and the comparison group (n= 64).

Table 2

Comparison of Test Scores between Experimental and Comparison Groups

	Experimental Group			Comparison Group				
Variable	n	Mean	(SD)	n	Mean	(SD)	t	*p*
Exam 1[a]	41	6.49	(0.68)	59	6.08	(1.28)	2.05	0.04
Exam 2[b]	40	5.37	(0.81)	No data available				
Final Exam[c]	39	10.79	(1.40)	64	10.47	(1.44)	1.13	0.26

Note. [a]Possible range was 0-7 for Exam 1, [b] 0-6 for Exam 2, and [c] 0-12 for Final Exam

Table 2 presents the results. The experimental group that used cooperative learning activities yielded significantly higher performance (M=6.49, SD=0.68) than the comparison group that did not use the activities (M=6.08, SD=1.28) in the exam 1, $p < .05$. However, the two groups did not differ in the final exam (Cooperative learning group, M=10.79 versus Traditional learning group, M=10.47). Thus, these results support the research hypothesis 1 partially, only with the exam 1, but not with the final exam.

Research question 2: The effect of cooperative learning activities on academic outcomes by student status. The second research question was to examine the effect of the cooperative learning activities on academic outcomes by student status (traditional or non-traditional students). Table 3 presents the results of the comparison. There were no differences between groups in any of the three exams. The traditional students had slightly higher exam mean scores than the non-traditional students, but it was not statistically significant. Thus, this result does not support the research hypothesis 2, which predicted better outcomes for traditional students.

Table 3

Comparison of Test Scores between Traditional and Non-Traditional Student Groups

Variable	Traditional Students			Non-Traditional Students			t	*p*
	n	Mean	(SD)	n	Mean	(SD)		
Exam 1[a]	26	6.50	(0.65)	15	6.47	(0.74)	0.15	0.88
Exam 2[b]	26	5.46	(0.71)	14	5.21	(0.98)	0.92	0.36
Final Exam[c]	25	10.96	(1.34)	14	10.50	(1.51)	0.99	0.33

Note. [a]Possible range was 0-7 for Exam 1, [b] 0-6 for Exam 2, and [c] 0-12 for Final Exam

Research question 3: The use of cooperative learning activities by student status. The third research question was to compare the use of the cooperative learning activities by student status (traditional or non-traditional students). Tables 4 and 5 present the results of the comparison of student status for antimicrobial sensitivity testing (AST) and gram positive organism testing (GPO). The students first use of cooperative learning techniques during the course was GPO followed several weeks later by the AST activity. Table 4 displays that traditional students used the cooperative learning activities significantly higher on the AST total (M=2.73) than non-traditional students (M=1.33), t (39) = 2.14, $p < .05$. Table 4 data also shows significantly higher cooperative learning variables for traditional students for Summarizer (M=0.73) and Provides positive feedback (M=0.81) compared to non-traditional students for both Summarizer and Provides positive feedback (M=0.27). Thus, these results support the research hypothesis 3, which predicted the more cooperative behaviors for traditional students.

Table 4

Comparison of AST Susceptibility CL Behaviors between Traditional & Non-Traditional Groups

	Traditional (n=26)		Non-Traditional (n=15)			
Variable	Mean	(SD)	Mean	(SD)	*t* (39)	*p*
Encourages Participation	0.54	(0.76)	0.33	(0.49)	0.94	0.36
Checks for Understanding/Checker	0.12	(0.33)	0.00	(0.00)	1.81	0.08
Contributes Ideas/Asks Questions	0.54	(0.81)	0.47	(0.83)	0.27	0.79
Summarizes Out Loud	0.73	(0.78)	0.27	(0.59)	2.00	0.05
Provides Positive Feedback	0.81	(0.90)	0.27	(0.46)	2.17	0.04
Total	2.73	(2.65)	1.33	(1.54)	2.14	0.04

Table 5 shows that there are no differences between the two groups in the total scores depicting CL behaviors during the GPO activity. Thus, this result did not support the research hypothesis 3, which predicted the more cooperative behaviors for traditional students. Of 6 categories of behaviors, one category, which is "Contributes Ideas/Asks Questions", shows that the traditional students demonstrated significantly higher (M=5.92) than non-traditional students (M=3.67), t (39) = 2.21, p <.05.

