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Peer-Led Team Learning: The Effect of Peer Leader and Student Interactions on Student Learning Gains and Course Achievement in Introductory Biology

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Abstract

This study sought to connect the literature on Peer-Led Team Learning (PLTL) to the work on student-teacher interactions as well as STEM role models. Student and peer leader interactions were explored to determine the effect of these interactions on student learning outcomes. Students and their peer leaders were both asked to determine the student's learning gains from the PLTL course. Perceived learning gains were measured using a modified version of the Student Assessment of their Learning Gains (SALG) instrument. Peer leader responses were paired with their student's responses to determine differences in peer leader ability to discern learning gains, learning gains from students in different groups, and to identify the pairings that were most closely aligned. Qualitative data from open-ended questionnaires collected from the peer leaders were used to establish contributing factors of these findings. The ability to relate to the student was found to be an important factor in peer leader's ability to assess learning gains and establishing a positive relationship between student and peer leader. Relatability was further shown to positively and significantly influence student's final grade in the course, as well as increase student perceived learning gains. When students considered their peer leaders to be a role model, perceived learning gains significantly increased but there was no measurable effect on final course grade. Positive interactions with the peer leader were shown to benefit all students, regardless of their chosen major. Qualitative responses from peer leaders and students were analyzed to identify the factors contributing to role model status.

Peer-Led Team Learning: The Effect of Peer Leader and Student Interactions on Student Learning Gains and Course Achievement in Introductory Biology

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Dedication

I would like to dedicate this work to my family. All of you have encouraged me and motivated me to keep persisting and never give up on my dreams, no matter how difficult things may have seemed. I truly love each and every one of you, and I am blessed to have such a reliable support system.

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TABLE OF CONTENTS

List of Tables

List of Figures

Chapter 1: Introduction

Overview

This chapter describes the interactions and relationships formed between peer leaders and undergraduate students in the Peer-Led Team Learning (PLTL) program and perceptions of the PLTL program as presented in the primary literature. Research questions have been developed based on previous studies and learning theory describing the impact of mentor-mentee relationships on students, learning gains, and course achievement. For the purpose of this study, learning gains will be defined and measured by the categories found on the Student Assessment of their Learning Gains (SALG) tool: Understanding, skills, attitude, integration of learning, the class overall, class activities, information about the class, and support for the student as an individual learner. This study evaluates the relationship between peer leaders and their students in PLTL program associated with an undergraduate Introductory Biology course and presents way to enhance the potential benefits of this mentorship.

Statement of the Problem

Student attrition from majors in science, technology, engineering and mathematics (STEM) has been a challenge facing institutions and employers for decades (Christe, 2013; Wang, Soffa, & Nachman, 2017; Webb & Cotton, 2018). The need for students to choose STEM programs and persist until completion of the degree has been nationally recognized as a pathway to economic success (National Academy of Science, 2005; National Research Council [NRC], 2013; National Science Board [NSB], 2007; President's Council of Advisors on Science and Technology [PCAST], 2012). The NSB (2016) has reported that the United States holds a relatively low number of all science and engineering degrees conferred globally at only 9%. According to the National Science Foundation, this is a lower percentage of conferred degrees

than China, India, and the European Union (NSB, 2016). Low numbers such as these support the claims that the United States is not producing an adequate number of STEM graduates for the desired workforce (Chen, 2013).

Student attrition has been found to occur in both high performing and low performing students in STEM courses (Marra, Rodgers, Shen, & Bogue, 2012). Additional factors must be considered for explaining student attrition. Research suggests interactions with instructors can significantly affect the student's decision to exit from STEM programs (Pascarella, 2006). One prominent explanation for student's aversions to STEM programs are the long-held stereotypes surrounding the disciplines (Hong & Lin-Siegler, 2012; Leslie, Meyer, & Freeland, 2015; Shin, Levy & London, 2016). One such stereotype that detracts from the appeal of STEM is the belief that successful STEM scholars are innately gifted and can fully understand and excel with little to no effort in the course (Fuesting & Diekman, 2017; Hong & Lin-Siegler, 2012; Leslie et al., 2015; Shin et al., 2016; Smith, Lewis, Hawthorne, & Hodges, 2013). In addition to this perpetuated stereotype, factors such as poor quality of teaching, an intimidating classroom climate, and a general lack of student nurturing have been found to contribute to the attrition of STEM students (Finn & Campisi, 2015; Seymour & Hewitt, 1997).

Peer-Led Team Learning (PLTL) has the potential to offer students the sort of nurturing experiences not often found in a traditional lecture hall environment. PLTL has been widely implemented since first developed in New York City in 1991 (Hewlett, 2004; Tenney & Houck, 2003; Woodward, Gosser & Weiner, 1993). Peer-Led Team Learning (PLTL) is an active learning strategy that focuses on student-student and student-peer leader interactions (Eberlein, Kampmeier, Minderhout, Moog, Platt, Varma-Nelson, & White, 2008). These interactions are between groups of students and a peer leader, and the close nature of these

interactions may give peer leaders more insight into the learning needs and gains of a student than a traditional course instructor. Additional benefits may be obtained from students who relate to their peer leader or consider their peer leaders to be a role model in any way.

PLTL has provided a range of benefits to students in various university settings across multiple science disciplines. The success of PLTL has been attributed to the program's ability to foster peer interactions (Finn & Campisi, 2015) as students collaborate in small groups under the guidance of a peer leader who has recently completed the same course (Gosser & Roth, 1998; Hewlett, 2004; Tenney & Houck, 2003). The responsibility of the peer leader does not extend to being considered an expert in the field or grading assessments. Peer leaders are expected to observe the group dynamic and make decisions about learning styles most advantageous for their students (Tien, Roth, & Kampmeier, 2002). A supportive peer leader who is attuned to student learning needs and gains may benefit the students greatly by adjusting the pace of the sessions accordingly and enhance student learning.

A peer leader who is attentive to the struggles and achievements of their students would likely come off as nurturing and caring. Positive perceptions towards learning may result in students experiencing an increase in academic achievement (Prince, 2004). Students are more satisfied with courses when they feel like they are learning, making it more likely that they will persist in STEM courses if they can achieve this feeling through programs such as PLTL (Stout & McDaniel, 2006). Student attrition has shown to be lowered and retention improved when senior students act as mentors; sharing advice, experiences and views on familiar programs of study (Colbron, 2012). While the benefits of PLTL for both students and leaders have been well-researched, there is yet to be an in-depth study comparing the perspectives of students to those of the peer leaders with respect to student learning gains from the PLTL sessions.

Prior findings indicate that when instructors are perceived as more supportive, students felt they learned more course content and material (Wheeler, Maeng, Chiu, & Bell, 2017). The close rapport developed between the student and peer leader, and most importantly how the student views the peer leader, may have a substantial impact on course achievement and perceived learning gains. Peer leaders may potentially be viewed as inspirational role models in STEM fields, or may positively influence student learning from being considered more relatable than a professor might be. Peer leaders providing students with a nurturing environment, attainable goals, and possibly acting as an accessible role model may persuade more students to persist in STEM courses. The current study aims to investigate the effect of a close relationship between student and peer leader, the relatability of the peer leader, and the status of the peer leader as a role model all have on student perceived learning gains and course achievement.

Theoretical Framework

Social constructivism theory best informs interactions between students and peer leaders in the PLTL program. Constructivism is a school of thought that states knowledge is constructed in the mind of the learner, and social constructivism adds a societal aspect. This means that the building of knowledge is done through cooperative interactions (Eberlein et al., 2008). Students engaged in PLTL sessions are guided through collaborative tasks and work towards developing concepts or explanations with their peer leader (Gosser, Cracolice, Kampmeier, Roth, Strozak, and Varma-Nelson, 2001). Answer keys for modules are not made available for students or peer leaders, therefore the group must work cooperatively to construct novel responses.

Vygotosky's Zone of Proximal Development (ZPD) can be used in conjunction with social constructivism to further examine the relationship between students and peer leaders. Each

can be used to support why, presumably, peer leaders would have a honed sense of student learning needs as well as a sharpened ability to detect student learning gains. The Zone of Proximal Development is a theory developed by constructivist Vygotsky in Russia in the 1920's (John-Steiner & Mahn, 1996). The ZPD is a component of Vygotsky's larger sociocultural theory of learning, which states that learning is a result of both social and cultural influences (Wass & Golding, 2014). The core aspects of sociocultural learning can be seen in PLTL through the student-student interactions as well as student-peer leader interactions.

Meaningful learning can take place when there is an exchange of knowledge and discussion of ideas (Macy, 2016). This type of communication is essential for the PLTL model. The ZPD explains how influential the peer leader is to the student's learning. According to Vygotsky (1978), "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or with more capable peers" (p.86). In the context of PLTL, peer leaders would fulfill the role of the more capable peers as described by Vygotsky.

The ZPD is unique to each individual student and contains a low end and a high end. The low end consists of work that can be successfully completed without any assistance, whereas the high end reflects a wider breadth of accomplishments that can be achieved through collaboration with others. An effective PLTL session engages students by working within their ZPD with peers and a peer leader (Cracolice, 2012). Problems that are outside of a student's ZPD cannot be solved even with assistance and would offer no learning gains. A task that is possible for a student to do on their own after they have been taught the underlying concept or method has widened the student's ZPD (Wass & Golding, 2014). Learning has occurred when the student's range of abilities has increased. "What the child is able to do in collaboration today he will be

able to do independently tomorrow" (Vygotsky, 1978, p. 211). One of the most effective scaffolds is peer support, which is described by Harland (2003) as the opportunity for student to observe and copy how a peer solves similar problems, get peer feedback, or collaborate and invent new strategies. Other scaffolds that can be removed once true learning has occurred are textbooks, handouts, and graphic organizers (Harland, 2003; Davis and Miyake, 2004).

The recognition that peer leaders serve not only as group facilitators but as potential role models for their students is derived from Bandura's social learning theory framework. Social learning theory states human behavior is transmitted largely through exposure to role models (Bandura, 1977; Bandura, 1986). Potential benefits of social learning are increases in conceptual learning and greater quantitative problem-solving abilities (Crouch & Mazur, 2001). Given the structure of the PLTL model, students should be expected to display modeling phenomena. Social learning theory is rooted in the belief that emulating the acts of a role model will lead to the same outcomes and results that the role model has achieved (Singh, Vinnicombe, & James, 2006). This belief is limited in the PLTL setting by student's individual learning goals and their criteria for personal success. Because the PLTL workshops are fundamentally based on student-peer interactions, and much of the success shown in these sessions has been attributed to these interactions (Finn & Campisi, 2015), a nurturing environment with an empathetic peer leader is established. The peer-leader may also be viewed as relatable or as a role model to the student, which may provide the student with particular learning benefits in addition to the already established benefits of PLTL as found in the literature.

Purpose of the Study and Research Questions

The purpose of the study was to contribute to the body of literature about the complex

interactions between peer leaders and students engaged in PLTL in the context of an introductory biology course at a large, private, research-intensive university in the northeastern United States, and to explore benefits gained by students who developed a close rapport with their leaders. Based on factors thought to be affected by mentor-mentee interactions, the student's experience in the course should be influenced by the level of attentiveness from their peer leader, whether the student finds the peer leader relatable, and whether the student views the peer leader as a role model. This study also sought to compare and contrast the student and peer leader aspects of these interactions. Additionally, as this study was performed with students in an Introductory Biology course, experiences of students enrolled in a STEM major program were compared to students enrolled in non-STEM major programs.

This study addressed the following research questions:

1. How closely do peer leader perspectives of student learning gains align with student self-reported learning gains as measured by a modified version of the Student Assessment of their Learning Gains (SALG) instrument?
2. What benefits, if any, are found for students whose perceived learning gains closely aligned with their peer leader's assessment of their learning gains?

   Sub-Question: Why do peer leaders expect their assessment of student learning gains to be similar to the student's self-assessment of learning gains?

   Sub-Question: Why do peer leaders expect their assessment of student learning gains to be different from the student's self-assessment of learning gains?
3. What differences in perceived learning gains and final course grade, if any, exist between students who relate to their peer leaders versus those who do not?

   Sub-Question: What factors do leaders attribute to their ability to relate to their students?

Sub-Question: What factors do leaders attribute to their inability to relate to their students?

4. What differences in perceived learning gains and final course grade, if any, exist between students who view their peer leader as a role model versus those who do not?

   Sub-Question: What traits or attributes do the students describe as common to peer leaders they consider to be role models?

   Sub-Question: What traits or attributes do the students describe as common to peer leaders they do not consider to be role models?

   Sub-Question: What is the peer leader perspective on being considered a role model and the necessary qualities of a role model?

   Sub-Question: What is the leader perspective on not considering themselves to be a role model?

5. What impact, if any, does considering the peer leader as a role model have for STEM students versus non-STEM students on perceived learning gains and final grade? What impact, if any, does peer leader relatability and role model status have for students enrolled in a STEM program versus those not enrolled in STEM programs?

Importance of the Study

There are many factors that can help shape the relationship formed between students and peer leaders. Ideally, a peer leader is viewed by the student as a relatable, fellow learner that participates in group work and facilitates Peer-Led Team Learning sessions (Boud, 2001). The relationship between instructors and students has been found to impact many aspects of the student's experience in the course. Poor course performance, lower grade point averages, and

attrition from STEM disciplines have been correlated with students perceiving a negative relationship with their professor (Micari & Pazos, 2012; Vogt, 2008). Findings indicate that when instructors were perceived as more supportive, students also felt they learned more course content and material (Wheeler et al., 2017). STEM courses have a reputation of propagating feelings of hostility and non-caring professors which makes students feel unwelcome in the discipline (Seymour & Hewitt, 1997).

A peer leader may be elevated to role model status by their students, potentially creating an easily accessible channel for students to receive benefits such as motivation to persist and encouragement to succeed in a challenging course. Recent figures show that more than half of students who begin in a STEM program drop out or switch majors before completing the degree (Ashby, C, 2006; National Academy of Sciences, 2005; Hartman & Hartman, 2006; Veenstra, Dey, & Herrin, 2008). A disproportionately high amount of first year students that switch majors or drop out of college are STEM students (Higher Education Research Institute, 2010).

Student attitude and perception of learning gains can have wide-reaching results for students studying in the STEM fields, as self-reported proficiency has been shown to be a positive predictor of academic achievement (Cassidy & Eachus, 2000). Students self-reporting positive learning gains and positive attitudes stemming from their interactions with their peer leaders in PLTL sessions may result in more STEM graduates, higher grade point averages, and better course performance and satisfaction. When students feel they are learning, they are more satisfied with the course, and then tend to stay in the discipline and persist to graduation (Stout & McDaniel, 2006).

Definitions

The following terms are defined for use in this study:

Peer-Led Team Learning (PLTL): An active learning instructional strategy that provides supplemental, small-group learning opportunities for students concurrently enrolled in a separate undergraduate course. Students work collaboratively to construct responses to specifically designed modules at weekly sessions in cooperation with a peer leader. Peer leaders are undergraduates who recently and successfully completed the accompanying course and attend weekly leadership training sessions with a learning specialist.

Biology 121: General Biology 1; A required entry-level course for biology majors and the first of a two-course sequence comprising a survey of essential biological concepts ranging from the molecular level to global ecology. The course is comprised of both lecture and laboratory components and offers a broad introduction to biology as well as preparation for upper-level biology courses.

Biology 221: PLTL Leadership Training 1; A course for returning and new peer leaders instructed by a learning specialist to relate educational research literature to classroom applications in problem solving activities.

Zone of Proximal Development (ZPD): The difference between the learning a student can achieve on their own and what they can learn or achieve with the help of more experienced peers.

Student Assessment of their Learning Gains (SALG): A valid and reliable, customizable instrument developed for college-level instructors to collect student feedback that can be used as a formative assessment, a baseline survey, or for instructor accountability purposes.

Blackboard (Bb): An online, educational platform which allows students to interact with other

students, the course instructor, post and receive assignments, and access other course related components such as documents and grades.

Student Self-Assessment of their Learning Gains (sSALG): The summation of the students self-reported score on the SALG instrument.

Leader's Student Assessment of their Learning Gains (lSALG): The summation of the report completed by a peer leader with respect to their student's learning gains.

Chapter 2: Literature Review

Overview

This chapter consists of a literature review relevant to the current study. First, a background and description of the PLTL program is described, followed by a thorough description of the expectations and responsibilities of the peer leader. The review then focuses on student and leader perceptions of the PLTL program. The focus then moves to literature describing student interactions with instructors, mentors, and faculty members and describes the benefits of a positive relationship. Finally, the literature review closes with an overview of role model literature, with specific examples from the STEM disciplines.

Peer-Led Team Learning. The Peer-Led Team Learning (PLTL) program consists of weekly workshops attended by students enrolled in a concurrent, larger course offered by a college or university (Gosser, Kampmaier, & Varma-Nelson, 2010). Students gather with peer leaders outside of scheduled course time to collaborate and discuss weekly modules related to the coursework, which develops general study skills and promotes active learning (Pazos, Micari & Light, 2010). Benefits of active learning techniques include increases in persistence, retention and satisfaction (Braxton, Milem, & Sullivan, 2000). The small group size of 6-8 students increases the opportunity for all students to participate in discussions (Gosser, 2015), which contributes to the nurturing and personal learning environment. Providing students with an interactive course component and utilizing active learning strategies has been shown to produce significant learning gains, and peer instruction may allow for the correction of misconceptions while simultaneously improving student attitudes (Mazur, 2009).

PLTL was first implemented in 1991 alongside a Chemistry course (Woodward et al., 1993). Due to positive outcomes and enhanced student learning, many STEM fields have since incorporated the PLTL model, including computer science courses and mathematics courses (Stewart-Gardiner, 2010; Quitadamo, Brahler & Crouch, 2009). Since implementing PLTL, an increase in student retention rates across all subgroups has been replicated across science courses at a broad range of institutions (Boud, 2001; Streitweiser & Light, 2010).

PLTL is effective in part because of the types of problems included in the modules. These modules contain questions which fall within the ZPD for most students, meaning they cannot be completed alone but can be completed when collaborating with others (Gafney & Varma-Nelson, 2008). To ensure learning, the problems need to be of appropriate difficulty and must not be too simple or too challenging. The multistep problems found within PLTL modules are specifically designed for groupwork, so that students must communicate with one another and seek guidance from the peer leader to successfully complete them (Eberlein et al., 2008; Gosser et al., 2001). The PLTL modules are designed to engage students in material that develops higher order thinking skills (Peteroy-Kelly, 2009). When students engage in their learning, higher order skills are developed and refined (Eberlein et al., 2008).

Students enrolled in the PLTL program have benefitted from improved grades on exams, quizzes and final course averages (Gosser, Roth, Gafney, Kampmeier, Strozak, Varma-Nelson, Radel, & Weiner, 1996; Peteroy-Kelly, 2009) as well as an increase in student enthusiasm for learning (Woodward et al., 1993). When comparing pre-scores and post-scores of PLTL participants to their non-PLTL counterparts in undergraduate Chemistry courses, there is a significant improvement in course grades, retention rates, final exam grades and attitudes (Loui & Robbins, 2008; Tien et al., 2002). Adding a PLTL workshop option to an organic chemistry

course significantly improved retention for all participating students when compared to traditional recitation sections over an 8-year span (Tien, Roth & Kampmeier, 2004). In courses where other variables such as professor, syllabus, and coursework were kept constant, incorporating the PLTL program has been shown to increase the percentage of ABC's and decrease percentages of DF's when compared to previous years where the PLTL model was not incorporated (Finn & Campisi, 2015).

The PLTL program can be implemented by institutions as a required course component or as an optional, supplemental program. The literature has identified multiple benefits for students who choose to enroll in the optional PLTL programs. When compared to their non-PLTL peers, PLTL students showed improved retention in the course and improved attitudes towards the material (Chan & Bauer, 2015; Lewis & Lewis, 2005). This suggest students enjoy the format of PLTL, and agrees with the findings of Seymour & Hewitt (1997) showing the desire of students to be challenged by coursework and preferentially choosing active learning pedagogies over traditional lecture formats. Students who voluntarily participated in PLTL sessions were also found to have greater levels of persistence in the course and higher course grades than their non-PLTL peers (Streitwieser & Light, 2010; Chan & Bauer, 2015). These students also self-report a positive experience at the end of the course (Streitwieser & Light, 2010; Chan & Bauer, 2015). Snyder, Sloane, Dunk and Wiles (2016) also found significantly better performances in an Introductory Biology course for students engaged in the PLTL program, and additionally found that PLTL helped to reduce the achievement gap between underrepresented minority (URM) students and non-URM students.