Table 5

Comparison of Gram Positive Organism CL Behaviors between Traditional & Non Traditional Groups

	Traditional (n=26)		Non-Traditional (n=15)			
Variable	Mean	(SD)	Mean	(SD)	*t* (39)	*p*
Encourages Participation	2.85	(1.91)	1.93	(1.58)	1.56	0.13
Checks for Understanding/ Checker	4.35	(3.38)	2.80	(1.52)	1.67	0.10
Contributes Ideas/Asks Questions	5.92	(3.55)	3.67	(2.26)	2.21	0.03
Summarizes Out Loud	2.58	(1.21)	2.87	(1.96)	-0.59	0.56
Provides Positive Feedback	2.46	(1.68)	2.67	(2.16)	-0.34	0.74
Total	18.15	(9.08)	13.93	(7.12)	1.54	0.13

Discussion

The goal of implementing cooperative learning techniques in the medical laboratory science microbiology course was to improve student's academic scores and understanding of the content. The secondary goal of the MLS program was to increase cooperative learning behaviors of all medical laboratory students.

The first research question asks if the addition of cooperative learning techniques will increase test assessment outcomes in the experimental group. The results demonstrated that there was an increase in academic outcomes for the experimental group over the comparison group for the exam 1, which supports the research hypothesis 1. These findings support what Duval and Johnson and Johnson (1989) have found. Duval (2008) noted that academic achievement increased when cooperative learning in small groups was used over individual learning which is comparable to traditional learning. Johnson and Johnson stated "A meta-analysis of all studies (Johnson & Johnson, 1989) found that the average person cooperating performed at about 2/3 a standard deviation above the average person learning within a competitive (effect size = 0.67) or individualistic situation (effect size = 0.64)" (p. A:14). However, the final exam didn't show any significant findings which would be related to the lapse of time between the cooperative learning activities which were near the beginning of the semester compared to the comprehensive final exam given during the last week of the semester. The time span between the cooperative learning activities and the exam 1 was shorter.

The second research question asks if there is a difference in academic outcomes on the assessments between the traditional and non-traditional students. These results showed no significant differences between these two groups' assessment outcomes, which did not support the hypothesis 2. This data showed that the implementation of cooperative learning techniques were equally beneficial regardless of student status. Per Johnson, Johnson, McKee, and Kim (2009), non-traditional students whom are considered "at risk" may have adverse academic outcomes but this research isn't consistent with those findings. This study is important because it shows how the addition of cooperative learning activities and behaviors narrowed the assessment gap in traditional and non-traditional students.

The final research question aimed at finding out if there were any differences in cooperative behaviors/social skills exhibited based on student status. The results for the GPO cooperative learning activity noted no significant findings between the traditional and non-traditional groups; thus, this result does support the research hypothesis 3. One exception was that the traditional students did contribute significantly more ideas and questions in the small groups. The results for the AST cooperative learning activity noted traditional students used the cooperative learning behaviors/social skills significantly higher during the AST activity than non-traditional students. These findings on AST activity support the hypothesis 3 that traditional students will engage more frequently in cooperative learning behaviors than non-traditional students. Communication and social skills in heterogeneous groups benefit students through engagement in the cooperative learning activities which is supported by Trees (2013) research working with international students (non-traditional). Acar and Tarhan (2007) described how student's social interactions and academic outcomes increased and the groups' benefit throughout the semester when cooperative teaching methods were used. Participation should be actively and equally given from all group members to ensure the highest possible benefits within a cooperative learning activity. Herman (2013) noted increased student engagement when cooperative learning discussions were integrated into his undergraduate chemistry course, but he didn't see the positive effect of increased academic outcomes in his study.

Summary

The results of this study support the addition of cooperative learning teaching methods which increase student academic outcomes. The results showed no significant difference in academic outcomes when comparing student status. Cooperative learning behaviors/social skills were increased in traditional students compared to non-traditional students in this study.

The limited research that has been previously done in medical laboratory science (MLS) programs and comparing traditional and non-traditional students' outcomes within a MLS program, both academic and social skills, validates why this research study was important. The literature review on cooperative learning in medical laboratory science courses was extremely limited. Other allied health education programs or non-science education findings had to be used to acquire a complete literature review. The literature resources became even less when the student status variable was added. Based on these other sources of literature, this study supports what has been found in other studies with an increase in academic outcomes when cooperative learning teaching methods are thoroughly and well implemented into curriculum.

Chapter Five

Summary and Conclusions

As mentioned in the introduction, students deserve an environment that provides a best case scenario for learning and creating knowledge. This purpose of this study was to determine if the addition of cooperative learning teaching methods in a medical laboratory science microbiology course would have any effect on test assessment outcomes. Additionally, this study wanted to determine if the assessment outcomes and the cooperative learning behaviors exhibited would differ between traditional and non-traditional students. The goal of the medical laboratory science program is to provide the best possible education to all students regardless of status and provide them with the knowledge to succeed in the medical laboratory science profession. This goal resonates broadly to all educational programs, and the researcher hopes that this study's findings can impact other educational programs and their students.

Significant Findings

The addition of cooperative learning teaching methods showed a significant increase in academic outcomes in the experimental group of students compared to the comparison group of students. There were no significant findings whether the addition of cooperative learning techniques affected academic outcomes when comparing traditional and non-traditional test score means. The students demonstrated the desired CL behaviors conducive to a well-planned cooperative learning lesson. Traditional students' participation was increased in exhibiting these cooperative learning behaviors compared to the non-traditional students. The cooperative learning behaviors displayed by both groups enhanced their learning and teamwork skills. These exhibited cooperative learning behaviors are important social skills which will benefit these students as they enter the professional workplace in laboratory science. The combination of increased academic outcomes and increased cooperative learning behaviors among students taught using cooperative learning methods are the significant findings from this study.

Educational Implications

Students enrolled in allied healthcare undergraduate programs are expected to learn a large quantity of detailed and complex material during their undergraduate courses. They need to retain the acquired knowledge and skills developed in the allied health science program, and apply this information as they proceed in their academics and into their professional careers. The ability to take care of and provide future patients with the best possible care without serious consequences relies on the students' ability to retain this knowledge. Cooperative learning methods promote deeper understanding of complex and difficult subjects as found in the research of Angawi (2014). His research also showed that CL methods promoted more communication and decreased data interpretation errors which are highly desired skills sought by employers, especially in employees of healthcare based jobs. More effective communication is another benefit of CL as exhibited in the research of Young and Talanquer (2013). These benefits apply to all undergraduate programs and will enhance the teamwork and academic outcomes which are important to succeed in college, and eventually in the workforce for most fields of study.

As educators, we strive to meet the academic goals within our courses, so that we are creating a bright and well prepared future workforce for the betterment of society. Cooperative learning activities help build teamwork skills, dependability and responsibility within individuals to complete tasks as a team member, create cohesiveness, and promote interdependence within the CL team. Introducing and using cooperative learning can help instructors meet their educational goals. Educators also strive to motivate and invigorate our students with the quest for knowledge rather than the sole purpose of getting a higher grade in the course. Students' can achieve high academic marks as well as high levels of learning when well-constructed and planned cooperative learning lessons are created and successfully implemented by instructors in their courses. It takes time, practice, skill, discipline, diligence and continuous evaluation of the lessons to create solid and efficacious CL lesson plans, but it is time well spent for educators when the students are achieving higher academic outcomes and educational goals for the course. This study showed an increased academic outcome from using CL teaching methods compared to traditional methods. Increased academic outcomes will benefit all undergraduate students, lead to higher graduation rates, and will enhance the teamwork and academic success skills which are important to succeed in the workforce.

Recommendations for Future Research

There are several possibilities for future research in studying the effects cooperative learning has on students. The qualitative effects of cooperative learning on students are particularly fascinating. What are the students' attitudes and beliefs about cooperative learning before, during and after completing cooperative learning activities? Does the level of competition increase or decrease in cooperative learning activities? Is the competition beneficial or destructive to the students learning in these lessons? How does cooperative learning affect students' motivation to work together and build a sense of community with their peers? These are some interesting research questions worth further exploration.

Science curriculum is stressful and can result in increased anxiety and pressure for students which could potentially affect their mental health and their academic outcomes. Student services are available to help students who have these tendencies, but the student has to initiate and seek out these services which many of them do not do. The affects cooperative learning could have on students' pressure and anxiety levels in stressful curriculum programs could be another area of study for a researcher to consider. If cooperative learning groups can create a sense of community within their small CL groups, then would this potentially lower the stress and anxiety student's experience?