The PLTL model may be most effective as a resource for high enrollment and introductory courses due to creating additional opportunities for quality study time and

meaningful interactions with the course material outside of a traditional lecture hall (Gafney & Varma-Nelson, 2008; Chan & Bauer, 2015). The climate of a lecture hall and the impersonal nature of large enrollment courses may contribute to the high course attrition rate found in STEM courses (Finn & Campisi, 2015; Seymour & Hewitt, 1997). The differences between the learning environment created by PLTL and the learning environment created by large lecture halls has been recognized in the literature. The environment of PLTL provides a framework that encourages questioning, analysis, discussion, and debate among group members facilitated by a group leader (Quitadamo et al., 2009). Research has long shown that small, interactive group work provides more conceptual understanding than traditional lectures (Laws et al., 1993).

An engaging learning environment is inherent to the PLTL model. There are several differences between the setting of a PLTL session and a traditional lecture hall. During a PLTL session, it would not be unusual for students to leave their seats and actively engage with the classroom or openly discuss their thoughts. With an informal classroom design and level of structure, discussing answers with peers during the lesson is encouraged (Topping, 1996). An informal classroom design such as this may help some students feel more relaxed and lower anxiety related to mastering the course content. When students feel comfortable and in a learning environment adaptable to them, there is a statistically significant improvement in student attitudes, behaviors, and grades (Marshall, 1991).

In addition to benefits for the students enrolled in PLTL programs, there are documented benefits for the peer leaders. Leaders have reported an increase in the breadth and depth of their own learning (Gafney & Varma-Nelson, 2008). Additionally, research by Streitwieser and Light (2010) has found that leaders may benefit by gaining teaching experience, serving as mentors, and using PLTL in part to refresh their knowledge for standardized exams. Students who serve as

PLTL leaders show an increased desire for a future teaching career (Otero, Finkelstein, McCray, & Pollock, 2006). Leaders also state participating in PLTL has allowed them to meet teaching requirements for their own programs of study, practice and develop teaching skills, and test new and innovative teaching formats (Tien et al., 2002).

Qualitative studies have shown leaders to credit PLTL with helping them to develop qualities such as confidence and perseverance, as well as gain presentation and team related skills (Gafney & Varma Nelson, 2008). Colbron (2012) supports these findings and adds that mentors gain more transferable skills as well as increase their self-confidence. This increase in confidence and transferable skills aligns with leaders' self-reported increase in willingness to accept new challenges in the university and local community (Colbron, 2012). Peer leaders also report that peer interaction, solving problems, and discussion during sessions are factors that can potentially influence their critical thinking skills, although PLTL does not necessarily have a significant impact on the critical thinking skills of the peer leaders (Snyder & Wiles, 2015).

Additional benefits have been recognized that extend beyond the students and peer leaders to the universities and departmental programs. PLTL has been successful across many different learning institutions, and is implemented at a relatively low cost to universities (Micari, Streitweiser & Light, 2005). The opportunity to run PLTL sessions serves as an avenue for students interested in teaching to test their aptitude, as well as potentially contribute to advances in new pedagogy and lesson styles (Tien et al., 2004). In addition, feedback from the leaders and learning specialists can cause faculty involved in the program to rethink the way they teach and write homework and exam problems (Streitwieser & Light, 2010). PLTL has been shown to benefit the enrolled students, the engaged peer leaders, and even the universities and departments implementing the program.

The role of the peer leader. The literature identifies capable peer leaders as an integral component of the successful PLTL model (Finn & Campisi, 2015). Peer leaders are individuals who engage the group in problem-solving activities, facilitate discussion of scientific concepts and ideas, and help students to develop deeper conceptual understanding of scientific topics (Chan & Bauer, 2015; Gafney & Varma-Nelson, 2008; Gosser et al., 2001). The peer leader has a responsibility to enhance and ensure learning while helping students apply knowledge to new situations (Eberlein et al., 2008). An effective leader enhances learning by "reinforcing course content, increasing critical thinking, increasing collegiality among students, and decreasing student anxiety" (Finn & Campisi, 2015, p. 39). Leaders must oftentimes deal with the relationship between anxiety and learning, assess when to cover material more in depth, and keep the session within the zone of proximal development for the students in the group (Amaral & Vala, 2009). The ability to change teaching styles and accommodate a wide range of learners requires leaders to "recognize, respect and support the learning differences of students" (Marshall, 1991, p. 226). This supports the expectation that peer leaders will be highly attuned to the learning needs and learning gains of students.

The peer leaders receive specialized training with a learning specialist to discuss leadership responsibilities and teaching strategies (Snyder et al., 2016; Tien et al., 2004). In addition to attending this training, peer leaders must have successfully completed the course, possess good people skills, and be well trained and supervised in facilitating small group interactions (Gosser et al., 2001). The leaders are expected to ask guiding questions, as well as build the level of student confidence by motivating the students and encouraging their lines of questioning (Younge, 2012). Heit and Bott (2000) suggest that peer leaders should also model

confident behavior, which would lend support to the belief that peer leaders serve as a role model to the students and form a unique bond with them.

The role of the peer leader may prove difficult in certain situations as recognized by the literature. If students do not consider the material in PLTL to be directly related to course assessments, such as exams, students are not likely to take their time seriously and will not actively participate (Mottley & Roth, 2013). Topping (1996) states that what a student learns depends on the student's degree of interest in what is taught, and largely students are only interested in what will give them a high mark on an exam. Students enrolled in higher education have been found to place more of an emphasis on performance in a course rather than truly learning (Cassidy & Eachus, 2000), which does not coincide with the objectives of Peer-Led Team Learning. Conducting PLTL sessions in a memorize-repeat format would directly oppose the format of the PLTL model, and simply recalling facts and reciting material read in a textbook will result in a very narrow ZPD (Wass & Golding, 2014).

Successful interventions that leaders can utilize to overcome these obstacles have been identified in the literature. Students will be more likely to participate in PLTL if they are given a clear explanation of the format and expectations, how the format is connected to research on learning, and perhaps most importantly, provided consistent reminders of how the PLTL classroom activities will result in long-term benefits (Eberlein et al., 2008). Students may also be more willing to participate in PLTL discussions if they perceive a connection or commonality with their peer leader. Ideally, students will view peer leaders as someone in a situation like their own, even considering them a fellow learner (Boud, 2001).

Strategies used by peer leaders to demonstrate to the students that they are fellow learners rather than content experts have been documented in a study by Streitweiser & Light (2010).

This study highlighted the unique relationship between peer leaders and students and included a comparison of the PLTL setting to a large lecture hall setting. One leader reported successfully starting conversations in sessions by sharing information about themselves with their students. This leader claims that sharing personal details caused the students to be more open and feel more comfortable within the group (Streitweiser & Light, 2010). Leaders from this same study also credited social contact and engagement in group discussions for the boost in conceptual understanding seen in students. Peer leader responses showed that leaders are quite conscious to the needs of their students and find deep satisfaction in helping others (Streitweiser & Light, 2010). A productive peer leader-student bond will allow both parties to feel comfortable sharing experiences and propagate learning. This contributes to the close rapport developed between peer leaders and students and allows students to engage more fully with the peer leader.

Student-instructor interactions and student-peer leader interactions. Student-instructor interactions have been identified as a significant factor that influences student learning in undergraduate science courses (Osborne, Simon & Collins, 2003; Pascarella, 2006). Students have based their decision to persist in a major in large part on the faculty members they encounter (Braxton, Millem, & Sullivan, 2000; Micari & Pazos, 2012). Improving a student's experience with faculty or instructors of the course can increase the number of STEM degrees earned by undergraduates (Tinto, 1993; Vogt, 2008). Peer leaders are in a position that falls between the students of the course and the instructors of the course, making it possible that their interactions with the student will also influence their decision to persist in the course or degree program.

Peer leaders are described in the literature as open and friendly resources for students

who might otherwise feel intimidated by professors (Micari et al., 2005). The role that peer leaders play in student's learning has several differences from the role that professors play in student's learning. While the peer leaders may act as fellow learners during PLTL sessions as described above, instructors of the course are not present at PLTL sessions because they would perturb the group interactions (Eberlein et al., 2008). As a result, peer leaders have a unique opportunity to witness the thought processes and skill development of the students in their group while the students brainstorm and construct answers during sessions. The open learning environment created by the PLTL model does not support individuals researching answers and responses to the PLTL module ahead of the session time (Mottley & Roth, 2013). Rather, the students and peer leaders are tasked with developing their own responses to the material as one learning unit.

It is this side-by-side cooperative construction of answers that that has been linked to alleviating the sense of superiority in the PLTL sessions. The collaboration takes place with other students and a peer leader during PLTL, and the outside help or guidance is not from someone perceived to have authority over the course or the grades (Gosser & Roth, 1998). Additionally, peer leaders do not possess an answer key to the modules, and that is made known to the students early in the semester. Students expect peer leaders to engage them in group discussion. However, students may feel uncomfortable or singled out when the course instructor or faculty directly ask them a question, even if that is not the intent of the instructor (Eberlein et al., 2008). Professors engrained in the traditional lecture format may find it more difficult to empathize with their students (McWilliam, 2008), whereas peer leaders can use that empathy to encourage and motivate learning. Peer leaders are expected to create a learning environment that encourages discussion without judging or intimidating students (Finn &

Campisi, 2015). The PLTL program may lessen the feeling of isolation that students in a large lecture hall may feel, and has lessened the separation between learner and teacher (Micari et al., 2005).

This supports the findings of a separate study showing unanimous agreement amongst students that student tutors are more involved with student groups and open to students' opinions than a tutor viewed as a superior (Rijdt, Dochy, & Vleuten, 2012). One possible explanation for the lack of connection between faculty and students is that faculty are currently focusing more on covering course content than student involvement (Christe, 2013). Another possible explanation for this disconnect is presented through results of a survey conducted by Savkar and Lokere (2010). When asked their opinion on hiring new professionals, 48% of university professors responded that a star researcher was preferable over a stellar instructor (Savkar & Lokere). Prioritizing research over teaching may be especially relevant to professors in STEM fields and research universities, and has been shown to detract from student-instructor connections (Christe, 2013; Seymour & Hewitt, 1997). Some learners feel that professors are insensitive to their learning needs and hold negative perceptions of the student-faculty relationship (Hong & Shull, 2010). It is important to note that professors do not necessarily share the same perceptions of the student-faculty interactions (Vogt, 2008), and in some instances STEM faculty may not even recognize that there is a disconnect (Mastascusa, Snyder, & Hoyt, 2011).

Micari and Pazos (2012) performed a study to examine the relationship between students and faculty and effects on student performance, confidence, and science identity in an organic chemistry course. Findings included three factors that correlate with students feeling a positive relationship with their professor: 1) admiring the professor, 2) approachability of the professor, and 3) feeling that the professor respects the students. Additionally, the stronger the perceived

relationship with the professor, the higher the course grade and student's confidence (Micari & Pazos, 2012). This 2012 also focused on science identity, on which there was no observed impact relative to a student's experience with the course professor. A qualitative study by Hong and Shull (2010) found additional qualities that student view as characteristic of a caring professor. These attributes include communicating outside of class, expressing concern about the student's future path, and being supportive (Hong & Shull, 2010). Supportive faculty was also found to be a contributing factor in female community college students and their decision and ability to continue to persist in STEM fields (Packard, Gagnon, LaBelle, Jeffers, & Lynn, 2011).

Documented aspects of the leader-student interactions such as these are particularly relevant to the current study suggests leaders are more attuned to the needs of their students than traditional course instructors. Interactions that peer leaders are expected to have with the students at every session include: listening to the group discussion, contributing ideas when appropriate, and gauging their sense of understanding. Peer leaders hold the ability to relate to and support their students with personal experiences from when they were enrolled in the course (Finn & Campisi, 2015). Leaders have additional special insight since they understand what is required from the program of study and the institution and can speak from experience (Colbron, 2012). Through providing a quality educational experience, peer leaders may also have a strong influence on the maintenance of a positive attitude toward science, particularly at the introductory level (Russel & French, 2002).

Perceptions of PLTL. Student's perceptions towards the PLTL program may be indicative of a number of other results and outcomes. Positive perceptions of the PLTL course and its content typically enhance academic achievement in the course that PLTL is being utilized

(Prince, 2004). Tien, Roth and Kampmeier (2002) argue that students will continue to enroll and participate in optional PLTL sessions once they start seeing results and reaching goals. In addition to increasing course grades, participation in debates and discussion during PLTL sessions can help students achieve the ability to better explain their position on issues, apply learned principles to new situations, and monitor their own understanding and misunderstandings of the content (Tien et al., 2002). Mottley and Roth (2013) further supported this claim by identifying factors reported by students who chose to continue attending PLTL for multiple semesters. These factors include students noticing high attendance rates at weekly sessions, students sensing an increase in personal performance, and students sensing satisfaction from peers and the peer leader. Participants in PLTL view the program as a valued resource, it is not regarded as a remedial or disciplinary class which might detract from its appeal (Tien et al., 2002).

PLTL has generally been viewed in a positive manner by students, instructors, and peer leaders (Prince, 2004). Reasons why PLTL is considered a positive experience for students include: the ability to review the course material in an environment outside of the classroom, the ability to apply course content to practical questions, the opportunity for students to check their level of understanding, and the opportunity to collaborate and discuss with peers (Finn & Campisi, 2015). Students also reported that they believed they were more proficient after completing the course modules (Cassidy & Eachus, 2000). The literature does not currently examine in depth the degree each of these factors and interactions has on the student perceptions of PLTL.

However, there is evidence to suggest that student perception of the learning environment, as well as the perceived efforts of their leaders, influences student achievement

levels. When educational conditions for individual learning needs are met, such as classroom environment and instructor attention, students report feeling more comfortable and less intimated by asking questions (Marshall, 1991). Marshall further found that students will be most successful and learn the best when he or she feels comfortable in a classroom environment and perceives a strong, positive relationship with their instructor. A recent study found that students who perceived their teaching assistant (TA) to be supportive believed they learned more content and felt they were encouraged to engage in more challenging curricula (Wheeler et al., 2017). Black and Deci (2000) also found that the student perception of peer leader support was an important factor in determining the student's course experience and objective performance. In a study looking at laboratory TA's, student perceptions of TA's led to significant differences in appreciation for the laboratory and content overall (Hazari, Key, & Pitre, 2003). These findings may be applicable to students enrolled in PLTL despite the differences in undergraduate and graduate instructors in these studies. Wheeler et al. gathered results suggesting there was no difference in the level of learning perceived by students when comparing between undergraduate TAs and graduate TAs.

Students report appreciating the value that the views, opinions, and advice of group leaders bring to the mentoring sessions (Bruno, Green, Illerbrun, Holness, Illerbrun, Haus, & Sveinson, 2015; Colbron, 2012). Students elaborated that they benefited from the leader's sharing of techniques that they themselves had used while enrolled in the course, and that leaders could guide students to focus on topics of more importance or difficulty (Bruno et al.). Students tend to perceive student tutors as more capable of providing clear explanations to questions than staff tutors (Rijdt et al., 2012). Reasons provided for this finding include that student tutors do not use difficult terminology, will utilize more interactive materials such as whiteboards, and

have a better understanding of fellow student's background knowledge. Course professors are perceived as more likely to provide excessive and elaborate information from being so well versed in the material (Rijdt et al.). These studies support the findings of Kuh and Hu (2001) which state that student satisfaction, effort, and learning gains were impacted by student-faculty interactions.

Positive perceptions of PLTL sessions may provide students with the internal motivation that leads to future success. By examining the results of the Academic Self-Efficacy Scale, Cassidy and Eachus (2000) found that students attributing success to internal factors are likely to expect future success. Students actively participating in the PLTL program have reported an increase in personal confidence and feelings of competency in learning, and interactions with leaders and other students may also improve emotional stability (Topping, 1996). Student's perceptions of the PLTL course, as well as interactions with the leader, are both expected to play a role in the student's perceived attitudes, achievements, and course success (Wheeler et al., 2017).

Students enrolled in a peer instruction program similar to PLTL have reported, both qualitatively and quantitatively, a better understanding of the material, feeling more prepared for examinations, feeling a decrease in course-related anxiety and stress, enjoying the small nature of the sessions and wide range of teaching styles, and believing sessions were inclusive and questions were welcomed by peers (Bruno et al., 2015). These perceptions and feelings are likely common to PLTL students due to the similar settings of the programs. Students who attended a discussion group program showed average exam grades increased as the semester progressed, and many students perceived the program helped them understand and use the main course concepts to logically solve problems (Peteroy-Kelly, 2009).

Role models. It has been found that when students have relatable, helpful, positive role models in the STEM field, motivation, recruitment, and retention in the field will increase (Drury, Siy & Cheryan, 2011). Relatability may be a component of the peer leader being viewed as a role model, but the two terms are not interchangeable. In the context of this study, the definition used for role models will be that of Lockwood,

> Role models are individuals who provide an example of the kind of success that one may achieve, and often also provide a template of the behaviors that are needed to achieve such success. By identifying with an outstanding role model, individuals can become inspired to pursue similar achievements (Lockwood, 2006, p. 1).

A further description of role models is that all role models share the common feature of providing inspiration to others and are perceived as talented in their respective field (Lockwood, 2006; Lockwood & Kunda, 1997). The focus of Lockwood (2006) is on gender matching for role models and participants, and concludes that having a role model of the same gender is more beneficial and impactful to women than it is for men. However, role model benefits are still possible regardless of matching dimensions such as race or gender, it is the degree of benefits that may vary.

STEM role models have been found capable of providing emotional support and advising (Packard et al., 2011), which aligns with the expectations of a peer leader throughout PLTL sessions. Student interactions with a role model have been recognized as having the potential to dispel the longheld stereotypes of the STEM field (Fuesting & Diekman, 2017), which suggests the possibility of PLTL to accomplish this task if students view their peer leaders

as role models.

The two prevalent STEM stereotypes found in role model literature are 1) STEM is for innately gifted individuals and 2) STEM is for European American males (Hong & Lin-Siegler, 2012; Leslie et al., 2015; Shin et al., 2016). There is support found in the literature suggesting that students who are aware of these stereotypes may be deterred from considering a STEM career (Hong & Lin-Siegler; Leslie et al.; Smith, et al, 2013). Both recruitment and retention of students in STEM fields may be affected by challenging these stereotypes through exposure to positive role models (Shin et al.; Fuesting & Diekman, 2017). While the exact degree to which gender influences role model perception remains contested, Smith, et al. finds that when women felt they had to exert more effort than their peers to succeed they experienced decreased motivation in the course. Emphasizing the normalcy of struggling in a STEM field and discussing the amount of effort required for success resulted in student's increased sense of belonging and motivation (Smith, et al.). Hong and Lin-Siegler hypothesized that students would increase their understanding and interest in science after being made aware of the need for scientists to work hard and overcome struggles before becoming successful. The hypothesis was supported by the results, which showed an increase in students' interest in science and ability to solve complex problems after being informed of the hard work and dedication that scientists had to exert before becoming successful (Hong & Lin-Siegler, 2012).

PLTL provides the students with the opportunity to engage in vicarious learning, which is described as "observing admired others engage in work task" (Fuesting & Diekman, 2017, p. 164). Peer leaders may serve as a mentor to the students in their PLTL sessions. Student mentoring has been shown to be successful in increasing student exam scores, increasing student averages, and decreasing attrition rate (Colbron, 2012). Upper level students may be effective

mentors because they are more readily accessible than some faculty and may be able to provide more instantaneous support and feedback (Budny, Cheryl, & Newborg, 2010). Peer leaders qualify to be mentors because they are at a more advanced stage in their education and can offer insight and guidance into particular aspects of the college or courses that may be relevant to the student's interest (Lockwood, 2006).

The impact of relatability between the students and peer leaders has not been extensively studied. A study done by Marx & Ko (2012) set out "to investigate whether increased role model similarity leads to even greater enhancement in performance in stereotyped contexts" (p.1). This study expanded the potential pool of role models by discussing factors that can create a sense of similarity between peers and non-peers (Marx & Ko, 2012). This study finds competence and similarity are factors for a better performing role-model. Interestingly, while competence must be shown in the field of study, the similarity trait may stem from any interest. Brown, Novick, Lord and Richards (1992) finds that any trivial information may be used to create feelings of similarity, and this supports the suggestion of Marx & Ko (2012) to discuss shared attributes as a method of creating similarity between in-group non-peers.

A study conducted by Shin et al. (2016) directly challenged the two prominent STEM stereotypes found in the literature: STEM is for innately gifted individuals and 2) STEM is for European American males. In this study, both STEM and non-STEM students were exposed to biographical passages from successful, fictitious members of the STEM community that purposefully challenged these stereotypes. The quantitative results of this study showed role models to be rated as competent, likeable, inspiring, and their success was considered attainable (Shin, et al.). The study further found that after exposure to the biographical passages, participants attributed the success of the role model figures to hard work rather than luck, and as

a result the participant's interest in a STEM major increased (Shin, et al, 2016). This study showed particular benefits for exposure to role models for STEM students in comparison to non-STEM students. STEM students exposed to role models showed an increase in perceived identity compatibility between self and STEM (Shin et al.). STEM students also showed an increase in academic self-efficacy after exposure to role models, showing that STEM role models increase STEM-specific perceived self-efficacy (Shin et al). It is worth noting that this study did not find a significant impact on academic expectations or degree intention, which may be accountable for by limitations of the study and instrument used and warrants future research. Importantly, this study found no negative effects of displaying female role model biographies to males and found perceived identity compatibility with STEM to increase for both males and females. but did find an increase in academic sense of belonging and academic self-efficacy after exposure to STEM role models (Shin et al.).

Besides the factors listed above that may contribute to whether the peer leader is considered a role model, the effectiveness of a peer leader to serve as a role model may be influenced by the motivation behind the individual becoming a peer leader. "We surmised that motivated volunteers could make excellent leaders and serve as role models for students" (Johnson, Robbins & Loui, 2015, p. 5). Motivation for becoming a peer leader may be an underlying factor in the way that the peer leader conducts PLTL sessions, which would in turn affect the interactions with students. The incentive for students to participate as facilitators in supplemental courses range from receiving payment, positive letters of recommendation, resume boosters, course credit in a leader training course, and a good review of course material as they take standardized tests to enter graduate school (Merkel & Brania, 2015; Mottley & Roth, 2013; Streitweiser & Light, 2010,). Motivated individuals who have the potential of becoming effective

role models may not be able to participate in PLTL due to the following reasons: conflicting obligations, such as classes during the session times or extracurricular activities are most frequently cited (Micari, Streitweiser, & Light, 2005).

Chapter 3: Methods

Overview

This chapter will first describe the limitations, delimitations, and conceptual assumptions of the study. The participants of the study, data analysis procedures, and methodological assumptions of the study will then be discussed. The instrument used in this study is the Student Assessment of their Learning Gains (SALG) and the novel use for this study is discussed following a description of the traditional use of the instrument as well as instrument reliability and validation.

Limitations

The sample of this study is limited to undergraduate students enrolled in a private, co-ed, research intensive university in the Northeast. This limits the generalizability of the study. The study does not make any claims to causality, but rather shows correlations within the population sampled. While the SALG is a previously validated and widely implemented instrument, the approach taken in this study to compare SALG results for one participant from two different respondents is novel and not previously explored. The participants are self-reporting the value they ascribe to particular aspects of the PLTL session that are otherwise non-measurable behaviors. Although self-report measures have raised concerns due to possible measurement errors, the SALG has been the prevailing choice of PLTL research on student learning gains (Christe, 2013). The novel use of this instrument also introduces the limitation of the peer leader's ability to report the student's learning gains in an accurate and non-bias manner.

Participants in this study were asked to self-report on their experiences and interactions

with peer leaders during weekly sessions of the PLTL course associated with Introductory Biology. The willingness of the participants to respond wholly and truthfully contributed to the limitations of this study. Students were informed that responses to all questionnaires would remain confidential and would not be reviewed until after final semester grades were submitted to registrar. All data requests were made to participants by non-instructor personnel (either the course coordinator or the learning specialist) to reduce the impact of perceived researcher/instructor influence on responses. Questionnaires were then analyzed with an approach based on Micari and Pazos' (2012) general thematic-analysis methodology. This process involved "identifying common key ideas in the comments, developing codes based on these, and then coding and categorizing the comments" (Micari & Pazos, p. 43).

The sample was further limited by the need for both students and peer-leaders to fully complete the questions presented on the SALG survey as well as the separate, open-ended questionnaire. Students who completed all necessary surveys yet had peer-leaders who did not complete SALG survey information could not be included in the portion of the study involving comparison analysis between student responses and peer-leader responses. The open-ended questionnaire and SALG survey were administered at the end of the Fall 2017 semester. While it was assigned as a reflective course component for peer-leaders, students were only incentivized to complete the survey and questionnaire as minor extra credit opportunities.

Delimitations

The students represented in the study are students who were enrolled in BIO 121: General Biology 1 and are concurrently enrolled and active in a supplemental Peer-Led Team Learning session. Students who dropped or withdrew from the course before the time of data collection

were not contacted to complete the open-ended questionnaire or SALG survey. The peer leaders represented in this study are students who recently completed BIO 121 with a grade of B or higher. Peer leaders must be enrolled in BIO 221: PLTL Leadership Training 1, which is instructed by a learning specialist. BIO 221 focuses on teaching and learning theory while allowing the peer leaders to discuss their experiences in past workshops and prepare for the upcoming modules.

This study aims to identify the impact of different peer leaders on the student's experience in General Biology and the interactions between those peer leaders and their students. The scope of the additional findings of the study is limited to the impact of peer leaders on students majoring in Science, Technology, Engineering, and Mathematics (STEM) fields versus students enrolled in a non-STEM program. Data for the effect of interactions between peer leaders and students based on gender, age, race, or 1st generation college students were not collected or included in this study.

Conceptual Assumptions

To determine the effect peer leader interactions had on student's experiences in the course, this study assumed that all participants could accurately and honestly perceive student learning gains throughout PLTL sessions. The study also assumes that the individual style of peer leaders facilitating PLTL sessions can influence student perceived learning gains. An additional assumption of the study is that peer leaders met expectations and responsibilities of a peer-leader as described in the literature. The SALG instrument used in this study has not been used as a comparison tool before, so the previously validation and established reliability of the

instrument was assumed to be comparable from one individual responding to the survey to another individual's learning gains.

Sample

Participants in this study are all undergraduate students at a large, private research university in the Northeastern United States. The students who were offered the opportunity to enroll in the PLTL sessions were concurrently enrolled in BIO 121: General Biology 1. This course is required for biology and other life science majors as well as many related STEM programs, pre-health professions programs, and is a foundational prerequisite for many upper-division STEM courses. However, as students at this university do not formally declare majors until the end of the first year, there is no first-year survey course in biology specifically for non-majors. The course is therefore a popular choice for students who may be interested in non-STEM programs but who need a science course for their liberal arts core (general education) requirement.

Students were enrolled in a PLTL session time that fit into their course schedule with the help of the learning specialist. In an attempt to promote diversity in the groups, the name of the peer leader facilitating each weekly session was not available to students at the time of enrollment. There were no other restrictions on enrollment besides scheduling conflicts. For the portion of the study in which participants are divided into "STEM" and "non-STEM" categories, students in social and behavioral sciences were sorted into the "non-STEM" categories in accordance with recent national reports on STEM recruitment and retention (Chen, 2013; PCAST 2012).

The peer leaders who participated in this study have all met the requirements of a peer

leader as stated in the PLTL literature, having recently completed BIO 121 with a final course grade of A or B. Leaders were either invited to participate in the Fall 2017 offering of PLTL by the learning specialist, or they expressed interest in becoming a peer leader and were subsequently approved by the learning specialist. All peer leaders were required to host a 55-minute weekly PLTL session meeting as well as enroll in BIO 221: PLTL Leadership Training 1. This course in leadership is instructed by the learning specialist and discusses various pedagogical approaches to helping students construct responses to course content.

Recruitment of Participants

Student and peer-leader participants in this study were recruited according to an Institutional Review Board approved protocol (Appendices E & F).

Students were made aware in the beginning of the semester that survey responses would be collected and used for research purpose, and they were allowed the option to opt out of participating without instructor knowledge and without penalty by contacting a non-instructor biology department staff member. Information on research participation was provided in the course syllabus and a recruitment/welcome email. Student participation was voluntarily, however an extra credit incentive to access the surveys online was offered. Students could earn the extra credit whether they completed surveys or not.

Peer leader responses to surveys and questionnaires were collected through Blackboard, a course management system used by the university for official communication between students and instructors. The surveys and questionnaires were presented to the peer leaders as a regular component of the BIO 221 leader training course designed to promote peer-leader reflection on their experiences, either as formative assessments or as a prompt for the weekly journal entry.

Instrument

The instrument determined to be best suited for this study based on research goals, theory base, target audience, time constraints, and flexibility is the Student Assessment of their Learning Gains (SALG) instrument (Seymour, Wiese, Hunter, & Daffinrud, 2000). The SALG was developed for college-level instructors to collect student feedback that can be used as a formative assessment, a baseline survey, or for instructor accountability purposes. The flexibility of the instrument makes it applicable to any pedagogies and disciplines outside of Chemistry, and it is commonly used in PLTL research to assess student learning gains (Christe, 2013). Peteroy-Kelly (2009) used the instrument in conjunction with separate pre- and post surveys, and reported findings from the SALG surveys by grouping the Likert responses of "Strongly Agree" and "Agree" together in one category, and reporting on the percentage of students who fell into this category for each question. Finn and Campisi (2005) administered the SALG survey to students and reported on results in terms of moderate, good, or great. An additional perceptual survey of the PLTL program was also used in addition to the SALG instrument.

The SALG instrument was a more appropriate choice for this study than end of semester evaluations or direct assessments such as exams because the research objectives are to determine which aspects of PLTL students have benefited most from, and how attuned the peer leaders are to these learning gains. The SALG instrument is a useful tool because it is completely modifiable to instructor needs, can be used as a baseline assessment or summative assessment, and can gauge student learning gains rather than just final grades in the course (Scholl & Olsen, 2014). The purpose of this study was to determine which aspects of PLTL were most beneficial to student learning and compare the self-assessments of students with the peer leader's assessment

of that student. Volkwein (2010) found several differences between faculty members that may confound results of studies that only use assessment grades as their measure: some professors assign grades once a certain level of knowledge is reached, others curve grades, some are done on the basis of effort and improvement, and still some faculty use the obtainment of the learning goals laid out for the specific course to assign grades. The SALG survey does not share these limitations, and additionally contains questions relating to enthusiasm and likelihood to pursue the subject after this course, allowing previous research findings to be verified and revisited.

The SALG instrument is a free, self-report questionnaire that is customizable for the needs of the course and is available at https://salgsite.net, which is a website hosted by the Wisconsin Center for Educational Research at the University of Wisconsin-Madison (Student Assessment of their Learning Gains, n.d.). According to this website, the SALG was developed with the intent to be utilized in college level courses and to focus "exclusively on the degree to which a course has enabled student learning" (Student Assessment of their Learning Gains, n.d.). The SALG survey consists of 5-point Likert Scale questions from 1 (no gains/no help) to 5 (great gains/great help), as well as the possibility for open-ended questions in each of the sections. The eight sections used to divide the questions on the extended SALG instrument are 1) Understanding of class content, 2) Increase in Skills, 3) Class Impact on Attitudes, 4) Integration of Learning, 5) The Class Overall, 6) Assignments, Graded Activities and Tests, 7) Class Resources, and 8) The information you were given. Five overarching questions of the SALG instrument are described on salgsite.net and are given below:

1. How much did the following aspects of the course help you in your learning?

(Examples might include class and lab activities, assessments, particular learning methods, and resources.)

2. As a result of your work in this class, what gains did you make in your understanding of each of the following? (Instructors insert those concepts that they consider most important.)

3. As a result of your work in this class, what gains did you make in the following skills? (A sample of skills includes the ability to make quantitative estimates, finding trends in data, or writing technical texts.)

4. As a result of your work in this class, what gains did you make in the following? (The sub-items address attitudinal issues such as enthusiasm for the course or subject area.)

5. As a result of your work in this class, what gains did you make in integrating the following? (The sub-items address how the students integrated information.

Instrument Reliability

The SALG instrument was developed in 1997 and most recently revised in 2007 by Carroll, Seymour and Weston (Student Assessment of their Learning Gains, n.d). The guidelines for reliability and validation as they particularly relate to the SALG instrument have been documented in the 2000 study by Seymour, Wiese, and Hunter and additional papers discussing validity are available through the https://salgsite.net website. Reliability was determined after extensive studies showed a consistent result when used repeatedly to measure the same variables, and validity was determined after studies showed the instrument measures students' perceptions

of their learning gains and not some other phenomenon (Seymour, et al, 2000). Because the instrument is customizable, recommendations for designing questions and retaining integrity have been published by the instrument developers. In concurrence with Kuh (2002), recommendations for collecting valid self-assessment data through SALG surveys must meet the following requirements 1) students must know the information they are asked to assess, 2) Questions should be phrased clearly and non-ambiguously, and 3) Questions should ask about meaningful activities and ask for a thoughtful response.

A study conducted by the instrument developers on 119 students in an astronomy course to test the ability of students to rate their understanding and skills accurately resulted in a moderately significant correlation of r=.41 between summation of each student's SALG score and final exam grades pertaining to the specific subject area pertaining to the SALG ratings. A meta-analysis conducted by Falchikov and Boud (1989) was used to demonstrate the validity of the SALG instrument, as the authors compare the correlation of r=.41 to the r=.39 that was found by Falchikov and Boud when calculating student self-assessment ratings to the faculty ratings of those same students. Because Falchikov and Boud's study was used to demonstrate validation of the SALG instrument, it is reasonable to expect the SALG instrument can also be used to compare and contrast the self-assessments of students to the peer leader's assessment of those students, as it was used for the current study. These validation studies also led the authors of the SALG website studies performed on student self-report led the instrument developers to the finding that science students and students in upper division courses were able to rate themselves more accurately than non-science students and students in introductory courses (Student Assessment of their Learning Gains, n.d.).

Instrument Administration

Participants completed the SALG instrument at the end of the Fall 2017 semester. Due to the design of this study and research objectives, the recommendations for online SALG instrument administration by the developers were not precisely followed. The needs of this project did not make utilizing a third-party website feasible, especially regarding peer leaders who had to complete the SALG instrument for as many as ten students. While data were still collected online, they were not collected through the salgsite.net convenient feature of designing a "wizard-style" interface. This interface is designed to provide features such as statistical analysis of class responses as a whole, which would not have been beneficial to this study. To best suit the research objectives of comparing student self-assessment of learning gains with the perceived learning gains of each student as reported by the student's peer leader, Blackboard was chosen as the method of survey administration. The "Test" function on Blackboard allows student identity to be attached to responses, allows for organized results, and simplifies the process of crediting students for completing the survey. Blackboard provides all necessary components for data collection and then further data analysis methods were utilized to compare student responses to leader responses with methods unavailable on the SALG website.

To maintain validity, the request for students to participate in the SALG instrument were made to the students by the course coordinator, and the students were assured that the researcher would not view their responses until after final course grades were submitted to registrar. Students were also informed that this data collection was for research purposes only, and there would be no adverse repercussion for them or their peer leader for any responses given.

The peer leaders were asked to complete the SALG instrument for each of the students in their group. The instructor of BIO 221 intertwined the SALG instrument as one of the required

course assignments. Survey templates were sent through email and documents were uploaded to Blackboard as part of the "Discussion" tool. Only the researcher and BIO 221 course instructor had access to peer leader responses. Peer leaders were assured that answers would remain confidential and would only be utilized for research purposes.

Data Analyses

Statistical analyses of the quantitative data collected from administering the SALG instrument to students and peer leaders were performed with two statistical software packages, SPSS version 24 and R 3.4.1 run in RStudio 1.0.153. The summation of all SALG responses was used for analyses. Summation of all responses was chosen for this analysis due to statistical means being a very generalized form of information that would lose the detail necessary for this particular research objective. In addition, Cronbach's alpha, a measure of internal consistency, was determined for students' SALG scores to verify that the SALG instrument was able to be used as a single measure of learning gains. Cronbach's alpha was found to be 0.98, which is considered excellent; thus using the sum of SALG answers is a defensible measure of student learning gains. Only student-leader pairings where each party completed 100% of the SALG survey were included in the analyses. Additionally, any of the analyses involving the effect of peer leader relatability and the peer leader's position as a role model were further limited to the students who responded to the qualitative questionnaire.

A mixed-design Analysis of Variance (ANOVA) was conducted first to determine if SALG score estimates of individuals differed if they were reported by the student themselves versus the leader, if the leaders differed in their students' SALG scores, and if leaders differed in their ability to correctly determine their students' SALG scores.

For further analysis, students who had a SALG score in the highest quartile and the lowest quartile were considered as students who had a “high” and “low” SALG score, respectively. A Welch’s Two-sample t-test was performed to determine if students with a high and a low SALG score differed significantly in the absolute difference between their scores and their leaders’ estimation of their learning gains.

The effect of students’ assessments of their peer leader as relatable on student perceived learning gains was determined using two-way ANOVA analysis, with major of the student (STEM major vs. non-STEM major) included as a second explanatory variable, as well as the interaction between relatability and major. This analysis was repeated with the substitution of students’ perceptions of their leader as a role model in place of relatability.

Pearson’s chi square test was used in all analyses which compared final course grades between one group of students and another. Calculations of final course grades compared students in AB grade ranges with students in CDF grade ranges. A final course grade of AB is considered successful for this study. AB is the successful grade range because this is the grade requirement for students to be eligible to register as PLTL leaders for the BIO 121 course. A significance level of .05 was used for all calculations.

Qualitative data were obtained from students through an open-ended questionnaire, and collected from peer leaders via private discussion boards and journal entries as a component of the mandatory BIO 221 course. A general thematic-analysis approach was used to analyze the qualitative data. Key ideas and recurring themes were identified in the passages or statements and then code was developed based on these themes. Comments were then coded and categorized.

Methodological Assumptions

The study was conducted using the SALG instrument in a novel way. It is reasonable to assume that the method of distribution for this study (i.e., through Blackboard rather than anonymously through salgsite.net) will not affect the validity of the samples. The instrument developers have listed reasons for switching from pen and paper surveys to the online tool, none of which should reasonably influence validity. These reasons are reduced amount of time for completion, ability for student to complete more responses in a lesser amount of time, and higher student response rates. The ability to attach SALG responses to student identity was critical for this study, as the purpose is to compare and contrast student responses with those of their peer leader.

This study assumes factors such as participant honesty while responding to the qualitative questions and that the participants felt the freedom to be open and complete with their responses. This study also assumes the students and peer leaders understood the task of responding to the SALG instrument as it pertains to the student's learning gains from the PLTL course. The perceptions expressed by the students and peer leaders were used to draw conclusions based on these assumptions. The two-way ANOVA test was performed under the statistical assumptions of independence, normality, constant error variance, and homogeneity. Pearson's chi square testing was done under the assumption of independence and an adequately large sample size. Yate's continuity correction was applied to inadequate sample sizes. Welch's T-test was performed under the assumptions of a representative random sample from the population, a normal mean distribution, and similar variances of the different groups. Cronbach's alpha was used on analyses of SALG responses to confirm internal consistency of the instrument.

Chapter 4: Results and Discussion of Findings

Overview

The results of the statistical analyses used, in part, to answer each of the research questions are presented first in this chapter. The SALG scores from both the students and their paired peer leader are examined for agreement between student and peer leader scores, differences in scores between students, and differences between leader abilities to assess the student at the same level that students assessed themselves. Qualitative responses were collected from the peer leaders explaining their beliefs as to why their assessed SALG score of the students may differ or closely represent the student's self-assessed SALG score.

The influence of a peer leader who is more closely attuned to student learning gains and needs is examined in comparison to both the student's perceived learning gains and final course grade. The impact of interactions with a peer leader on the student's final course grade and perceived learning gains is also examined under the conditions that the student found the peer leader to be relatable, followed by the student viewing the peer leader as a role model. Additional findings of the benefit to viewing the peer leader as relatable and, separately, as a role model, are also explored by comparing responses from students who are enrolled in STEM programs versus non-STEM programs.

The breadth of the interactions between peer leader and students enrolled in a PLTL program for Introductory Biology are explored through qualitative responses. The affirmative and negative responses for peer leaders are discussed through representative quotes for why they do or do not view themselves as relatable or, separately, as a role model. The student

perspectives are presented describing specific aspects of their interactions with peer leaders that cause them to consider the peer leader as a role model, as well as attributes that caused them to not consider their peer leader to be a role model. Research questions and sub-questions are analyzed and interpreted separately from the other research questions. The chapter concludes with a discussion of the findings for each question, and incorporating previous research to justify proposed explanations.

Key Questions, Findings, and Analyses

How closely do peer leader perspectives of student learning gains align with student self-reported learning gains as measured by a modified version of the Student Assessment of their Learning Gains (SALG) instrument? At the end of the Fall 2017 semester, students enrolled in PLTL were asked to complete a modified SALG survey as described in Chapter 3. The instrument used contained 25 questions on a 5-point Likert-Scale, and the summation of each student's responses was calculated as a range from 0-125 (sSALG). A higher score represents a greater amount of learning gains. The peer leaders were administered the same SALG instrument but were asked to complete the survey for each of their individual students with respect to the student's learning gains. The summation of these assessments was reported as a value ranging from 0-125 (lSALG). Student scores were then paired with their peer leader's score, making it possible to determine which student-leader pairing was most closely aligned in terms of the perceived learning gains of the student. Only student-leader pairings where both parties completed 100% of the SALG survey questions were included in this analysis (n=152).

The results of the mixed-design ANOVA were used to determine differences between sSALG and lSALG, if the students differed in their SALG scores in each PLTL group, and if

leaders differed in their ability to correctly determine their students' SALG scores. These results are shown in Table 1 and Figure 1. Students and leaders significantly differed in their assessment of the students' learning gains $F(1,113) = 24.1$, $p < .001$, and this difference significantly differed by leader, $F(35,113) = 1.93$, $p = .005$. The data also show that students differed in their SALG scores between leaders, $F(35,113) = 1.57$, $p = .041$.