Limitations

Cooperative learning in the classroom works best when the cooperative student groups have an entire semester or a full year to achieve the full benefits of cooperative learning. The full benefits from using cooperative learning methods as described by Johnson, Johnson and Holubec (2013) include: student efforts lead to achievement, positive relationships are formed, and positive behaviors or social skills are developed. This research incorporated cooperative learning into two activities in a microbiology class during the semester which may not have achieved the full benefits of using cooperative learning. A more in-depth immersion into cooperative learning would have been preferred by the researcher, but due to time constraints the CL activities were limited.

Summary

The purpose of this study was to determine if the addition of cooperative learning activities would increase academic outcomes in medical laboratory science students in a microbiology classroom which was proven to be true. The academic outcomes were further analyzed to determine if there were assessment score differences between traditional and non-traditional students which were not exhibited in this study. Finally, cooperative learning behaviors displayed were evaluated and compared between traditional and non-traditional students which showed no significant differences based on the students' status. The goal of implementing cooperative learning into the MLS microbiology course was to improve academic outcomes and increase cooperative learning social behaviors of all medical laboratory science students. Educating students using CL teaching methods will increase their academic outcomes in the classroom while supporting the needs of the student in a safe environment. The cooperative learning method is a beneficial addition in allied health science curriculum and worth consideration for further research.

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Appendix A

COOPERATIVE LESSON PLANNING FORM

Grade Level: Year 4 **Subject Area:** MLSP **Date:** 9/5/14 Nicole Zahnle

Lesson: Week 3: Cooperative Learning Lab activity Gram Positive Tests

Making Preinstructional Decisions

Academic Objectives: Briefly describe the following gram positive organism tests including the purpose, principle, reagents and supplies required, procedure, quality control, and interpretation and reporting of the tests. You will also demonstrate how to set up the assigned GP tests to your lab partners:
Student 1: Disk Challenge (Novabiocin), and Wet Mount Motility
Student 2: Tube Coagulase and CAMP
Student 3: Bile Esculin & 6.5% NaCl and Semi-solid Motility
Student 4: Staphyloslide and Microdase
Student 5: Hippurate Hydrolysis and Germ Tube
Student 6: O/F Glucose and Serotyping (Group A & B)

Social Skills Objectives: Summarizing Out Loud: Summarizing out loud what has just been described/demonstrated as completely as possible without referring to notes or original material

Group Size: 4-6 **Method of Assigning Students:** Table lab partners = small group

Roles: **"Teacher"** – student whom is responsible for explaining and helping the other group member learn the test and also demonstrates how to perform the test; **Checker** – checks to make sure each group member understands the test and could perform it; **Encourager (1-2 per group)** – watches to make sure each person in the group is contributing and prompts those who are reluctant into the discussion; **Observer** – records the actions/contributions of each group member but doesn't actively participate (keeps quiet); **Recorder –** takes notes on the worksheet for the test being taught on behalf of the group.

Note: These roles will rotate to a different group member in a clockwise pattern after each test that is being taught amongst the students in the group. All group members will have a chance to participate in each role.

Room Assignment: Groups are students already assigned to Lab Tables: Site 1: 5 students/bench; Site 2: 3 students/bench (will combine two benches for a total of 6 students/group – otherwise it is too many tests for each student to teach. The students should form a tight circle or move close together to promote a group atmosphere.

Materials:
1) One set of role cards/bench day of activity
2) One set of Gram Positive Test cards/bench provided during previous Week 2 Day 2 lab to randomly assign who will be teaching which GP tests during Week 3 lab activity

___ **One Copy Per Group** ________ **One Copy Per Person**

X **Jigsaw** ________ **Tournament**

Other:

Explaining Task and Cooperative Goal Structure

. Task:	Students are to “teach” each the other members in their group about the gram positive test, demonstrate how to set up the test, and answer any questions about the test their group members may have.
. Criteria for Success:	All group members must be able to explain the gram positive test and demonstrate the test if asked to do so. Instructors will randomly ask one member of each group to describe and/or demonstrate a gram positive test for the instructor. Successful completion
. Positive nterdependence:	The cooperative goal is for al group members to agree on the test information, and how to properly set up the test, and understand when the test would be used in the identification of a gram positive organism. The students are assigned roles and they need to rely on each other to accomplish the task of learning the academic objectives and completing the worksheet. The roles will change with each test taught to each other so they will get to perform all of the assigned roles and experience each group role. At the end of the activity, all members of the group will initial the worksheet to be handed in when all group members agree on the information to be submitted.
. Individual ccountability:	Students must show up prepared to teach their randomly assigned tests to their group members. At the end of the activity, they will provide feedback to each other and assess each other on their CL behaviors exhibited
. Intergroup ooperation	If there is time, have groups interact with other groups to double check their knowledge.
. Expected Behaviors:	The group members should perform their roles to help the group reach understanding, the members should ask for help if they don’t understand or can’t remember what materials are specific to each type of gram positive test, and provide positive feedback to each other for contributing ideas which are helpful.

Monitoring and Intervening

1. Observation Procedure: ______ **Formal** X______ **Informal**

2. Observation by: x______ **Teacher** ______ **Students** ______ **Other:**

3. Intervening for Task Assistance: Instructor will systematically observe the students in their groups for evidence of using cooperative learning and social skills to complete the lab worksheet. This is accomplished by sitting down within the group and listening/observing their interactions. Ensure that they are working towards completing the task, participating in their group roles, and redirect them as needed. Provide positive feedback!

4. Intervening for Teamwork Assistance: The group members should perform their roles to help the group reach understanding, the members should ask for help if they don't understand or can't remember what materials are specific to each type of gram positive test, and complement each other for contributing ideas which are helpful.

5. Other:

Assessing and Processing

1. Assessment of Members' Individual Learning: Students will have to hand in their "teaching" tools for completion and accuracy check by the instructor. An individual post lab quiz may be handed out .

A – If all members in the group can match the correct type of gram positive test to the organism on the post lab quiz. B- If one or more members can correctly match 95% of the scenarios. C – If one or more member can correctly match 90% of the scenarios. D – If one of more members can correctly match 85%. F – If one of more members can correctly match 80% of the scenarios **** Point out that by working together they can accomplish an A, but without teamwork an A may not be possible. Go Team!!

2. Assessment of Group Productivity: Group worksheet with notes on each test will be handed in for evaluation of group productivity. The students are assigned roles and they need to rely on each other to accomplish the task of learning the academic objectives.

3. Small Group Processing: The group members should perform their roles to help the group reach understanding, the members should ask for help if they don't understand or can't remember what materials are specific to each type of gram positive test, and complement each other for contributing ideas which are helpful. At the end of the activity, have the group look at the observers chart. The group analyzes the data to determine how effectively they worked together. Have the students provide

3. Small Group Processing:	The group members should perform their roles to help the group reach understanding, the members should ask for help if they don't understand or can't remember what materials are specific to each type of gram positive test, and complement each other for contributing ideas which are helpful. At the end of the activity, have the group look at the observers chart. The group analyzes the data to determine how effectively they worked together. Have the students provide one compliment or positive feedback to each group member. Also, the group should come up with a group goal for improvement next time they work together.

4. Whole Class Processing:	If there is time, have groups interact with other groups to double check their knowledge. Also, the Instructors will lead a discussion on how well the groups worked together in a 5 minute wrap up at the end of the class. The instructor will share observations made during their monitoring time within each group and stress positive group behaviors observed. The instructors should also collect each group's observation sheet to elaborate on also. You could provide class totals for behaviors observed and chart the results so the class could have a visual display and work on increasing their cooperative behaviors for the next lab activity.

5. Charts and Graphs Used:	Observation (group) of behaviors

6. Positive Feedback to Each Student:	The group members provide positive feedback to each other within their groups and the instructor will provide positive feedback to the whole group per their observations during class monitoring.

7. Goal Setting for Improvement:	At the end of the activity, ask the groups to come up with a goal for next time.

8. Celebration:	Instructor will have the class chant "Team MLS" and/or high five each other for their great efforts put forth today in class! Instructor may also provide treats for after class (bag of candy, etc.)