Once significant deviations were found, Welch's Two-sample t-test was performed to determine if students with relatively high SALG scores and relatively low SALG scores differed significantly in the absolute difference between their scores and their leaders' estimation of their learning gains. The calculations based on the number of differences found between the student-leader pairings found the minimum number of differences between student-leader pairings to be 0 and the maximum number of differences to be 94. The median number of differences is 27, with the lower quartile being 14 and upper quartile at 40.25. The number of differences between the student-leader pairings were found to be very significant to student self-reported learning gains (Welch's 2-sample t-test: $t = 7.63$; $df = 135.38$; $p \ll 0.001$). The students who reported the highest perceived learning gains had SALG scores that aligned more closely with their peer leader's assessments than those students with low perceived learning gains. Students that had low SALG scores had a significantly greater distance between their SALG score and their leaders' assessments of their SALG scores when compared to students with a high SALG score (Figure 2).

What benefits, if any, are found for students whose perceived learning gains closely aligned with their peer leader's assessment of their learning gains? The data show that while there are significant differences between certain leaders and their students in assessing the

student learning gains, the students who engaged in PLTL with peer leaders with the most harmony between lSALG and sSALG scores reported significantly higher learning gains than students with a peer leader who's lSALG scores differed greatly from the sSALG. This finding indicates that in a PLTL setting, a peer leader who is more closely attuned to a student's learning needs and attentive to their student's personal progress may contribute to an environment where students perceive learning to be taking place. The data show that certain peer leaders are better at gauging their student's perceived learning gains than others, and that sSALG scores do vary by leader. To formulate recommendations for future peer leaders on key interactions with students that enhance perceived learning gains, and potentially academic achievement, peer leaders were asked to explain, with anecdotal evidence from sessions, why their lSALG may differ or be similar to the sSALG.

Sub-Question: Why do peer leaders expect their assessment of student learning gains to be similar to the student's self-assessment of learning gains? Peer leaders were asked to complete an assignment describing if they expected their lSALG responses to closely align with the sSALG responses of students in their PLTL group. Of the peer leaders who responded (n=37), 66.7% of leaders stated they expected lSALG scores to be similar to those of their students. The leaders described basing their assessment off cues, behaviors, and actions that they observed and interpreted to mean that the student was progressing with their learning.

Environment of PLTL. Some leaders credited the similarity between SALG scores to the atmosphere they were able to create during the sessions and their method of facilitating workshops. The intimate atmosphere of PLTL also makes it possible for students to freely express when they do not understand topics, and even share which type of learning modules they

prefer (i.e. case studies) with their leader. As one leader phrased it, "…I also felt like I was approachable and the students felt comfortable enough to ask my questions or asked if we could do something a different way." The flexibility to adjust the pace and direction of sessions based on the student's learning needs was a recurring theme in the peer leader responses as a reason for SALG score agreement.

> …I was approachable and the students felt comfortable enough to ask me questions or asked if we could do something a different way. I think that was extremely helpful for their learning experience, because we spent the majority of the time doing what they wanted, and what they felt was helpful for them.

The peer leaders also expressed that having a peer-led environment resulted in a level of comfort that allowed students to feel open to asking questions to deepen their understanding of the subject matter. One peer leader stated: "… [the students] were very honest with me on how they felt about PLTL and were never shy to let me know when something wasn't right or the types of questions they liked and disliked."

Listening to student feedback and presenting information in a variety of ways made the peer leaders more confident in their assessments of the students' learning gains and progress throughout the course. They expressed feeling empowered over the ability to give students a way of learning that differed from typical classroom lectures:

> I think my students would rate their own learning gains similar to the way that I would rate them. I think my sessions were geared toward each student's learning style… …We did a lot of visuals on the board and on the TV just so we could show the processes, and explain them in ways that were different than what was presented in class.

The peer leaders expressed feeling capable of explaining difficult concepts to students in a way the students will understand, which supports the previous finding of students perceiving student tutors as more capable of providing clear explanations to questions than staff tutors (Rijdt et al., 2012). Reasons provided for this finding include that student tutors do not use difficult terminology, will utilize more interactive materials such as whiteboards, and have a better understanding of fellow student's background knowledge, which is a finding supported in the current study. The peer leader's use of the phrases "on the same level" and "in their shoes" is representative of the idea that they have a better understanding of their student's background knowledge than someone more distant from their learning, such as a professor, might have. Further, this supports the idea that the PLTL sessions and collaboration with peer leaders is operating within the student's ZPD.

Personal relationships. While many peer leader responses alluded to a close rapport that had developed between them and the students over the semester, several peer leaders explicitly credited the personal relationships fostered as the reason for similar lSALG and sSALG scores. The leader has the opportunity to be considered a fellow learner, and students view them as someone in a situation like their own without being unnerved or intimidated by a power dynamic (Boud, 2001). As peer leaders describe assuming the responsibilities of a fellow learner as well as a caring friend who is accessible outside of set classroom hours, they believe that they have the capability of assessing student learning gains accurately.

> I think their responses will be similar because the students never had an issue talking to me about the things they were struggling with, so I was usually able to gauge where they were at. None of them were all that reserved and they viewed me almost as a "knowledgeable friend." I gave them all my phone number so that they would be able to

> ask me any questions they had. Most of the time when the students texted me it wasn't even related to their biology class, but rather about research they were interested in, like [the campus volunteer ambulance] or even medical school. This led me to believe that the students were comfortable sharing things with me.

Based on these findings and previous findings as discussed in Chapter 2, it is not unreasonable to assume the students feel more comfortable showcasing their knowledge and sharing weaknesses with peer leaders than with faculty. A response particularly relevant to the overall study involves a peer leader first stating how they could relate to the student, then sharing strategies for success with the students, then discussing the result of these positive interactions as having positive learning outcomes for his or her students.

> I personally think they would rate their own gains greatly similar to what I rated them as we were all on the same page as leaders and students[…] [S]ince I was able to relate to my students a lot, I was able to share strategies I did when in [BIO] 121 which helped me excel in this course which is why the students in my session were able to do well also. Having them know that I was once in their position and trying to study so much information for one exam, but still being able to do well enough where I have ultimately become a bio PLTL leader is something I think influenced them to try harder in PLTL and the course itself.

It is unsurprising that many of the aspects of these responses from the peer leaders are echoed in later sections describing what characteristics make a peer leader relatable, as well as what attributes are possessed by a peer leader considered to be a role model by their students. The findings of the current study show that students have higher perceived learning gains for each of the following criteria: similar lSALG and sSALG, relatability to the peer leader, and

considering the peer leader to be a role model. These findings are discussed in detail in the appropriate sections of this chapter, but it is important to highlight the underlying features of positive leader-student interactions as described above. These recurring features of the interactions are the foundations for peer leaders to assume relatability and role model status. All of these aspects are connected to higher perceived learning gains.

Progression of course grades. The open and honest communication as described above may have encouraged some students to share information typically associated with course success, such as exam grades or quiz scores. As one leader states, "They [the students] often shared their exam scores with me and their scores seemed to improve each time." This knowledge was beneficial for some peer leaders and they credited their ability to judge student learning gains to this information.

> One example of why I think we would give similar responses is that frequently my students were very open about their exams and how they did so I have a good idea of how well they were all doing in the class which gives me a good indication of the knowledge they learned well in PLTL.

The peer leader quoted above is not alone in believing that learning gains from PLTL may be reflected on formal assessments in BIO 121. Another peer leader acknowledged the benefits of frequently attending PLTL sessions and believes that was reflected in student exam grades, "I found those who attended the sessions more regularly gained more and performed better on the exams."

Responses such as these are indicative of both the student and leader focusing PLTL efforts on successfully completing the course with high marks on formal assessments. However, this did not discourage the peer leader from expecting to have similar perceptions of student

learning gains as would be measured by the SALG instrument. In these instances, a positive relationship between student and peer leader where the student felt connected enough to the peer leader to disclose grades was enough for the peer leader to expect similar results.

Direct observation of learning gains. The most common reasoning found in all the peer leader responses is that being in a position to directly observe and participate in the student's learning is why the lSALG will align closely with the sSALG. This is also the aspect of student-leader interactions that is explained most in Chapter 2 by comparing the role of the peer leader to typical student-faculty interactions. Responses of this nature did not revolve around information students were willing to disclose to the peer leaders, but rather what the peer leaders were able to witness while fulfilling the expected duties of a peer leader during a PLTL session.

> Over the course of the semester I have seen the students who show up regularly be more open to discussion, come to sessions better prepared, piece together concepts better, and overall become more adept at learning and understanding BIO 121 material.

Often, as shown above, the leaders made a broad statement about observing benefits of the PLTL model in general. However, there were also instances described were specific gains for individual students were identified.

> I can also see gains from the students' actions in class. For instance, I noticed that one student was not engaged in the conversations in the beginning of the semester, but once she started completing the readings in the textbooks before each session, she had much more to say during the sessions…In addition, another student was very shy in the beginning and seemed skeptical of being there. Now, she is engaged and very into the activities that we complete. I think that she has gained great conversational skills from attending the PLTL sessions and that she would agree. Lastly, a different student is

> constantly helping her peers out when they don't understand a concept. I think that she has gained great skill in working with others.

The ability of the peer leader to recognize progress for each individual student lends further support to the concept of PLTL creating a nurturing and personal environment where learning can take place. Peer leaders develop a close rapport with the students as they actively engage in modules each week; students are not passively learning or lost in a crowd as they may be while seated in a large lecture hall. As discussed in chapter 2, the informal design of the PLTL model and the types of questions used in modules requires the student to share thought processes and opinions in a way that would not be allowed in a typical lecture hall.

> In the beginning of the sessions, I noticed that when a student would give an answer to a workshop question, she would not defend her answer or say why she believed it was this versus that, but as the semester went on, they all learned to defend their answers. This is a helpful tool that they will be able to use in all subjects…. I could see this in how they worked on the workshop activities because the sessions would not be quiet and there would be constant discussion of each question.

One peer leader elaborated how they were able to witness growth from the student's in the PLTL session, but could also see that the student was making strides to apply skills learned throughout the sessions to real-world applications.

> …She was one of few students who consistently pointed out discrepancies in graphs and critiqued study methods that she felt did not appropriately reflect the intended goal of the study. This shows growth in one's ability to take previous scientific knowledge and use it to infer real world scenarios...

All the traits described by this peer leader are measurements used to assess learning gains on the SALG instrument. Separating learning gains from the formal course assessments makes it likely that lSALG will align with the sSALG. Differences in measurement criteria such as these where recognize by multiple peer leaders who anticipated a difference between lSALG and sSALG. Proposed peer leader explanations for differences are examined in the responses for the next sub-question.

Sub-Question: Why do peer leaders expect their assessment of student learning gains to be different from the student's self-assessment of learning gains? Of the peer leaders who completed all necessary components for this analysis, 25.6% expected their score for student learning gains to differ from the student's self-reported learning gain score. This expectation was not portrayed in the responses as a negative statement or as a shortcoming on the part of the leaders or the students. The qualitative responses overwhelmingly expressed the belief that students were making learning gains that they could not recognize in themselves. Responses stating that students may not be able to view their own learning gains in the same manner as the peer leaders when completing the SALG assessments are separated into two categories: Different measurement criteria and peer leader point of view.

Different measurement criteria. One key reason offered by peer leaders for the discrepancy between lSALG and sSALG is that students were using more traditional methods to assess success, such as exam scores, rather than reporting on learning gains as measured by the SALG instrument. As one peer leader explained: "…students will [rate themselves] lower because they are thinking how it relates to lecture and not actual skills." Another peer leader echoed this sentiment, as well as correctly predicting that a difference in lSALG and sSALG scores would most often result from a lower sSALG score.

> I believe that my students would rate their own learning gains well below what I gave them. This is not because they believe they have learned nothing in session but since there are no answers it might be hard for them to gauge their improvement.

In addition to the disconnect students may feel between formal assessments and learning gains as measured by the SALG instrument, students may not perceive learning gains to the same extent that peer leaders do because they have a different perspective than peer leaders when making these assessments. The different point of views was used by several leaders to explain possible differences in SALG scores.

Peer leader point of view. Peer leaders referenced their personal experiences in academia as well as the responsibilities of the peer leader as described in Chapter 2 to defend their position that they have a different point of view than the students when it comes to assessing student learning gains.

> … my observation of the students and their observations of themselves are completely different. I am actively evaluating them and looking to see if I can help them improve in their ways of thinking and they are more focused on just trying to get the right answers and not HOW they get to the right answers.

The peer leader above is describing the tendency of the students in their group to focus more on earning high marks on exams from knowing the correct answers rather than focusing on the skills and techniques gained from the process of learning, and using those measurements as criteria for success. Content mastery is not assessed on the SALG instrument, so if the leader is correct in his explanation then it would be likely he or she would have differing SALG scores from their students. To address this discrepancy, one leader recommends raising student

awareness of the expected learning outcomes for PLTL so they will recognize growth in the same manner that the peer leader has:

> It is easy for me to track their progression and see the changes from week to week, especially since it is my responsibility to gauge their progress throughout the semester via discussion and journaling. I could do a better job as a leader if I were to stress the expected learning outcomes of PLTL for the first few weeks of sessions, instead of just mainly the first one. I think they might be able to see how differently they work through problems and how much more efficient they are with their time now.

In addition to aligning the responses of student learning gains between students and peer leaders, providing students with information about PLTL such as the format, expectations, and reasons why classroom activities will benefit them has also been suggested by Eberlein et al., (2008) and is expected to increase the likelihood that students will accept course material and participate.

The next two peer leaders justified having a different point of view on student learning gains than their students would by discussing their ability to reflect on their own experience of being a student in PLTL:

> …it took probably a year since being a student in PLTL for me to realize how much I did get out of it. At the time of taking the class it was hard to make the connections to how it helped and related… …As of now I think their own assessments of their gains are going to be minimal but from the position I am in and the fact that I shared the same position as my group of students I still believe their gains to be significant (Peer Leader X).

> I believe my student's learning gains will be greater than they would rate them. Specifically, I think that my students are very fixated on their grade and less on the tools they have acquired throughout the semester. I believe that [the students] will realize all of the benefits and learning gains they have acquired when they have to apply it to other classes. Until then, I believe that they will see PLTL as an extra credit opportunity until they are put in a situation where they have to use the tools they have acquired through PLTL (Peer Leader Y).

Compounding the explanations above, one of the participating peer leaders encompassed the knowledge of how learning gains in PLTL would benefit him or her later in life along with attendance in PLTL. It is known that attendance in PLTL correlates with course achievement, the more PLTL sessions the student attends the higher the final course grade (Peteroy-Kelly, 2009). However, in the context of lSALG and sSALG, attendance offers a new dimension for the possible discrepancy between scores. It is possible that the student viewed low learning gains because they felt they did not benefit from PLTL, correlating with a low attendance record. Possible reasons presented by Mottley and Roth (2013) for students to stop attending PLTL sessions are that students notice there is not a large turnout at sessions, they do not sense an increase in personal performance, or they do not sense satisfaction from peers and the peer leader. However, it is also possible that the student felt they benefited greatly from the few PLTL sessions they did attend, but the peer leader was unable to effectively gauge these learning gains due to intermittent or sparse attendance. A peer leader who held the viewpoint that the discrepancy may lie with the difficulty of the peer leader to judge learning gains based on poor attendance rather than actual low learning gains stated "…I had students show up and stop

coming or come intermittently throughout the semester and I may have had some difficulty gaging their learning gains."

What differences in perceived learning gains and final course grade, if any, exist between students who relate to their peer leader versus those who do not? Students were asked the question "Do you relate to your peer leader?" and then were subsequently sorted into either a "Yes" or a "No" category. The students in the "Yes" category showed significantly higher perceived learning gains than the students who did not relate to their peer leader (two-way ANOVA: F=5.145; df=1,112; p=.0248). These results are shown in Figure 3 and Table 2. As shown in Figure 4 and Table 3, students in the "Yes" category also earned significantly higher final grades in the associated General Biology course than those who did not relate to their peer leader (Pearson's chi square: X^2= 18.573, df=9, p= .029).

Of the students who met the completion requirements for both the SALG survey and the questionnaire as described in Chapter 3, 81.6% of the students were in the "Yes" category (n=114). When leaders were asked the corresponding question, "Do you think the students in your group relate to you?", 93% of the respondents answered affirmatively (n=43).

Sub-Question: What factors do leaders attribute to their relatability with their students? Peer leaders were asked to explain their response to this question as part of an assignment for the BIO 221 course. These explanations provided reasons as to why peer leaders consider themselves to be relatable to the students in their PLTL sessions. These responses can be sorted into 4 categories: Similarities, common career/academic goals, acting as a fellow

learner, and engaging students in discussion of topics outside of Biology and college life. The responses below are typical of peer leader explanations for each category.

Similarities. This category contains the most peer leader responses. The responses that are included in this category encompass one or more of the following themes: age and ZPD, the overall college experience, and the BIO 121 experience. The BIO 121 experience includes peer leaders describing familiar aspects of the course to the students, such as what to expect from the laboratory, lecture, or homework. The BIO 121 category then expands to responses where peer leaders explicitly stated agreeing with students about specific struggles or areas of weaknesses that students are currently encountering in the course.

The first similar aspect that peer leaders described as making themselves relatable to their students was their similarity in age. One peer leader states their perceived benefits of being close in age to their students, stating how it allowed for the students to view them as an "acquaintance rather than a teacher so, they felt comfortable around me and were able to ask me questions". This idea of closeness in age leading to a friendship is a sentiment echoed by other peer leaders.

> "I believe that my students could relate to me because we were all around the same age. I would also talk to them as if they were my friends, rather than a teacher-student conversation."

Viewing themselves as a younger friend rather than having the positionality of the teacher allows the peer leader to put themselves at their student's knowledge level.

> I would talk to them about their classes and when I took the class so I was more at their level and less someone who was older and look to as more of a teacher. It [is] important to put yourself at their level.

Placing themselves in the ZPD of the students was a common reason provided by peer leaders for relatability. While the ZPD does not depend on age, it does depend on ability level. Peer leader responses entwine age and ability level, and use both along with the college student experience to support their argument that they are relatable.

Factors that coincide with age, such as being at similar life stages and attending and transitioning to college were also identified as factors in relatability.

> I think the students were able to relate to my struggles initially with how to study for the exams as college is different than high school and I also think they struggled with similar concepts (Peer Leader Z).

> I was in most of their position only two years ago. I went through a lot of the same things they are with challenging course work and the adaption of living away from home for the first time. For many of them I have taken other classes they are in so can give them input on those classes as well. I think the way the students and leaders can relate to each other is a big reason why good friendships are often formed (Peer Leader A).

The following is an atypical, yet insightful and honest, response from a peer leader showing the perceived strength of the college similarity in establishing relatability. While this peer leader does not necessarily feel capable of relating to students in the PLTL context, they have found they are able to relate based on being a fellow college student.

> I think the students can relate because I am also a student. I have gone through what they are going through now. Sometimes it's difficult for me to relate to them when it comes to the PLTL session specifically because I didn't find the PLTL sessions when I was a

> freshman that helpful so I didn't go often, but when it comes to other school related things such as courses or the problem solving process that can be applied to things outside of PLTL they can relate with me since I have also gone through those things.

This statement exemplifies that something trivial may be enough to establish relatability in situations where it seems even the most basic characteristics are not shared between students and peer leaders, which supports the findings of Brown et al. (1992) and Marx and Ko, (2012).

The following responses show relatability based on the similarity of experiencing the same BIO 121 course.

> I explained to the students from the start that I was in their shoes not even a year ago. I told them that I understood [that] BIO 121 would be a challenging course. There would be times that there would be a topic or chapter that would frustrate them. This seemed to work and the students we [*sic*] had a much more effective relationship because of this.

As seen in the peer leader responses about similar lSALG and sSALG scores, peer leaders believe relatability is a component of a positive relationship with students and indicative of being attuned to their learning needs. Straying slightly from the ZPD aspect are the responses that only discussed the similarity of having taken BIO 121, such as "I share stories from when I was taking the class and it seems to make the students more comfortable and trusting of me as a leader." The next peer leader takes this one step further, saying how they not only share stories from BIO 121 but also offer advice: "I tell [the students] how I was in the same situation as them for some points and they ask me how I handled the situation I went through." Presumably, establishing relatability will require reciprocal action from the student. This means that the student must be sharing concerns and struggles with the peer leader in order for the peer leader to

relate to their challenges. Peer leaders state that they were able to find common ground with the students because "Most of their concerns were the same concerns I encountered while enrolled in Biology. So, because of this they were able to relate to me on a peer/student level…".

Common academic/career interests. Peer leaders who described common academic interests or career goals with their students tended not to mention any other factors in their responses. Using only one factor, even though it may seem trivial or an already obvious connection, again supports Marx and Ko's (2012) and Brown et al.'s (1992) suggestions of forging similarities between group members. Even one perceived similarity may be enough to establish relatability and hold potential learning benefits for students. This peer leader was able to find a different academic similarity with each of his or her students even though each student was on a different career path from one another.

"The students relate to me because they are all on similar paths as I am. One student is pre-med just like I am, while another is a psychology major, which I am too."

As most of the responses about similar career tracks involve a STEM field, presumably because the peer leader is interested in STEM, it was reasonable to expect to find particular benefits for STEM majors who relate to their peer leader, however this was not supported by the quantitative results of this study. Peer leaders often use STEM as a factor to establish relatability.

> …the one student who comes to session is a neuroscience major, the same as myself. So often when we are done early she will ask me questions about the major and about being premed…they were asking me what it was like to apply for medical schools and take the

> MCAT and such. So, I think that the premed students or neuro students find it helpful to talk to someone who has gone through and almost finished everything they want to accomplish.

This peer leader took advantage of the commonality that was present before sessions even began, showing that relatability may be easily established for students and peer leaders within the same discipline.

> Firstly, me and my students already had something in common - the fact that we were all science majors allowed us to all relate in terms of understanding how difficult these courses may be… …They have similar concerns and because of that, they were able to be much more comfortable engaging in the session.

Acting as fellow learner. These responses are categorized separately from the earlier responses which simply stated that the peer leader is relatable to the students in their group because, like them, they are also a college student. Sharing a status as a college student was placed under the "Similarities" category. The responses categorized here delve deeper into the role of the peer leader and how they interact with the students during the sessions. Students found themselves learning alongside the students, as is the goal of PLTL as described in Chapter 2. As one peer leader explains this: "… Also some questions none of us knew the answer so they could relate to me in the sense that I won't always know everything and neither will they." Since the peer leader is only constructing answers with the students during weekly PLTL sessions these responses are limited to the scope of problem sets encountered during PLTL sessions; they do not extend to problems found in the lecture, laboratory, or homework assignments. A response typical to this category is shown below.

> I sometimes give them opportunities to complain about things in the course, like the mastering biology homework. I also like to stress the fact that I am also a student, and when we were completing the workshop activities and they ask me a question, many times I would not be sure of my answer, and would rely on internet sources or their textbook. I wanted to create an atmosphere where everybody in the session, including me, are learning together, instead of one person teaching and 8 people listening.

Other **s***hared interests.* Some peer leaders recognized that their similarities extended past the BIO 121 experience: "We are able to relate not only because we are or have taken BIO 121, but because I ask the students about themselves and what they are interested in." Additional responses discussing these other shared interests provided evidence of a growing relationship with their students.

> …I'd also initiate non-biology related conversations with them before and after my sessions so we were able to bond about other things as well. They felt they could talk to me about a variety of concepts, including everyday topics.

The ability of peer leaders to bond with students and share information not directly related to class sets these peer leader-student interactions apart from the typical faculty-student interactions as discussed in Chapter 2. One of the attributes of a caring professor identified by Hong and Shull (2010) is communicating with students outside of class time. Peer leader responses show that some leaders do interact with their students outside of session times, and

they do discuss topics outside the scope of the course. When conversations extended past the subject matter, peer leaders believed they established relatability.

> The students would always ask me questions that weren't directly related to biology; one time a student simply needed recommendations on which courses to take next semester, and another wanted to know about good places to eat on campus, so I could tell that the students were able to relate to me…

Interestingly, only one peer leader mentioned gender in their response as a factor used to determine relatability. This was also the only participant whose response overlapped multiple categories in addition to common academic pathways.

> I have a group of all girls who are interested in perusing a STEM major and potentially going to medical school. Some of my students are even near my hometown of Boston. I felt that my students were able to relate to me based on my gender and my attitude toward school. I am a very hardworking and dedicated student and my students have similar qualities. I believe due to this they were able to relate to me.

Given the amount of research devoted to the topics of gender and ethnicities regarding both PLTL research and role model status, this atypical response is worth reporting. An important observation is that none of the students described either gender or race as a limiting factor for why their peer leader can or cannot be considered relatable, or as seen later in the discussion, a role model.

Cross-category theme: motivation and reassurance. An overarching theme in 37% of the peer leader responses was being a source of motivation for their students and offering them reassurance. This was not sorted into a category of its own because it appeared as a component in

a wide variety of responses. The responses discussing reassurance also extended into a description of how the peer leaders treat their students. These treatments are all positive and would produce an environment conducive to learning if the students share in these perceptions (Hong & Shull, 2010; Mastascusa et al., 2011; Micari & Pazos, 2012).

> I think the students in my session can relate to me because I talk a lot about when I took the course and what I did to prepare myself well enough to succeed. I also share my frustrations about school this semester with them as they share theirs with me so that they know were all on the same page and going through the same thing. I also don't judge them or make them feel stupid on the subject matter because I know it's hard and I tell them that.

The above quotation represents the possibility of peer leaders to establish relatability while simultaneously motivating their students when students reciprocate by telling the peer leaders their struggles.

> I constantly remind my students that I was in their exact shoes last year. When they express their concerns or stresses about the course, I reassure them that they are all valid and normal. I don't disregard their worries but rather relate to those concerns and give them my personal advice and experience.

Normalizing the worries of the student not only motivates the student, but demonstrates how the peer leader is fulfilling their duties of lowering student anxiety associated with learning (Amaral & Vala, 2009; Finn & Campisi, 2015). In addition to offering general reassurance, the following peer leader explicitly stated how they informed the student that it required hard work and effort

to obtain the success that they did. Statements such as these are important to challenging STEM stereotypes and may encourage student persistence, as discussed in Chapter 2.

> I reassure the students that BIO121 is a very difficult course and that I put in a lot of my time to do well in the course and that it did not come easy to me. I reassured them that it very possible to do well and I think that was a reliever for a lot of the students.

Effectiveness of sharing BIO 121 experiences. Since a large proportion of the peer leader responses focused on sharing experiences from BIO 121, students were asked the question "Does your leader share experiences from when they took BIO 121?", 94.8% said "yes" (n=212). Of these students, 170 responded to the follow up question asking, "Do the experiences that your leader shares from their time in BIO 121 motivate or inspire you to do well in the course?", to which 88.2% also responded "yes" and only 11.8% responded "no". This verifies that sharing BIO 121 experiences helps establish relatability, while also serving as a motivational factor from the student perspective.

The peer leaders were asked the corresponding question "Do you share experiences from when you took BIO 121?" and 95.3% responded "yes" (n=43). Of the peer leaders who responded yes, 94.7% also responded "yes" to the follow up question, "Do you think the students find the experiences you share from your time in BIO 121 to be motivating or inspires them to do well in the course?". These results indicate that peer leaders tend to place slightly more value to sharing experiences from BIO 121 than their students do, which verifies findings from Colbron (2012) and Bruno et al. (2015) about the perceived importance leaders hold towards sharing course experiences. Sharing experiences from BIO 121 may enhance the relatability of the peer leader to student, and relatability with a peer leader in PLTL may offer an avenue for potential

benefits in addition to reassurance and motivation that this research is exploring. but that it is still widely considered a positive practice that helps to establish relatability, encourage student motivation, and may ultimately led to positive potential learning outcomes.

Sub-Question: What factors do leaders attribute to their inability to relate to their students? Only three peer leaders who participated in this study stated that they did not think their students related to them, and all had very similar answers explaining why. All three stated that there were no commonalities between them and the students, and specifically mentioned the part BIO 121 played in their relationship with their students. Two peer leaders felt that even though they took BIO 121, they "felt [the students] could not relate to [them] because, although they were in the same class, they had two different professors so the tests were not the same." They also noted that their difference in experiences arose out of "the change in professors and course style, which is why [they] don't share the same experience, and therefore can't relate."

The remaining peer leader who did not think the students related to him or her noted that the commonalities between themselves and their students ended at BIO 121 and the PLTL program. This peer leader did not share the belief that an obvious connection such as this would be enough to establish relatability, in contrast with several other leaders and previous literature findings as described earlier.

"[The o]nly thing they could relate to is that we both took Bio 121 and did PLTL. Other than that we do not have much in common."

While the above peer leader believes that relating through BIO 121 and PLTL is possible, it was not perceived as enough of a connection to make them think relatability had been

established. This directly contradicts another peer leader, who when asked to explain why they believed their students could relate to them simply stated, “I also have been a PLTL and BIO 121 student before, so being able to share my experiences with them helps us relate to one another.”

The phrasing and subtle differences in these two responses may actually be very insightful. The peer leader that does not feel relatable only states that they have completed BIO 121 and participated in PLTL. The leader who does feel relatable has also completed BIO 121 and participated in PLTL, but specifically states how helpful sharing personal experiences from these programs has been in assisting their students to relate to them. It is necessary to clarify the factors that contribute to making a peer leader relatable because students with a relatable peer leader benefit from higher course grades and greater perceived learning gains. As shown above, relatability can be relatively easy to establish and there are many avenues to do so, making it a feasible goal for every PLTL session.

What differences in perceived learning gains and final course grade, if any, exist between students who view their peer leader as a role model versus those who do not? The students were asked to respond “yes” or “no” to the question “Do you consider your peer leader a role model in any way?” The students were then categorized into two separate groups based on these responses. Only the students in these two groups who also filled out 100% of the SALG survey questions were considered in the following analyses (n=113). 73.5% of students responded “yes,” meaning that they do consider their peer leader to be a role model. The differences in perceived learning gains between the students who responded “yes” and “no” were statistically significant (Table 4, Figure 5), with the students who view their peer leaders as a role model having higher perceived learning gains (2-way ANOVA $F=4.13$; $df=1, 111$; $p=0.044$). As

shown in Table 5, there was no significant difference in final grades between students who viewed their peer leader as role models and those who did not (Pearson's Chi-Square Test: X^2=11.283, df=9, p= .257).

Sub-Question: What traits or attributes do the students describe as common to peer leaders they consider to be role models?

The students were asked to expand on the following question: "BRIEFLY explain why you do or do not consider your leader a role model." Recurring themes were found in the responses of the students. These recurring themes were: the peer leader was successful in the course, the peer leader represents student's goals, the peer leader's personality, and the peer leader is perceptive to student's learning needs. The below are student responses typical of each category.

Success in BIO 121. Many students framed their responses about leaders as role models in terms of their prior success in introductory biology. Students appreciated that their peer leaders "did well in the class and had good study habits when [they were] in the class, so [they are] setting a good example for us". The types of examples that students were looking for peer leaders to set in order for them to be considered a role model were described as "someone who put in work during the course and were then able to have the opportunity to be a leader and help guide others to achieve the same". One student elaborated on the way that his or her peer leader guided them to success and the benefits they gained from their peer leader's advice: "She gave a lot of helpful study tips and admitted when she struggled with a certain topic which made me feel better and more confident in the course."

Due to their success in BIO 121 and familiarity with the course, students stated that they

value the advice and opinions of their peer leader, supporting the literature findings on the perceptions of PLTL as described in Chapter 2. A representative quote is presented below. "Because he got an A in the course last year and gives us great advice how to accomplish what we want to while also warning us not to burn out."

As discussed in the literature review, a stereotype that detracts students from STEM is that all members of the STEM community are innately gifted and did not need to put in any effort to succeed in the course. Students did mention hard work and determination in their responses to why they consider their peer leader to be a role model.

> I consider my peer leader a role model because he works hard in tough courses like biology in order to achieve his goals. His dedication to biology makes me work harder to achieve my goal of receiving a good grade in biology.

Having a student, such as the one quoted above, identify that a peer leader whom they consider to be a role model works hard in challenging courses to achieve their goal is a great step towards directly challenging this stereotype and motivating students to persist in STEM.

The peer leader represents the student's goals. Sharing goals with one's role model is a prominent feature in the literature, as shown in Chapter 2. It was expected that the responses explaining why a student considers their peer leader to be a role model would revolve around sharing common goals. Further, these common goals are typically already achieved by the peer leader and described by the students in the past tense, such as "My leader also took Bio 121 and has taken several other classes since that I will probably take or I am interested in" as well as "She is applying to med school". One student describes considering the peer leader to be a role model because they share an attainable goal such as "I would like to pursue being a PLTL

leader", which could be achieved within the next few years.

One student included more practical reasons for considering the peer leader to be a role model, such as work-life balance.

> I do consider my leader a role model. We have similar majors and it is obvious he takes his schoolwork very seriously. He has both a social life but also strives to do well in school, which is the perfect balance.

In the cases described above, the shared goals are seemingly attainable and something that the peer leader has already successfully completed and able to offer insight and advice on.

The peer leader's personality. Student responses did not always involve aspects of academia or future careers. As one student puts it, "He gives respect and is nice to us, as well as being knowledgeable in the subject". This indicates that there are many factors involved in considering someone to be a role model, success in the subject area is not necessarily enough to declare someone a role model. Many students listed personality traits of the peer leader as the reasoning behind the role model status. If peer leaders are expected to serve as unintimidating, open, and friendly resources for students (Micari et al., 2005), it is unsurprising that personality traits such as honesty, dependability and availability are found in student responses. Showing a passion for helping students learn and treating students with respect are factors identified by students in the current study as criteria for role model status, as well as reported in prior research as factors that would heighten student-instructor connections, particularly in the STEM fields (Christe, 2013; Savkar & Lokere, 2010; Seymour & Hewitt, 1997).

The three factors identified by Micari and Pazos (2012) which correlate to students viewing a positive relationship with their professor can be found in the student responses in this

section. When applied to the peer leader, these three factors would be admiring the peer leader, approachability of the peer leader, and the peer leader shows respect to the students. While the factor of admiration has been seen in the earlier categories of this section, "Success in BIO 121" and "The peer leader represents the student's goal," all three factors are clearly represented in responses focused on the peer leader's personality.

One student connects the peer leader's confidence to her role model status, "She is a very confident upperclassman who clearly knows what she wants to do in life, and I look up to that", while another appreciates the peer leader's displayed passion of teaching, "She genuinely likes helping us learn, which is something I admire". It is unsurprising that the students would recognize a peer leader compassionate about the student's learning, as uncaring professors or professors who prioritize research over teaching contribute to the disconnect present in some student-faculty interactions, as discussed in Chapter 2. One student extends their admiration to the peer leader as someone that they would like to emulate outside the classroom, as well:

> I consider my peer leader a role model because she [is] understanding and able to help the group if we don't know the answer to a question. She's patient and that's someone I strive to be everyday as a student and person in the community.

Students describe looking for role models who possess "a good work ethic and is patient and thoughtful", and describe the importance of honesty in learning and their subsequent consideration of a peer leader to be a role model.

> [The peer leader] is honest, on time, studious, dependable, and he knows what he is talking about. He gives good advice and if he doesn't know the answer he doesn't pretend that he does. He points us in the right direction to get help if he can't do it.

Another student echoes the sentiment of how important honesty is to their learning, they appreciate a peer leader who can admit they do not know an answer rather than misleading the group. The following quote also describes the trait of relatability and the ability of the peer leader to motivate them.

> She is a role model, because she takes ownership where and when she's made mistakes while not letting that hold her back. She relates to us but is also motivating. She never belittles us when we are confused, but rather encourages us to overcome our struggles.

The traits identified and described by students such as peer leader confidence and encouragement of questions and learning align with the description of behavior that should be modeled by effective peer leaders (Younge, 2012; Heit and Bott, 2000), and were expected to influence the student decision to view the peer leader as a role model.

The peer leader's perceptiveness. Student responses that recognized the peer leader's perceptiveness indicated a positive perception of their interactions with the peer leader. Negative perceptions are reported by learners when they feel that professors are insensitive to learning needs (Hong & Shull, 2010), a feature common to the traditional high enrollment lecture course (Finn & Campisi, 2015) that may be alleviated by the small group learning setting of PLTL. Due to the small groups, one student explained, "[the peer leader] can easily identify strengths and weaknesses, she focuses on areas that need improving" The PLTL model also differentiates the peer leader from the faculty member in that the peer leader is able to witness firsthand when a single student is struggling, and has the freedom to remain on a concept longer and explain it

several ways until the student is satisfied (Mottley & Roth, 2013; Eberlein et al., 2008). One student emphasized, “My peer leader is definitely a role model, because if he sensed that we were struggling, he would go back and spend as much time as we needed to understand the topic.”

Peer leaders can strengthen their bond with students by pacing the course accordingly to get all students involved, they do not need to focus on covering a certain amount of material before a deadline, as might be a struggle for some faculty (Christe, 2013). This bond was described by one student as noting that their peer leader was “able to identify with me and tell me what her strengths and weaknesses are/were in biology.” Another noted that “I would consider my PLTL leader a role model because not only does he try relate to us when we struggle with certain concepts, but he increases our confidence in understanding them as well.” This strengthens the earlier argument that relatability is a component of the role model status, and may be more readily established. The informal learning environment of PLTL and the perceptiveness and actions of peer leaders are generally well-received and appear to make students more comfortable with their learning.

Sub-Question: What traits or attributes do the students describe as common to peer leaders they do not consider to be role models?

Personality did not seem to be a factor for why students did not view leaders as a role model, which differs from the importance shown to positive personality traits when deciding the peer leader is a role model. However, there is the possibility that the students were hesitant to make personal statements against the peer leaders on a survey associated with the course. Only one student who responded negatively to the question of whether or not the peer leader was a

role model listed the personality of the peer leader as the reason, stating: “Her personality is off-putting and she can come off as annoying.” No other factors besides personality were included in the reasoning.

While this single response is not representative of the data collected, it further shows the role personality plays for student determination of a role model. The qualitative responses show that personality traits more heavily influence the decision to deem a peer leader as a role model and does not play as significant a role when deciding a peer leader is not a role model.

Definition of role model. The most common reason given for not viewing the peer leader as a role model is simply that the peer leader does not fit the student’s definition of role model.

While a student who did not find their peer leader to be a role model might identify a peer leader as a resource, they recognized that “She seemed very ‘knowledgeable’ but she wasn't somebody I necessarily looked up to.” And although the peer leader might not meet the student’s definition of “role model,” that same positive view of their peer leader’s knowledge sometimes caused a student to express admiration or an aspiration to be like their leader:

> I think my leader is really great and I do admire her drive and knowledge. I wouldn't go so far as to call her a role model, but I hope to exemplify some of the same work ethic that she does.

Another student tips to the fact that their peer leader is relatable in their role as a fellow student, but draws a line between that similarity and their qualifications for being deemed a “role model”:

> I would just consider them as a student like us, and they haven’t really been an influence as in the role model aspect. Yes, they have helped, but not to the point where I would consider them a role model.

The semantics between the word “role model” and similar words like “mentor” also came into play in other responses: “I don't look up to my leader, he’s a student just like me. If anything, he’s just a good mentor but not a role model.” A description of mentors in the literature review discusses mentors and the responsibilities of mentors that overlap with the responsibilities of the peer leader. Still others reduced the peer leader/student relationship even further: “He is just another student doing practice problems with me.”

Generally, the responses did not appear to have a negative tone. Students did not list faults of the peer leaders; they often stated that the peer leader is fine but does not meet their criteria of being labeled a role model. However, some were more straightforward than others when explaining their criteria for role models: “I do not consider my role models to be leaders of biology extra credit classes. However, I do respect them for doing this for us and I think it was overall beneficial.”

These findings indicate that regardless of whether the student found the peer leader to be a role model, there were still benefits from interactions with the peer leader and the PLTL sessions as a whole. While this study is using the definition of role model defined by Lockwood in Chapter 2, it is noteworthy that only one student, out of all the student and peer leader respondents, included their own definition of the term “role model” when responding to the question concerning the peer leader’s status as a role model.

“A role model is an individual who leads the way and shows his/her students the way. That is obviously what my PLTL leader did.”

Responses to this study may have differed if students were provided with a definition of role models to use when answering the questions, however allowing the students the freedom to form

their own responses as they deem appropriate provides additional insight into the qualities they are looking for in role models.

Lack of preparation for meetings/content knowledge. While the peer leader's personality was not stated as a deterrent from viewing them as a role model, how they conducted the PLTL sessions and presented themselves during these sessions proved to be impactful: **"**She could have been more enthusiastic about the class, and sometimes there was a question I knew we got wrong but we moved on, so I was not that confident in what I was learning." Many students said they noticed when the peer leader was unprepared or strayed from the goals of PLTL, "She lacks basic understanding of what our PLTL is about and she doesn't understand at all how to help us when we get stuck because she doesn't understand most of the questions."

Just as the students in the previous section reported placing value upon the peer leader's advice because they were successful in BIO 121 and displayed content knowledge, the opposite is shown here. The advice received from the peer leader was not considered valuable after the peer leader stated they did not complete the necessary work to truly learn the course material, and therefore the student did not wish to emulate this behavior or consider their peer leader a role model. A representative quote is shown below.

> **"**My Peer Leader admitted on many occasions that they did not read the textbook or truthfully do the masteringbio [online homework] assignments. All my leader said was that they memorized the PowerPoint slides and got an A in the course. So I don't really think that that is a role model. Anyone can memorize information. When anyone had a question about bio the leader usually googled the answer."