9. Other:	Other resources needed for activity: GP Test Cards, Observation tracker sheet, Worksheet handout, and Post lab quiz (if used)

Appendix B

Instructor Cooperative Learning Monitoring Form

Instructor:_________________________Date:____________

Lab Activity (circle): Gram Positive organism test Sensitivities

Instructor monitoring guidelines: Make informal observations that are specific, brief, and captures a cooperative behavior of one or more students, and answer questions as needed. Intervene if the students are not on task, are not acting in a cooperative manner, or to correct misunderstandings or misconceptions. **Provide a brief positive feedback response to the group to reinforce academic learning and use of cooperative behaviors**. CL Behaviors: summarizing, teaching others, checker/checks that others understand, student observer/listener, encourager and recorder (takes notes for the group). Are they engaged and interacting together?

Group members: Note 1:
Group members: Note 2:
Group members: Note 3:
Group members: Note 4:

Appendix C

Cooperative Learning Student Observation Form

Observer:_________________________
Date:______________

Use tally marks to indicate each time someone participates in a cooperative learning action.

ACTION	Student Name	Student Name	Student Name	Student Name	Student Name	Group Total:
Encourages Participation						
Checks for Understanding /Checker						
Contributes Ideas/Asks Questions						
Summarizes Out Loud						
Provides Positive feedback						
Individual Total:						

After teaching each other, all group members should compare all of the observation forms.
Answer the following questions after your small group processing:

1. List one group goal on how your group can improve for the next time you work together.

2. List one area you can improve to better contribute to your group next time.

Appendix D

GPO assignments

Student 1	<u>Gram Positive Tests</u> Disk Challenge (Novobiocin) Wet Mount Motility	Briefly describe in 2-3 minutes: The test: purpose, principle, reagent & supplies needed, procedure, QC, interpretation of test results, and reporting. Demonstrate the test.
Student 2	<u>Gram Positive Tests</u> Tube Coagulase CAMP	Briefly describe in 2-3 minutes: The test: purpose, principle, reagent & supplies needed, procedure, QC, interpretation of test results, and reporting. Demonstrate the test.
Student 3	<u>Gram Positive Tests</u> Bile Esculin & 6.5% NaCl Semi-solid Motility	Briefly describe in 2-3 minutes: The test: purpose, principle, reagent & supplies needed, procedure, QC, interpretation of test results, and reporting. Demonstrate the test.
Student 4	<u>Gram Positive Tests</u> Staphyloslide Microdase	Briefly describe in 2-3 minutes: The test: purpose, principle, reagent & supplies needed, procedure, QC, interpretation of test results, and reporting. Demonstrate the test.

Student 5	<u>Gram Positive Tests</u> Hippurate Hydrolysis Germ Tube	Briefly describe in 2-3 minutes: The test: purpose, principle, reagent & supplies needed, procedure, QC, interpretation of test results, and reporting. Demonstrate the test.
Student 6	<u>Gram Positive Tests</u> O/F Glucose Serotyping (Grp A & B Strep)	Briefly describe in 2-3 minutes: The test: purpose, principle, reagent & supplies needed, procedure, QC, interpretation of test results, and reporting. Demonstrate the test.

MLS TEST CARDS: Cut per row, and have on the bench for students to randomly select.

Appendix E

AST assignments

Student 1	(AST) Susceptibility Tests Tuesday – Groups of antibiotics	Briefly describe in 5-6 minutes: The different groups of antibiotics used in AST; their purpose and how to select the drugs.
Student 2	(AST) Susceptibility Tests Tuesday – Standardization	Briefly describe in 5-6 minutes: The QC and factors which need to be standardized in AST disc diffusion testing.
Student 3	(AST) Susceptibility Tests Tuesday – KB Demonstration and Principle	Briefly describe in 5-6 minutes: Demo how to set up disc diffusion AST and describe principle for your group. *Even seat numbers will set up KB; odd seat numbers will set up Microscan's.
Student 4	(AST) Susceptibility Tests Tuesday – Microscan Demonstration and Principle	Briefly describe in 5-6 minutes: Demo how to set up Microscan AST to your group and describe principle. *Even seat numbers will set up KB; odd seat numbers will set up Microscan's.
Student 5	(AST) Susceptibility Tests Thursday - Interpretation	Briefly describe in 5-6 minutes: Describe how KB and Microscans sensitivities are interpreted using CLSI guidelines. As a group, read and discuss your KB and Microscan MIC's.