In many instances where the peer leader was not considered a role model based on performance during PLTL sessions, students are focusing specifically on gaining correct information, and "...do not consider [their] leader a role model because [they] don't think [the leader] has mastered the material." Presumably, the definition of success for these students are to do well in the course and better inform their overall understanding of biological concepts. This may be an example of a type of student who would prefer a professor were present, or that the peer leader would provide the students with the correct answers before leaving the sessions, "My peer leader tries her best to help us but she is not very well versed on all the subject matter like a professor would be."

These students might be expected to have a low sSALG score, as their responses indicate they are basing learning gains on content knowledge which is not measured by the SALG instrument. This expectation is strengthened in that students who did not consider their peer leader to be a role model have lower perceived learning gains than those who do. In addition, a lesser connection between these students and their peer leader may be expected because students who do not believe the PLTL course is directly associated with getting better grades in the Introductory Biology are less likely to actively participate (Mottley & Roth, 2013).

Interestingly, the reasons given by the students above for not considering their peer leaders to be a role model are arguably characteristics expected of peer leaders from the literature. Peer leaders are not expected to be content experts (Snyder & Wiles, 2015), nor are they there to simply provide the correct answers to problems without discussion or working as a fellow learner to complete the tasks (Boud, 2001; Mottley & Roth, 2013). If the peer leader were an expert in content, the same as a professor, then that may put them at risk of distancing themselves from their students. Course professors are perceived as more likely to provide

excessive and elaborate information from being so well versed in the material (Rijdt et al., 2012), a trait not common to peers and a reason cited by students for their preference of student tutors over faculty tutors. The peer leader should not already know all the answers before the session starts, and questions are designed to engage peer leaders in discussions with their students to construct correct responses as a group (Eberlein et al., 2008; Gafney & Varma-Nelson, 2008). Even though these aspects of the interactions caused some students to have less faith in their peer leader's abilities and were unable to consider them a role model, students who still found the peer leader to be relatable may have benefited from that aspect of the interactions.

Lack of personal connection. Students identified a personal connection and relatability as necessary factors when considering peer leaders to be a role model, "I liked my peer leader a lot, but we are not very similar of people. Because of this I found it hard to consider a role model." Students often alluded to the desire to get to know the peer leader better before making the decision to view them as a role model and described not considering their peer leader "as a role model because [they] don't know [the leader] well enough to be aspired by his work and actions." Streitweiser and Light (2010) reported peer leader experiences that may overcome this hurdle. However, this may not always be the case as demonstrated by the student who appreciates that the peer leader did well in the course, but still would like a personal connection: "I think it's great that she did well in the course and I would use her as a reference for biology material but I don't feel I know her well enough to consider her a role model."

Strategies to make a personal connection with the students include peer leaders discussing personal interests outside of academia and future careers and joining in to the group discussions when the students in their group are having a conversation unrelated to the course. A

personal connection has been determined to be particularly important and critical to the role model status, as one student clearly explains, “I do not know my PLTL leader well enough to genuinely know anything about her. Therefore, I can not necessarily consider her a role model.” A personal connection formed between students and leaders has been credited with students being more open and comfortable in the PLTL sessions which in turn allows for peer leaders to be more conscious to the learning needs of their students (Streitwieser & Light, 2010). It would also help in establishing relatability, as shown earlier in this chapter.

Earlier findings as discussed above indicated that it may be easier to establish relatability between peer leaders and students than it is to establish the peer leader as a role model. The hierarchy of relatability and role model is demonstrated by student responses such as “I don't really relate to my leader on a personal level, and i need that connection to consider a person a role model.” This response indicates that forming a personal connection with the peer leader is necessary for relatability, and relatability is necessary for the leader to be considered a role model.” As one student describes this situation, “It wasn't like we got so close that my peer leader was a role model to me. So I don't see my peer leader as a role model. We can’t relate to each other.” This is not discouraging or surprising, as Marx and Ko (2012) found that two factors commonly present for students to consider someone a role model are competence and similarities. Since the current study shows that students can benefit from viewing a peer leader as relatable in both the areas of final course grade and perceived learning gains, this is not a bad thing.

Sub-Question: What is the peer leader perspective on being considered a role model and the necessary qualities of a role model? The peer leaders were asked “Do you consider

yourself a role model to your students in any way?", and then asked a follow up question to "BRIEFLY explain why you do or do not consider yourself a role model to your students." Of the peer leaders who responded, 86% answered "Yes" (n=43). When asked to expand on their answers, the peer leader's responses can be categorized into the recurring themes of: academic success/intelligence, relatability, quality treatment of students, and shared attainable goals with students and acted as a motivator. Noticeable in the peer leader responses is that 62.2% of affirmative responses involved discussing their experiences in BIO 121. Sharing BIO 121 experiences overlapped often with the recurring themes, or was used as the framework for the recurring theme. Sharing BIO 121 experiences was also found to be important in establishing relatability with students, as discussed above.

Academic success/intelligence. Peer leader responses in this category are all crafted in a similar way. They state how they have done well in the course and have become knowledgeable about the course content. Peer leaders in this category tend to indicate that the goal of their students is to be successful in BIO 121. The following are responses typical of this category.

> I think the students see that I have done really well in BIO 121 and in this way they are aiming to be like me, making me a sort of role model. I don't think I'm a role model in many other ways other than my students looking up to me in terms of the success I have had in BIO 121 when I was in their shoes.

> As stated above, the students are able to see that I have been successful in the course, and that just like them I'm a typical SU student that they can always look up to for help in times of need.

> I consider myself a role model to the students because I did well in BIO 121. The students look up to me to get tips on how to do well in the course, and they also ask for help on the material covered in class. In addition, they ask for advice on social experiences as well.

*Relatability***.** The qualitative results collected from the peer leaders indicated that relatability is easier to attain than role model status. Relatability is also a component of the role model status, for both the students and the peer leaders. As seen with the responses to what makes a peer leader relatable in an earlier section, peer leaders have again embedded relatability in with a shared Biology experience, "I think my students look up to me as a biology student, as a student and just as a friend. They have asked me a lot of questions about their schedules and the lab practical etc." This type of response is taken one step further by peer leaders who say relatability helps establish a role model status.

> I do consider myself a role model to my students because it's very easy to relate to student in which [*sic*] you were once in their shoes. By sharing my experiences with them, I think that this was a key factor in my students viewing me as role model in the course.

As seen with the peer leader responses about the factors that makes a relatable peer leader, only one peer leader stated that gender may influence relatability, which in turn is identified as a contributing factor to being considered a role model by their students.

> I believe that my students see me as someone they can truly relate to… I have a group of all girls who have many similar qualities to me due to the fact that they have similar

> career goals and value doing well in their courses as I do… I believe my students value that I have been in the same boat as them but that I have also had similar experiences when studying for an exam.

Attainable goals. The responses from peer leaders often described their achievement of a goal that is also desired by their student and cited this achievement as a reason for being a role model to their students. These goals range from student's desire to become a peer leader, apply to medical school, and successfully complete BIO 121.

> Many of my students have expressed interest in becoming a PLTL leader in the Fall of 2018. I would like to believe that this is due in part to me acting as a role model for students looking to acquire leadership skills.

The responses in this category often overlapped with other trends found in the responses. The responses involving attainable goals were far more likely to include explicit statements of how they shared their personal BIO 121 experiences with students, which further coincides with peer leaders stating that these stories motivated or inspired their students to succeed.

> I think I could be considered a role model to my students because I demonstrated leadership qualities. I inspired my students to keep returning to their sessions and taught them how to be successful students in BIO 121.

The motivational aspects typically consisted of peer leaders informing students of the struggles and obstacles they encountered while enrolled in BIO 121. Many peer leaders

discussed comparing themselves to their students, and showing their students that it is possible to achieve the same success as the peer leader.

> As I previously mentioned, I constantly remind my students that I have been in their exact shoes. I encourage them by saying "If I can do it, so can you." Their goals are to do well in bio and master material and that's exactly what I have done.

More than half of these peer leader responses also included revealing to the student that it required time and effort to become successful. As discussed in the literature review, exposure to a role model that directly contradicts the prevalent stereotype that STEM is only for innately gifted individuals as been determined as a way of challenging this stereotype and encourage student participation in STEM. While the responses collected and the current study do not address the second stereotype that STEM is for European American males, the PLTL model and peer leader responses involving gaining role model status by sharing personal experiences of utilizing hard work and determination to find success in STEM fields directly challenges the first stereotype found in the literature (Shin et al., 2016). An example of such a leader stated:

> I consider myself a role model because I am a motivated student who wants to do well in all my classes. I help reassure my students that they will do fine in the course and that they will do fine in college if they put the effort in.

Similar to the above findings about what qualities peer leaders possess that make them relatable to their students, peer leaders also described discussing the challenging nature of BIO 121 and STEM courses to their students in response to the qualities that make them a peer leader.

However, there is one important distinction. The responses in the role model section all discuss the goals that the peer leader has already met, strategies for how they overcame the obstacle. They are not in the present tense. They are in the past tense as responses to what they have already achieved and what the student can strive to do. Relatability responses were about commiserating with the difficulty of courses, not on the success achieved after taking them.

> I consider myself to be a role model to my students because, they would always look to me for answer and help. I was seen as the living example that it was possible to make it out of this class successfully.

Importantly, responses such as the one above dealt with showing the students that the struggle exists for everyone, not just the student, and it is possible to overcome these obstacles with effort.

Discrepancy with regards to age. Peer leaders who considered themselves to be role models differed in their opinions about the role that age played in determination of role model status. One peer leader states the importance of their academic success in role model determination, but then goes on to question if that is enough, given their closeness in age.

> I think I could possibly be a role model in terms of doing well in the course. They know I did very well in BIO 121/123 and in my freshman year of school as a whole. Considering we all take the same classes, it's possible I could be. However I'm not sure, and after all I am only a year older than them.

The majority of peer leader responses did not consider the age difference to be a potential restriction. It was most often thought to be advantageous and would help influence the student's

decision to consider the peer leader as a role model. A slight age difference, less than those typically found in a student-professor relationship, appears to have enhanced relatability from the peer leader perspective and still allowed for them to be considered a role model. As one peer leader stated, “I consider myself a role model for my students because I am a Junior and they look up to me”, implying that the slight difference in age was enough to remain relatable yet still allow the peer leader to have more experience and knowledge to share with the student and be considered a role model.

Other peer leaders who used the difference in age as an advantageous factor also described other characteristics that may contribute to the student’s decision to view them as a role model, such as “I am smart and a student”. Peer leaders also acknowledged that they are similar to their students in that they are both college students, and peer leaders use this similarity to not only explain why their advice is considered valuable, but also why they expect to be considered a role model.

> …They always asked me about my experiences in both biology class and college in general. I would offer up my advice and most of them would take it and tell me if it did or didn't work for them. Even though I am only a year older then these students, they valued my opinion very much because I recently went through what all of them were going through (Peer Leader B).

> The students looked up to me as an experience[d] peer, because they knew I was also a student at Syracuse that had previously taken this course they appreciated my input because I have been in school longer than them (Peer Leader C).

While these findings support those of Colbron (2012) and Bruno et al. (2015) in that students tend to value and respect the advice of more experienced peers, crediting a similarity in age has not previously been reported in the literature.

Positive atmosphere. Peer leaders also credited their role model status to the environment they created during PLTL sessions.

> I would consider myself a role model for my students because I would always start the session with a positive outlook in hopes of spreading this positivity to all of my students. I also think that by explaining prior schooling along with my work ethic and how I was able to work towards a good grade in BIO 121 that I am a role model.

Responses involving a positive atmosphere tended to coincide with peer leaders believing they helped motivate the student.

> I think the students look up to me as a leader because I am respectful and here to help them whenever they ask a question. I try to answer their questions and help them learn further from the question they have asked. The mood is always positive and everybody seems comfortable.

The peer leader above describes how treating the students respectfully has a positive impact on the atmosphere of the PLTL sessions. This peer leader view corroborates the student's opinions presented earlier that a respectful peer leader will be viewed positively by the student, and the student will benefit from a greater level of success in the course.

A recurrent finding in this study is that responses that involved peer leaders sharing their BIO 121 experiences were found to be linked to motivation of the students: "I would share my positive experiences from Biology and I felt that it pushed them to want to do better". The long-

term effects of this motivation may reach further than the scope of the current study can report, as students who receive shared advice and experiences with those familiar with the program of study are linked to greater retention and lower attrition from the course (Colbron, 2012).

A closer look. To gain a more in-depth description of what factors contribute to the peer leaders' considering themselves as a role model, it may be beneficial to examine a subset of the peer leaders and their responses. Limiting analysis of responses to peer leaders who view themselves as a role model, were viewed as a role model unanimously by the participating students in their group, and also placed in the top 10% of closest matches to student perceived learning gains can provide more insight into an effective peer leader and better inform suggestions for peer leader behavior.

As shown in the previous section, the peer leaders as a whole have isolated several common factors that they believe qualifies them to be considered a role model: Positive atmosphere in PLTL, age, attainable goals, relatability, and academic success/intelligence. Looking at the subset of peer leaders, none of them have stated that their success in BIO 121 or intelligence is what qualifies them to be considered a role model. While these may be features they possess, they chose instead to focus their comments on acting as a resource to their students and providing advice as well as motivation and encouragement. These are features and attributes expected of the peer leader (Finn & Campisi, 2015; Chan & Bauer, 2015; Gafney & Varma-Nelson, 2008).

It is significant and telling that the elite peer leaders who made it into this subset focused on their responses on their relationship with the students and what they could provide on a personal level. None of these leader responses stated that the peer leader contribution was being

able to provide information about what was on the exams, or speaking from experience on the teaching styles related to the professor of the course and ways to score highly on assessments in their course. These peer leaders did not discuss the importance of the students earning a good grade in the course, or by using that definition as their measure of success. Age was not a factor that was brought up by these leaders. Half of them described using their experiences in the course to relate to students about general aspects of college life or the sciences or provide informative anecdotes, but none specifically described only discussing BIO 121. Things such as study habits and time management were the center of these anecdotes, rather than just stating that they passed the course with a high final grade. An example of a peer leader using past course experience to find common ground and develop a connection with students is as follows:

> Similar to me, many of my students are perfectionist and truly value understanding the material. When they come in before an exam and they are stressed out it is easy for me to speak to them/reason through the stress because I respond similarly to tests.

These peer leaders discuss that they are a role model because they are open to all sorts of questions by students, not just ones pertaining to the course material. The questions described have a personal feel, that the students are implicitly asking for the peer leader's advice and learning more about the peer leader's personal course history and future goals.

> I think my students look up to me because they all always ask me questions about classes and what I'm doing and how I'm doing in school. For example, last week they asked me about my majors and minors and grades but obviously I reassured them how hard I have to work for my grades and I hope that motivates them to do really well in their classes. I also think the fact that they ask me real world questions and for advice shows that they look up to me and care about my opinions.

In one instance, the peer leader just seems focused on letting the students share in his or her passion for learning: “I think they are able to see that there is a balance of having fun and getting work done through our sessions, and I certainly hope that they see that caring about a subject you’re passionate about and sharing that with others is a very fulfilling task.” Almost all of the leaders in this subset explicitly state that they offer advice or are willing to ask questions whenever a student needs it, even if it relates to topics outside of the course.

> “…there have been multiple times that my students have asked me for advice not just from BIO 121 but about future classes they will take and then social advice campus life and general things.”

However, there was one leader who focused their response more on the environment they wanted to create during the PLTL sessions by stating “[they] try to help [the students] as much as [they] can, but also make sure that [students] know that they are doing it themselves. I also try to come prepared for the students.”

Based on the findings in the current study and the prior literature, it is unsurprising that finding interests outside of the course, respecting the students, and demonstrating to the students that they care about their learning are characteristics of these highly acclaimed peer leaders.

Sub-Question: What is the peer leader perspective on not considering themselves a role model?

Of the leaders who responded “no” to the question “Do you consider yourself a role model for your students?”, all peer leaders shared a similar perspective. All responded that they do not consider themselves a role model, but rather a peer or a fellow learner. Not only does this

align with Boud's (2001) description of the peer leader as a fellow learner, it also supports the claim made from the current study's data that establishing relatability is less complicated than establishing role model status. There is no significant difference in course achievement between students who view the peer leader as a role model and those who do not (Figure 4). However, students who do consider their peer leader also perceive higher learning gains than those who do not (Figure 3). Several peer leader responses seemed to display the same discrepancy that was seen with the student responses of personal criteria and definitions of a role model. The most prominent limiting factor seems to be that the peer leader considers themselves on the same level as their students, and therefore would not be considered a role model. "Personally, I think of myself as a peer to my students. I would not necessarily consider myself as a role model in most aspects to my students." which is a sentiment echoed by another peer leader, "We are all college students, so we are learning from each other." These responses seem to express a belief that a role model is someone of elevated status, lending more support to the claims of this study that relatability is more readily established than role model status.

> The image that I have tried to establish with my students is that I am also a student, not an expert on biology. Sometimes I explicitly remind them that. I don't think they consider me as a role model, and I don't want them to. I believe establishing trust and comfort to be more important.

The peer leader quoted above is content with not being considered a role model, and the findings of this study support this decision as no additional benefits were discovered for role models that are not available from relatability.

In half of the instances for the peer leaders who responded “no,” the discrepancy seemed to be the value associated with the word “role model,” which is similar to multiple student responses as described in a previous section.

> A role model is simply too strong of a word especially applied in this environment. It would take a much longer amount of time for my students to interact with me, get to know me outside of the sessions, and relate in other ways for me to be considered a role model for them. I personally believe for the time being, I am simply another resource to my students if they have any concerns or they are looking for a last-resort.

The following peer leader response demonstrates the possible benefits of interacting with students, even when the role model status is not present.

> I wouldn't call myself a role model, but in a sense I do believe students sometimes look up to you to reassure themselves that they can do it. I never took PLTL when I was a freshman but I would’ve liked to have seen someone who has already gone done a similar path to the one I plan to take and realize that it is possible.

What the peer leader is describing is essentially the same characteristics that were discovered to establish relatability between students and peer leaders. Without being considered a role model, peer leaders can still relate to the students by finding similarities and providing reassurance as someone who has already experienced the course. These qualitative responses support the claim that relatability is more readily established than role model status, and provides benefits to students such as greater perceived learning gains and improved course grades.

What impact, if any, does peer leader relatability and role model status have for students enrolled in a STEM program versus those not enrolled in STEM programs?

Viewing the peer leaders as a role model has been shown to increase student perceived learning gains (Table 4), as stated earlier in the chapter. While the interaction is not significant (Figure 7), there is some support that this trend is stronger for STEM students versus those who are not enrolled in a STEM program (two-way ANOVA: $F = 2.88$; $df = 1, 111$; $p = 0.092$). This finding, coupled with the qualitative data, indicates viewing the peer leader as a role model may provide additional benefits in perceived learning gains for STEM students such as motivation and persistence, which will lead to less attrition from the STEM fields. As shown in Table 3, final course grades did not significantly differ between STEM students who viewed the peer leader as a role model and non-STEM students who viewed the peer leader as a role model (Pearson's Chi square with Yate's Continuity Correction: $X^2 = 0.034188$, $df = 1$, $p = 0.8533$). No interaction was found between choice of major and relatability to the peer leader on student perceived learning gains (Table 2).

Discussion

Peer leader and student interactions have many of the hallmarks described in the literature of STEM role models and perceptions of faculty-student interactions, but have not yet been studied extensively in these contexts. The responsibilities of peer leaders and faculty instructors are different, leading to different student interactions and possible learning outcomes for both. However, it is reasonable to expect that peer leader-student interactions will affect student decision to persist in a STEM course, just as instructor-student interactions have been found to do (Osborne et al., 2003; Packard et al., 2011; Pascarella, 2006).

When students perceive interactions as positive and supportive, students report feeling as if they learned more course material (Wheeler et al., 2017). Positive experiences and interactions with faculty or instructors has also been identified as a possible solution to increasing the number of STEM degrees earned by undergraduates (Tinto, 1993; Vogt, 2008), again linking positive interactions with persistence in STEM. Opposite these findings, negatively perceived interactions with instructors have been correlated with poor course performance, lower grade point averages, and attrition from STEM disciplines (Micari & Pazos, 2012; Vogt, 2008).

A main factor associated with student held negative perceptions of faculty relationships is that the professors are insensitive to student learning needs (Hong & Shull, 2010). This aligns with prior descriptions of STEM courses in particular, as STEM courses have a reputation of propagating feelings of hostility, competitiveness and non-caring professors that make students feel unwelcome in the discipline (Seymour & Hewitt, 1997). The interactions between peer leaders and students appeared to alleviate many of these obstacles. Students largely reported that they felt their peer leader was passionate about helping them learn and perceptive to their learning needs and gains.

It was expected that there would be differences in the ability to peer leader's ability to assess their students learning gains, and this was supported in the results above. Since peer leaders differ in their perceptiveness to student learning gains, and the students who reported learning gains most aligned with the peer leader's perception of their learning gains had higher overall learning gains, it is important to identify factors that will enhance the peer leader-student interactions and increase potential learning gains. When students feel they are learning they are more satisfied with the course and more likely to persist in the course until completion (Stout & McDaniel, 2006). As described in Chapter 2, it is the role of peer leader to facilitate and

participate in group discussion and ensure that learning is taking place. This supports the hypothesis that effective peer leaders can significantly influence the student's decision to persist in the course if they are attentive and responsive to student learning needs and gains.

The majority of peer leaders attributed similarities in SALG responses to directly observing students as they grow and learn throughout the semester. These types of observations are made possible due to the style of questions and modules used in the PLTL workshops. These assessments differ from the ones typically administered by faculty and used to determine student success. The questions on exams are typically used to measure content mastery, while the PLTL modules develop skills that can be more accurately measured with an instrument such as the SALG survey. The findings of the current study agree with the assessment of Micari et al. (2005) that the interactions of the peer leader with the student serve to lessen the feelings of isolation that students feel in a large lecture hall, and has lessened the separation between learner and teacher.

While the feelings and perceptions of students are undoubtedly an important factor in their decision to persist in the course, and PLTL provides students with positive perceptions of peer leader interactions and the course in general, there was still a significant difference found in the self-assessed SALG scores of the student and the SALG score prescribed to students by their peer leader. While some peer leaders were much more efficient at gauging student learning gains in the same manner as the student, it was often the case of scores that differed greatly for the peer leader to assign a higher SALG score to the students than the students assigned to themselves. several peer leaders were not expecting to have similar scores to their students. Reasons provided by the peer leaders for a differing SALG score are described below and agree with prior findings discussed in the literature review.

Peer leaders who are expecting different scores between student-leader pairings do not attribute the differences to lack of attention or not being involved in student learning. One leader makes the argument that it is precisely due to fulfilling the responsibilities of a peer leader that their scores will differ from their students. This peer leader makes the point that they are "actively evaluating them (the students) and looking to see if I can help them improve in their ways of thinking." It is also possible that students are not aware of, or viewing, their progress in accordance with the measurements of the SALG instrument. The typical peer leader response states that the students in their group are "fixated on grades" and may not recognize progress in the types of learning gains assessed by the SALG because they are "focused on just trying to get the right answers and not how they get to the right answers." The attitudes towards learning being described by the peer leader coincides with the findings of Cassidy and Eachus (2000) which shows students enrolled in higher education place more of an emphasis on performance in a course rather than truly learning.

This provides some validity to the peer leader's explanation for a difference in SALG scores. Although not explicitly stated by any of the peer leaders, it is important to consider the peer leader perspective and the possibility that their responses may reflect bias, whether intentional or not. Peer leaders may be rating their student's learning gains higher than they truly believe them to be, with a possible interpretation of these high learning gains reflecting positively on the leader's abilities.

The peer leaders who predicted their SALG scores to greatly differ from their students were all accurate with their belief that the students would be the party with the lower rating in these pairings. The data from the student-leader pairings showed that 2/3 of all students rate their learning gains lower than their peer leader. One peer leader suggests that the differences in

student-leader assessments may be lessened if students were reminded of the objectives of PLTL continuously throughout the semester in order to have them better recognize their learning gains.

Peer leader responses reported earlier in this chapter also expect the leader to have a greater difficulty gauging the student's learning gains if the student is not engaging in PLTL sessions to their full potential. This prediction is supported by both the literature and quantitative results. Students have been found to not participate or engage when they do not see a direct connection between the task at hand and something that will directly impact their grade, such as an exam (Mottley & Roth, 2013).

All of the leaders expecting a difference between student-leader scores have state that their students are using formal assessment marks and "correctness" of responses as benchmarks for their learning gains. Because of this, students may not value the learning gains they are making from PLTL modules if they do not believe the modules are covering the exact information they will be tested on in BIO 121. Topping (1996) states that what a student learns depends on the student's degree of interest in what is taught, and largely students are only interested in what will give them a high mark on an exam. Because the quantitative data shows that students with similar SALG assessments to their peer leaders have significantly higher perceived learning gains, the students may be giving themselves a low SALG score because they do not find the material immediately relevant. Conversely, the students may be self-reporting great gains but the peer leader is unable to reciprocate these gains because the student did not fully participate during PLTL sessions and learning gains were not presented in an observable manner.

Relatability and motivation. In addition to enhancing the learning experience for students and indirectly motivating them to persist in the course, this study shows that direct encouragement from the peer leader through anecdotes and personal experiences are valued by the student and may also influence their decision to persist in STEM. This aligns with Colbron (2012) and the belief that peer leaders have special insight, as they are familiar with the program of study and can speak from experience. The current study shows that having peer leaders share experiences from BIO 121 is an excellent way to motivate or inspire students, as almost 95% of peer leaders believe this to be effective, as do 88% of students. The differences between qualitative responses pertaining to general experiences in BIO 121 versus sharing strategies of success and stories of achievement in BIO 121 are explained in detail later in the discussion.

It is one of the founding principles of PLTL that the sessions are led by a peer who recently completed the course, and the current data show that this characteristic of peer leaders may be enough to initiate relatability. Recent completion of the same course may seem trivial, but similar situations have been reported with previous research on shared attributes establishing relatability such as attending the same university or enrolling the same major (Blanton, Crocker & Miller, 2000; Lockwood & Kuda, 1997; Marx & Roman, 2002). Finn & Campisi (2015) recognized the ability of peer leaders to relate to and support their students via personal experiences from when they were enrolled in the course, an advantage of peer leaders over the typical faculty instructor of a course.

Once initiated, relatability can be expanded on by other characteristics as identified by the leaders above, such as similarities, common academic/career interests, shared interests outside of academia, and the ability of the peer leader to reassure students when they are faced with familiar situations. Several themes that were found in the peer leader responses for what

makes them relatable to their students were also used by peer leaders as the reasoning for expecting similar SALG scores for their students: the welcoming environment of PLTL sessions, the freedom felt by students to ask peer leaders questions, and that students relate to peer leaders by viewing them as a fellow learner. Responses indicated no feelings of superiority over their students, and peer leaders often justified their relatability to their students because they "were just in their shoes" a year or two ago and "understand" the challenges they are facing, whether they are specific to BIO 121 or another parallel in their lives.

Ninety-three percent of peer leaders believe they are able to relate to students, and 81.6% of students believe they can relate to their peer leader. These high percentages were not unexpected, as the literature documents the preference for student-tutors over faculty-tutors with regard to openness to student opinion, involvement in student learning, and ability to answer questions in a way that makes sense to the student (Rijdt et al., 2012). These themes are present in the peer leader responses, and are described as being achieved through the ability of the peer leader to assess the student's learning needs and utilize a teaching method that best suits their students. Peer leaders often cited these abilities as the rationale behind why they expected their assessment of the student's learning gains to closely align with the student's self-assessed learning gains.

Relatability has been found to influence student-instructor perceptions as well as student perceptions of a course, as described in the literature review. The results of the current study show that ability to relate to a peer leader is a factor that influences student learning outcomes in PLTL. Students who feel they can relate to their peer leader complete the course with higher grades than those who do not relate to their peer leader, and these students also have higher perceived learning gains. The benefits of relating to the peer leader are seen for all students,

regardless of being a STEM or non-STEM major. The significant improvements found in both of these areas when students identify a peer leader as relatable supports the claim by Cracolice (2012) that peers are better catalysts for student learners than their superiors. As relatability is often included as a characteristic of a role model, the findings suggest that the ability to relate to a student is more readily acquired than the status of a role model.

Role model status and positive peer leader-student relationships. Relatable, helpful and positive role models have been found to increase student motivation, recruitment and retention in STEM (Drury, Siy, & Cheryan). The current study sought to connect the role of the peer leader to the literature on role models and examine if the student-peer leader interactions met the criteria for positive relationships as described in the faculty-student interaction literature. It is reasonable to expect that the desired qualities of a positive professor-student relationship would extend to the qualities desired for a positive peer leader-student relationship. These qualities include admiring the professor, a highly approachable professor, and a professor who shows respect to students (Micari & Pazos, 2012). Student responses, as presented earlier in this chapter, addressed all of these as qualities possessed by peer leaders they consider to be role models. Further, responses from peer leaders and responses from students both discussed situations where the peer leader has communicated with students outside of class time, expressed concern about the student's future path, and the most frequently mentioned characteristics of being supportive. These three attributes have been identified by Hong and Shull (2010) as necessary for students to view a professor as caring. The ability of the peer leader to fulfill all three of these requirements in a way that may not always be practical for faculty, in addition to the positive qualitative responses from students, supports the hypothesis that peer leaders have

largely positive interactions with students. A strong, positive relationship with the instructor creates a learning environment where students will learn best and be most successful (Marshall, 1991), and positive perceptions towards learning may result in students experiencing an increase in academic achievement (Prince, 2004) and positive learning gains (Wheeler et al., 2016).

It was expected that since the peer leader-student interactions were deemed to be positive, students who considered their peer leader to be a role model would benefit from an increase in academic achievement as well as perceived learning gains. The results of this study, as discussed earlier in the chapter, show that while students who considered the peer leader to be a role model did perceive higher learning gains than students who did not consider the peer leader a role model, there were no differences in final course grades. The benefit of higher learning gains was observed for all students who consider their peer leader to be a role model, regardless of STEM or non-STEM majors. There is some support that this trend is stronger for students who have declared majors within a STEM program versus those who have not, which agrees with previous research findings as discussed in Chapter 2. However, the interaction is not significant in the current study.

When peer leaders were asked why they considered themselves to be a role model to their students, the responses fell into the following five categories: the positive atmosphere of PLTL created in part by the peer leader, similar ages between students and peer leaders, academic success/intelligence, relatability, and achieved attainable goals. When the students were asked why they considered the peer leader to be a role model, the responses corresponded to the peer leader responses with the categories of success in BIO 121 and the peer leader representing student goals, but the student responses also extended to the categories of peer leader's personality and the perceptiveness of the peer leader. The literature, students, and peer leaders all

identified attainable goals and tendency to inspire students as necessary to establishing role model status. About three-quarters of the students (73.5%) stated that they consider their peer leader as a role model, and 86% of peer leaders consider themselves to be a role model to their students.

Attainable goals and the BIO 121 experience. Sharing BIO 121 experiences, common goals, and motivation are recurring themes found to make for a positive peer leader-student relationship. While all are important to students' consideration of the peer leader to be relatable or a role model, they are presented in slightly different contexts when comparing the sets of qualitative responses. As indicated in the results above, motivation is frequently interworked with the factors of sharing BIO 121 experiences and common goals. This connection shows that there are different types of motivation and different ways that the peer leaders can inspire their students to succeed.

The first factor for which there is a noticeable difference between the way it is represented between relate and role model is the completion of BIO 121. When BIO 121 is introduced as a factor for relatability, it is in a passive way. The leader simply states that they have recently and successfully completed BIO 121, and this knowledge is enough to create relatability between the peer leader and the student. Establishing a common background with the students to establish relatability and begin a connection supports the findings of previous research (Finn & Campisi, 2015; Streitweiser & Light, 2010). When BIO 121 is described in the responses for role models, it is an active way. It is not treated as just a defining trait of the peer leader, but rather the peer leaders describe going in depth and sharing BIO 121 experiences with their students through stories and anecdotes.

A theme found in all of the responses from peer leaders who felt they could not relate to their students was that they did not share BIO 121 course experiences with their students because they believed the students would have a different experience due to a new professor teaching the course. As shown in the results above, these peer leaders all felt that this was the distinguishing factor making them unable to relate to their students. Factors such as the college experience, other common interests, and similar goals that the other peer leaders found to help them relate to their students were not discussed. Because ability to relate and motivation have been found to correspond with a student's depiction of a role model, sharing specific stories from BIO 121 may allow more peer leaders to be considered a role model by their students.

The next factors that are different in the context of relatability and role model responses are the ways that students can be motivated by peer leaders through sharing common goals. A student goal as reported by both peer leaders and students has been shown to be successfully completing BIO 121. However, as shown in the results above, which looked closer at the top 10% of peer leader responses who were considered a role model by all of their students, successfully completing BIO 121 is not the only requirement necessary to be considered a role model to the students. Other factors such as peer leader personality and perceptiveness to student learning needs were non-academic factors identified in the responses as integral to student consideration of a peer leader as a role model. Many responses, both from the students and the peer leaders, focused on similar academic pathways or career goals as a reason for increasing both relatability and the likelihood of considering the peer leader a role model. The difference between the relatability and role model categories is that in the context of relatability, the peer leaders and students are sharing long-reaching, future goals that have not yet been attained by either the peer leader or the role model. In the context of role models, the shared goals are

typically something that the peer leader has already done successfully, such as become a peer leader, get accepted into medical school, or balance a social life with academic success. Many of the student responses for why they considered their peer leader to be a role model revolve around the notion that peer leaders are inspirational because the student sees them as a realistic portrait of success they can attain in the near future.

The motivation provided to the students as described in the relatability responses tended to focus on leaders sharing in the students' current frustrations about challenging coursework or identifying shared areas of weaknesses. Stories of when a peer leader struggled throughout the BIO 121 course or other aspects of their lives when they faced barriers were also described in the role model responses from both students and peer leaders. However, in the context of the relatability responses, the struggles were identified as being in the present. In the role model context, they tended to be obstacles and barriers that the peer leader had successfully overcome. Peer leader and student responses did not tend to recognize peer leaders with current areas of weakness, frustrations, or obstacles as role models. Exposing current weaknesses appears to be a strategy used by peer leaders to relate, but not when it comes to the student or peer leader perspective of being considered a role model.

Overcoming these obstacles seems to differentiate relatability and being a role model, as seen in the results above. Importantly, half of the peer leaders whose responses indicated that they motivated their students through sharing experiences of overcoming difficulties, explicitly said that they described the amount of effort and work required in order for them to succeed. Students elaborated in their responses for considering the peer leader as a role model that they benefitted and were motivated from leaders sharing techniques that they themselves used to achieve success, which supports previous research findings (Bruno et al., 2015; Colbron, 2012).

This declaration provides evidence that peer leaders who are considered role models by their students have the potential to dispel one of the prevalent STEM stereotypes. As discussed in the literature review, one of the STEM stereotypes that may deter students from joining or persisting in the STEM field is the belief that the STEM fields are only for the innately gifted, people who understand science naturally and do not need to exert effort to succeed.

The findings of this study correlate with this description of commonalities between all role models: "They are all perceived to be talented in their respective areas and provide inspiration to others" (Lockwood, 2006; Lockwood & Kunda, 1997). Responses from the peer leaders and the students show that talent is not enough on its own to be a role model; the role model should also motivate the students and develop a personal. A common barrier to considering the peer leader a role model, as identified by both students and peer leaders, is simply that the peer leader does not meet that individual's criteria of a role model. This reasoning was discussed by all peer leaders who responded that they did not consider themselves a role model to their students in any way as well as many of the students.

The findings indicate that relatability is a component of the role model status, and also appears to have a great impact on outcomes such as student final course grades and perceived learning gains. When students feel as though they are learning, they are more likely to actively participate in the course and persist through challenging material. As students actively participate in PLTL sessions and interact with their peer leader, this allows the peer leader to effectively judge the learning gains and needs of the student. A peer leader who is perceived as nurturing and caring, descriptions commonly made by peer leaders with very few differences between sSALG and lSALG, potentially inspires and motivates the students to persist in STEM courses. This study finds that when sSALG and lSALG are closely aligned, the student perceives higher

learning gains. Relatability has been determined as a common factor in positive student interactions, close agreement in SALG scores, greater perceived learning gains, and higher course grades. There is a relatively low threshold for establishing relatability, and there are many avenues that a peer leader can use to achieve relatability and greatly benefit student learning outcomes.

Chapter 5: Summary, Conclusion, and Recommendations

Summary

Background and focus of study.

A review of the previous literature on the PLTL model showed numerous benefits for the students engaged in PLTL, the peer leaders facilitating the sessions, and the institutions that have implemented the program. Peer leaders are an integral part of the PLTL program, and the success of the PLTL model has been attributed to the role of the peer leader. PLTL may address and eliminate many of the obstacles found to hinder student relationships with faculty members in higher education. Simultaneously, effective peer leaders may directly challenge a prevalent stereotype in the STEM field and serve as motivational role models to the students in their groups. A positively perceived relationship between students and peer leaders will likely contribute to the retention of students and increase the likelihood of persisting with the course until completion, as previously demonstrated in the literature.

This study attempted to connect the PLTL literature to the literature on student-faculty interactions and benefits of exposing students to role models, specifically with regard to the role of the peer leader and their interactions with students. Given the differences in the responsibilities of faculty members and peer leaders, it is expected that peer leaders will develop a close rapport with their students that will be viewed by the students as a positive interaction. Factors such as relatability may be established early in the relationship, and then the students may progress to viewing their peer leader as a role model as they continue to interact. As student attitudes, learning gains, and course achievement have been found to be impacted by learning environment, the effect of different student and leader interactions on these learning outcomes

were explored. Social constructivism theory and social learning theory served as the framework for this study as to best inform interactions between students and peer leaders in the PLTL program and role model behavior, respectively.

Research questions.

1. How closely do peer leader perspectives of student learning gains align with student self-reported learning gains as measured by a modified version of the Student Assessment of their Learning Gains (SALG) instrument?
2. What benefits, if any, are found for students whose perceived learning gains closely aligned with their peer leader's assessment of their learning gains?

   Sub-Question: Why do peer leaders expect their assessment of student learning gains to be similar to the student's self-assessment of learning gains?

   Sub-Question: Why do peer leaders expect their assessment of student learning gains to be different from the student's self-assessment of learning gains?
3. What differences in perceived learning gains and final course grade, if any, exist between students who relate to their peer leaders versus those who do not?

   Sub-Question: What factors do leaders attribute to their ability to relate to their students?

   Sub-Question: What factors do leaders attribute to their inability to relate to their students?
4. What differences in perceived learning gains and final course grade, if any, exist between students who view their peer leader as a role model versus those who do not?

   Sub-Question: What traits or attributes do the students describe as common to peer leaders they consider to be role models?

Sub-Question: What traits or attributes do the students describe as common to peer leaders they do not consider to be role models?

Sub-Question: What is the peer leader perspective on being considered a role model and the necessary qualities of a role model?

Sub-Question: What is the leader perspective on not considering themselves to be a role model?

5. What impact, if any, does considering the peer leader as a role model have for STEM students versus non-STEM students on perceived learning gains and final grade? What impact, if any, does peer leader relatability and role model status have for students enrolled in a STEM program versus those not enrolled in STEM programs?

Methods and procedures.

Data were collected from student and peer leader participants in a PLTL program associated with an Introductory Biology course at a 4-year research institution in the Northeast. Only participants who completed 100% of the quantitative survey and the majority of the qualitative questionnaire were included in data analysis. Only students who remained active in the PLTL sessions and enrolled in BIO 121 in the last week of the semester were provided with the opportunity to complete the SALG survey and questionnaire. Procedures in instrumentation and data analyses are summarized below.

Instrumentation. The instrument used to measure the student's self-assessed learning gains was a modified version of the valid, reliable, and customizable Student Assessment of their Learning Gains (SALG) instrument (Seymour, Wiese, Hunter, & Daffinrud, 2000). The SALG was developed for college-level instructors to collect student feedback that can be used as a formative assessment, a baseline survey, or for instructor accountability purposes. The instrument used contained 25 questions on a 5-point Likert-Scale, and the summation of each student's responses were calculated as a range from 0-125. A higher score represents a greater amount of learning gains. A secondary use of the SALG instrument required peer leaders to complete the SALG assessment for each of the students in their PLTL group. Validity and reliability have not been established for the secondary use of the SALG instrument, as the current study is the first to utilize this instrument in the novel way.

Qualitative data were collected through an open-ended questionnaire given to both the students and the peer leaders then analyzed with a heuristic approach.

Data analysis. Statistical analyses of the quantitative data associated with the SALG were performed using SPSS and RStudio. Qualitative data were analyzed using a heuristic approach.

Selected Findings

The results of a mixed design ANOVA determined that there are significant differences between the SALG scores reported by the students and the SALG score reported by peer leaders with regard to the student's learning gains $F(1,113) = 24.1$, $p < .001$, and this difference significantly differed by leader $F(35,113) = 1.93$, $p = .005$. Additionally, students differed in their SALG score between leaders, $F(35,113) = 1.57$, $p = .041$. It is not unexpected for students to report different SALG scores from different sections of PLTL, or for certain peer leaders to be more attuned to the perceived learning gains of their students than other peer leaders. Overall, peer leaders are reporting higher SALG results for their students than students are reporting for themselves.