Student 6	(AST) Susceptibility Tests Thursday –Problem solving and limitations	Briefly describe in 5-6 minutes: Discuss potential problems, interferences, and limitations of AST. Note any problems with your groups AST's.

Instructor CL Directions:

1. Cut out CL assignments per row/student and arrange upside down on table. Students will randomly select their assignment for the following week.
2. Cut out CL role descriptions and arrange upside down on the table. Students will randomly select their role for each topic of discussion. When it's a different students turn to lead the discussion, the other students will pass their role description to the person on their right and assume a different role for the next discussion topic.
3. Hand out CL Observation Form; provide instructions on how to complete.

Student Instructions:

"Using tally marks, make one mark for each CL contribution a group member makes towards the discussion. At the end of the discussion, add up the tally marks for the action AND the individual student."

4. Answer any questions students may have about their assignments and/or roles.
5. Describe the purpose of the CL lesson and expected outcomes for the students.

INTRO TO CL STATEMENT: (to state at the beginning of class or post into Moodle)

"Today's lab activity is a cooperative learning activity. Working together you can learn and achieve more. We are striving for all group members' success in learning about and performing AST. Through discussion and by working together cooperatively, the group will ensure that all group members understand each test. All group members must come prepared to lab to lead the groups discussion about the part they selected, and also be prepared to learn from the other group members. The expected cooperative behaviors of all group members are: active participation in each role, asking questions and helping answer them within your group, and encouragement for your group members. All group members are expected to participate in the discussion in any role, but should concentrate on their particular role designation per topic. Criteria for success can be demonstrated when someone within the group is asked to summarize out loud about ANY portion of AST and can demonstrate how to set up the KB or Microscan sensitivity if asked to do so. Together you can learn more and have some fun too!"

6. During student discussions, monitor student groups and complete the instructor CL Monitoring Form.
7. Thursday, at the end of the lab activity, have all students hand in their CL papers. Have a whole class summary discussion about any muddy points/clarifications needed on sensitivities. Celebrate the new knowledge learned by all!

Appendix F

1602E83643 - PI Zahnle - IRB - Exempt Study Notification

Inbox x

irb@umn.edu Feb 22

to me

TO : djrausch@umn.edu, zahnl001@umn.edu,

The IRB: Human Subjects Committee determined that the referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #4 EXISTING DATA; RECORDS REVIEW; PATHOLOGICAL SPECIMENS.

Study Number: 1602E83643

Principal Investigator: Nicole Zahnle

Title(s):
Effects of Cooperative Learning in a Diverse Undergraduate Medical Laboratory Science Course
Nicole Zahnle

This e-mail confirmation is your official University of Minnesota HRPP notification of exemption from full committee review. You will not receive a hard copy or letter. This secure electronic notification between password protected authentications has been deemed by the University of Minnesota to constitute a legal signature.

The study number above is assigned to your research. That number and the title of your study must be used in all communication with the IRB office.

If you requested a waiver of HIPAA Authorization and received this e-mail, the waiver was granted. Please note that under a waiver of the HIPAA Authorization, the HIPAA regulation [164.528] states that the subject has the right to request and receive an accounting of Disclosures of PHI made by the covered entity in the six years prior to the date on which the accounting is requested.

If you are accessing a limited Data Set and received this email, receipt of the Data Use Agreement is acknowledged.

This exemption is valid for five years from the date of this correspondence and will be filed inactive at that time. You will receive a notification prior to inactivation. If this research will extend beyond five years, you must submit a new application to the IRB before the study's expiration date. Please inform the IRB when you intend to close this study.

Upon receipt of this email, you may begin your research. If you have questions, please call the IRB office at (612) 626-5654.

You may go to the View Completed section of eResearch Central at http://eresearch.umn.edu/ to view further details on your study.

The IRB wishes you success with this research.

We value your feedback. We have created a short survey that will only take a couple of minutes to complete. The questions are basic, but your responses will provide us with insight regarding what we do well and areas that may need improvement. Thanks in advance for completing the survey. http://tinyurl.com/exempt-survey

Click here to Reply or Forward