The results of Welch's Two-sample t-test was performed to determine if students with a relatively high and a relatively low SALG score differed significantly in the absolute difference between their self-assessed scores and their leaders' estimation of their learning gains. The number of differences between the student-leader pairings were found to be very significant to student self-reported learning gains (Welch's 2-sample t-test: $t = 7.63$; $df = 135.38$; $p \ll 0.001$). The calculations based on the number of differences found between the student-leader pairings showed the minimum number of differences between student-leader pairings to be 0 and the maximum number of differences to be 94. The median number of differences is 27, with the lower quartile being 14 and upper quartile at 40.25. The students who reported the highest

perceived learning gains had SALG scores that aligned more closely with their peer leader's assessments than those students with low perceived learning gains.

Whether the students relate to their peer leader has a significant effect on student perceived learning gains ($F=5.145$; $df=1,112$; $p=.0248$), where the students who stated that they related to their peer leader had significantly higher learning gains than those who did not. This effect was seen in all students who relate to their peer leaders, regardless of a STEM major or non-STEM major. Considering the peer leader to be a role model is also has a significant positive effect on student self-assessed SALG scores ($F= 4.134$; $df= 1,111$; $p=.0444$), and there is some evidence of an interaction between students with a STEM major and benefits from viewing the peer leader as a role model ($F=2.884$; $df=1,111$; $p=.0923$), but this interaction is not significant. All students who relate to their peer leader and consider their peer leader to be a role model have significantly higher learning gains than those who do not, regardless of the student's major. Students who reported relating to their peer leader also completed the course with higher grades than those students who do not relate to their peer leader (Pearson's Chi-Square Test: $X^2=11.283$, $df=9$, $p=.257$). No significant differences were found in the final course grades of students who considered their peer leaders to be role models and those who did not (Pearson's chi square: $X^2= 18.573$, $df=9$, $p =.029$).

Qualitative responses typical of peer leaders list the following as reasons they consider themselves relatable to their students: similarities, common academic/career interests, role as a fellow learner, shared interests outside of academia, and motivation and reassurance which is embedded in anecdotes told to their students about their personal experiences in BIO 121. Leaders who did not believe they were relatable to their students stated that they nothing in common with their students either besides or beyond BIO 121 and participating in PLTL. It was

far more common for leaders to perceive themselves as relatable to their students than not relatable. Based on qualitative responses, and the percentage of peer leaders who believe they are relatable to students (93%), as well as the percentage of students who responded affirmatively that they relate to their peer leaders (81.6%), relatability appears to be established more readily than role model status.

This inference is supported by prior research findings, which include relatability as a criterion to becoming an impactful STEM role model (Drury, Siy & Cheryan, 2011). In general, students rated role models as competent, likeable, inspiring, and their success is considered attainable (Shin et al., 2016). When peer leaders were asked why they considered themselves to be a role model to their students, the responses fell into the following 5 categories: the positive atmosphere of PLTL created in part by the peer leader, similar ages between students and peer leaders, academic success/intelligence, relatability, and achieved attainable goals. When the students were asked why they considered the peer leader to be a role model, the responses corresponded to the peer leader responses with the categories of success in BIO 121 and the peer leader representing student goals, but the student responses also extended to the categories of peer leader's personality and the perceptiveness of the peer leader. The literature, students, and peer leaders all identified attainable goals and tendency to inspire students as necessary to establishing role model status. About three quarters of the students (73.5%) stated that they consider their peer leader as a role model, and 86% of peer leaders consider themselves to be a role model to their students.

Conclusion

The data collected from this study show that PLTL, and specifically the role of the peer leader and their interactions with students, is an effective strategy to overcome challenges facing student-faculty interactions in an introductory STEM course with a large lecture component. PLTL also provides students with an avenue to interact with peers they may find to be relatable or potential role models. Greater perceived learning gains were found among students with a peer leader who could accurately depict the student's perceived learning gains. Peer leaders credited the ability of being attuned to student learning gains to the direct observation of growth while participating in the student's learning as well as relating to and understanding the student's needs. Prior research had not examined how peer leaders were perceived as potential role models by their students, but given the attributes of peer leaders that have been identified previously and the tendency of PLTL research to refer to peer leaders as potential role models, it was expected, and confirmed herein, that students do often view their peer leader as a role model. It was quite common for students in this study to relate to their peer leaders. Almost all of the peer leaders surveyed in this study consider themselves to be role models as well as relatable to their students. Relatability was identified as a component of the role model status.

Different impacts on learning outcomes were seen for students who relate to their peer leaders versus students who consider their peer leader to be a role model. Students who relate to their peer leader benefited in both the areas of course achievement and learning gains. Students who view their peer leader as a role model showed a greater increase in perceived learning gains than those who did not, but there was no difference in final course grades between the two groups. Students benefited from positive interactions with their peer leader regardless of enrollment in STEM or non-STEM majors. The qualitative responses support the claim that

relatability is more readily establish than role model status and aligns with the literature describing relatability as a quality present in role models. Simply having taken the same course, such as BIO 121, is enough to establish relatability in most cases observed in the current study.

Establishing role model status requires more than simply having taken the same courses. The responses show that peer leaders are often considered role models when they inspire or motivate students by sharing their personal struggles and how they achieved success in areas that the student is also passionate about succeeding in. Role model status involved the peer leader already having completed a goal, and these goals were viewed as attainable to the student. While students benefitted most from viewing a peer leader as relatable, there were no adverse effects found for peer leaders who were not considered to be a role model. It is also encouraging that exposure to peer leaders may be able to directly challenge STEM stereotypes, so it is recommended that peer leaders explicitly tell the students of the struggles that they overcame and the amount of effort required to be successful.

Recommendations for Future Research

While many studies have focused on the status of the role model and the particular benefits for STEM students, no other studies have studied this in the context of PLTL. Further studies on the impact of peer leaders as role models are therefore recommended, in addition to studies specifically focusing on the relatability aspect of this status. To do so, questions on the student open-ended questionnaire can be devoted to the student's perspective of establishing relatability with the peer leader, and compare and contrast these responses to similar responses focusing on course faculty. It is recommended that future studies should explore the influence of demographical factors such as gender, race, first generation college student, and age on the

interactions of the student and peer leader, and whether there is any significance on students and peer leaders sharing these characteristics.

The findings would be improved by further research incorporating a larger sample size of increased generalizability. Due to the known variations of self-assessment results, it may be beneficial to incorporate a measurement of actual student learning gains in addition to perceived learning gains. This could be achieved through administering the SALG in the beginning of the semester to assess a baseline score, or through formal course assessment grades. These comparisons would also provide insight into the accuracy of both the student self-assessment of learning gains, as well as the peer leader's ability to assess student learning gains. Student attitudes and peer leader disposition could potentially influence the given ratings on the SALG instrument. Future studies should also explore more potential benefits arising from student-leader interactions, such as persistence in the STEM major, enrollment in future science courses, and whether or not the student becomes a peer leader in subsequent semesters. To aid in these results, students who withdrew from the course should be asked to explain what role, if any, peer leader interactions played in their course experience and decision to leave the course.

Appendix A

Modified Student Assessment of Their Learning Gains (SALG) Instrument (Student Version)

1. As a result of your work in PLTL, what GAINS DID YOU MAKE in your UNDERSTANDING of the main concepts explored in this class?

2. As a result of your work in PLTL, what GAINS DID YOU MAKE in your UNDERSTANDING of the relationships between the main concepts?

3. As a result of your work in PLTL, what GAINS DID YOU MAKE in your UNDERSTANDING of how ideas from this class relate to ideas encountered in classes outside of this subject area?

4. As a result of your work in PLTL, what GAINS DID YOU MAKE in your UNDERSTANDING of how studying this subject area helps people address real world issues?

5. As a result of your work in PLTL, what GAINS DID YOU MAKE in the SKILL of identifying patterns in data?

6. As a result of your work in PLTL, what GAINS DID YOU MAKE in the SKILL of recognizing a sound argument and appropriate use of evidence?

7. As a result of your work in PLTL, what GAINS DID YOU MAKE in the SKILL of developing a logical argument?

8. As a result of your work in PLTL, what GAINS DID YOU MAKE in the SKILL of working effectively with others?

9. Please comment on what SKILLS you have gained as a result of this class

10. As a result of your work in PLTL, what GAINS DID YOU MAKE in your enthusiasm for the subject?

11. As a result of your work in PLTL, what GAINS DID YOU MAKE in your interest in discussing the subject area with friends or family?

12. As a result of your work in PLTL, what GAINS DID YOU MAKE in your interest in taking or planning to take additional classes in this subject?

13. As a result of your work in PLTL, what GAINS DID YOU MAKE in your confidence that you understand the material?

14. As a result of your work in PLTL, what GAINS DID YOU MAKE in your confidence that you can do this subject area?

15. As a result of your work in PLTL, what GAINS DID YOU MAKE in your willingness to seek help from others (teacher, peers, TA) when working on academic problems?

16. As a result of your work in PLTL, what GAINS DID YOU MAKE in connecting key class ideas with other knowledge?

17. As a result of your work in PLTL, what GAINS DID YOU MAKE in applying what you learned in this class in other situations?

18. As a result of your work in PLTL, what GAINS DID YOU MAKE in using systemic reasoning in your approach to problems?

19. As a result of your work in PLTL, what GAINS DID YOU MAKE in using a critical approach to analyzing data and arguments in daily life?

20. HOW MUCH did participating in discussions during PLTL HELP YOUR LEARNING?

21. HOW MUCH did listening to discussions during PLTL HELP YOUR LEARNING?

22. HOW MUCH did participating in groupwork during PLTL HELP YOUR LEARNING?

23. HOW MUCH did reviewing a case study during PLTL HELP YOUR LEARNING?

24. HOW MUCH did the following aspect of PLTL HELP YOUR LEARNING: Explanation of how the class activities, reading, and assignments related to each other.

25. HOW MUCH did the following aspect of PLTL HELP YOUR LEARNING: Explanations given by leaders of how to learn or study the material.

26. HOW MUCH did the following aspect of PLTL HELP YOUR LEARNING: Explanation of why the class focused on the topics presented.

27. Please comment on HOW the SETTING of the PLTL session helped your learning.

Appendix B

Modified Student Assessment of Their Learning Gains (SALG) Instrument (Leader Version)

1. As a result of work in PLTL, what GAINS have the students made in their UNDERSTANDING of the main concepts explored in this class?

2. As a result of work in PLTL, what GAINS have the students made in their UNDERSTANDING of the relationships between the main concepts?

3. As a result of work in PLTL, what GAINS have the students made in their UNDERSTANDING of how ideas from this class relate to ideas encountered in classes outside of this subject area?

4. As a result of work in PLTL, what GAINS have the students made in their UNDERSTANDING of how studying this subject area helps people address real world issues?

5. As a result of work in PLTL, what GAINS have the students made in the SKILL of identifying patterns in data?

6. As a result of work in PLTL, what GAINS have the students made in the SKILL of recognizing a sound argument and appropriate use of evidence?

7. As a result of work in PLTL, what GAINS have the students made in the SKILL of developing a logical argument?

8. As a result of work in PLTL, what GAINS have the students made in the SKILL of working effectively with others

9. Please comment on what SKILLS students have gained as a result of this class.

10. As a result of work in PLTL, what GAINS did students make in enthusiasm for the subject?

11. As a result of work in PLTL, what GAINS do you believe the students have made in their interest in discussing the subject area with friends or family?

12. As a result of your work in PLTL, what GAINS did students make in their interest in taking or planning to take additional classes in this subject?

13. As a result of work in PLTL, what GAINS did students make in their confidence that they understand the material?

14. As a result of work in PLTL, what GAINS did students make in confidence that they can do this subject area?

15. As a result of work in PLTL, what GAINS did students make in willingness to seek help from others (teacher, peers, TA) when working on academic problems?

16. As a result of work in PLTL, what GAINS did students make in connecting key class ideas with other knowledge?

17. As a result of work in PLTL, what GAINS did students make in applying what they learned in this class in other situations?

18. As a result of work in PLTL, what GAINS did students make in using systemic reasoning in their approach to problems?

19. As a result of work in PLTL, what GAINS did students make in using a critical approach to analyzing data and arguments in daily life?

20. HOW MUCH did participating in discussions during PLTL help the students' learning?

21. HOW MUCH did listening to discussions during PLTL help the students' learning?

22. HOW MUCH did participating in groupwork during PLTL help the students' learning?

23. HOW MUCH did reviewing a case study during PLTL help students' learning?

24. HOW MUCH did the following aspect of PLTL help students' learning: Explanation of how the class activities, reading, and assignments related to each other.

25. HOW MUCH did the following aspect of PLTL help students' learning: Explanations given by leaders of how to learn or study the material.

26. HOW MUCH did the following aspect of PLTL help students' learning: Explanation of why the class focused on the topics presented.

27. Please comment on HOW the INFORMATION you provided the students about the class helped their learning.

28. Please comment on HOW the SETTING of the PLTL session helped your student’s learning.

Appendix C

Student Questionnaire

How have the interactions between you and your leader changed from the beginning of the semester until now?

Does your leader share experiences from when they took BIO 121?

Do the experiences that your leader shares from their time in BIO 121 motivate or inspire you to do well in the course?

Do you relate to your peer leader?

Do you feel comfortable sharing your areas of weakness with your leader?

Do you think your leader is able to identify when you are struggling with specific concepts or skills?

Do you think your leader is able to identify when you have mastered specific concepts or skills?

In general, I am comfortable asking the professor of a course for help with the content of that course (Likert Scale)

In general, I am comfortable asking the teaching assistant of a course for help with the content of that course (Likert Scale)

In general, I am comfortable asking a peer leader of a course for help with the content of that course (Likert Scale)

In general, I think the professor of a course will be able to satisfactorily answer a question associated with the content of the course (Likert Scale)

In general, I think the teaching assistant of a course will be able to satisfactorily answer a question associated with the content of the course (Likert Scale)

In general, I think the peer leader of a course will be able to satisfactorily answer a question associated with the content of the course (Likert Scale)

Do you believe your leader is helping you to accomplish your goals in Biology?

Do you consider your leader a role model in any way?

BRIEFLY explain why you do or do not consider your leader a role model.

Does PLTL provide a learning environment in which you feel comfortable?

Please explain your answer to the above question "Does PLTL provide a learning environment in which you feel comfortable?"

Please BRIEFLY explain how what your peer leader does during your sessions impacts your learning, whether it is negative or positive.

Appendix D

Leader Questionnaire

How have the interactions between you and your students changed from the beginning of the semester until now?

BRIEFLY explain your response to how the interactions with your students have changed from the beginning of the semester until now.

Do you share experiences from when you took BIO 121?

Do you think the students find the experiences you share from your time in BIO 121 to be motivating or inspires them to do well in the course?

Do you think the students in your group relate to you?

Please explain why or why not the students in your PLTL sessions could relate to you.

Do your students feel comfortable sharing their areas of weakness with you?

Do you think you are able to identify when your students are struggling with specific concepts or skills?

Do you think you are able to identify when your students have mastered specific concepts or skills?

In general, my students are comfortable asking the professor of a course for help with the content of that course (Likert Scale)

In general, my students are comfortable asking the teaching assistant of a course for help with the content of that course (Likert Scale)

In general, my students are comfortable asking a peer leader of a course for help with the content of that course (Likert Scale)

In general, my students think the professor of a course will be able to satisfactorily answer a question associated with the content of the course (Likert Scale)

In general, my students think the teaching assistant of a course will be able to satisfactorily answer a question associated with the content of the course (Likert Scale)

In general, my students think the peer leader of a course will be able to satisfactorily answer a question associated with the content of the course (Likert Scale)

Do you believe you are helping your students to accomplish their goals in Biology?

BRIEFLY explain your response to "Do you believe you are helping your students to accomplish their goals in Biology?"

Do you consider yourself a role model to your students in any way?

BRIEFLY explain why you do or do not consider yourself a role model to your students.

Do you think your students consider you to be a role model in any way?

Do you think PLTL provides a learning environment in which your students feel comfortable?

Please BRIEFLY explain the features of the PLTL environment that influenced your response to the question "Does PLTL provide a learning environment in which your students feel comfortable?"

Appendix E

SYRACUSE UNIVERSITY
Institutional Review Board
MEMORANDUM

TO: Jason Wiles
DATE: November 24, 2014
SUBJECT: **Determination of Exemption from Regulations**
IRB #: 14-313
TITLE: *Enhancing Recruitment and Retention in Introductory Biology Through PLTL*

The above referenced application, submitted for consideration as exempt from federal regulations as defined in 45 C.F.R. 46, has been evaluated by the Institutional Review Board (IRB) for the following:

1. determination that it falls within the one or more of the five exempt categories allowed by the organization;
2. determination that the research meets the organization's ethical standards.

It has been determined by the IRB this protocol qualifies for exemption and has been assigned to category **1**. This authorization will remain active for a period of five years from **November 24, 2014** until **November 23, 2019**.

CHANGES TO PROTOCOL: Proposed changes to this protocol during the period for which IRB authorization has already been given, cannot be initiated without additional IRB review. If there is a change in your research, you should notify the IRB immediately to determine whether your research protocol continues to qualify for exemption or if submission of an expedited or full board IRB protocol is required. Information about the University's human participants protection program can be found at: http://orip.syr.edu/human-research/human-research-irb.html Protocol changes are requested on an amendment application available on the IRB web site; please reference your IRB number and attach any documents that are being amended.

STUDY COMPLETION: Study completion is when all research activities are complete or when a study is closed to enrollment and only data analysis remains on data that have been de-identified. A Study Closure Form should be completed and submitted to the IRB for review (Study Closure Form).

Thank you for your cooperation in our shared efforts to assure that the rights and welfare of people participating in research are protected.

Tracy Cromp, M.S.W.
Director

DEPT: Biology, 107 College Place **STUDENTS:** Julia Snyder, Jeremy Sloane

Office of Research Integrity and Protections
121 Bowne Hall Syracuse, New York 13244-1200
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Appendix F

SYRACUSE UNIVERSITY
Institutional Review Board
MEMORANDUM

TO: Jason Wiles
DATE: October 6, 2015
SUBJECT: **Amendment for Exempt Protocol**
AMENDMENT#: 2 – Addition of Research Staff (Ryan Dunk & Christina Winterton)
IRB #: 14-313
TITLE: *Enhancing Recruitment and Retention in Introductory Biology Through PLTL*

Your current exempt protocol has been re-evaluated by the Institutional Review Board (IRB) with the inclusion of the above referenced amendment. Based on the information you have provided, this amendment is authorized and continues to be assigned to category 1. This protocol remains in effect from **November 24, 2014** to **November 23, 2019**.

CHANGES TO PROTOCOL: Proposed changes to this protocol during the period for which IRB authorization has already been given, cannot be initiated without additional IRB review. If there is a change in your research, you should notify the IRB immediately to determine whether your research protocol continues to qualify for exemption or if submission of an expedited or full board IRB protocol is required. Information about the University's human participants protection program can be found at: http://orip.syr.edu/human-research/human-research-irb.html Protocol changes are requested on an amendment application available on the IRB web site; please reference your IRB number and attach any documents that are being amended.

STUDY COMPLETION: The completion of a study must be reported to the IRB within 14 days.

Thank you for your cooperation in our shared efforts to assure that the rights and welfare of people participating in research are protected.

Tracy Cromp, M.S.W.
Director

DEPT: Biology, 107 College Place

STUDENTS: Julia Snyder, Jeremy Sloane

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Appendix G

SYRACUSE UNIVERSITY
GENERAL BIOLOGY I (BIO 121) – Course Syllabus, Fall 2017

COURSE DESCRIPTION
Bio 121 – General Biology, 4 credits
Required entry-level course for biology majors and the first of a two-course sequence comprising a survey of essential biological concepts ranging from the molecular level to global ecology. Two lectures and 1 combined lab/recitation section per week. Students in Biology 121 will explore the nature of science and the diversity of organisms within a framework of major themes including the flow and regulation of energy and information within living systems, and the central and unifying concept of evolution. Efforts will be made to relate key concepts to model organisms for research and practical examples such as diseases and environmental issues.

Goals

- To give a broad introduction to biology
- To learn about science as a way of exploring the natural world
- To gain laboratory skills applicable to upper-level courses in biology
- To gain a deep understanding of the fundamental principles which underlie all of the life sciences

Lecture:

M & W 10:35 am – 11:30 am

OR

M & W 12:45 pm – 1:40 pm

Both in Gifford Auditorium (in HBC)
Students should ONLY attend the section in which they are enrolled.

Attendance essential. Cell phones should be silenced and put away during the entirety of the lecture. Please attend with the intention to be fully "present", and respect others who wish to focus on learning.

Lab/discussion:
One 3-hour session per week,
LSC 134, 136, 146, 148
Students MUST attend the session in which they are enrolled; NO EXCEPTIONS.

Attendance required. Cell phones must be silenced and put away during the entirety of the lab session. Texting, etc., with others outside of lab is NOT participating in lab.

Instructional Team:
Course Instructor:

Christina Winterton ciwinter@syr.edu
150 Life Sciences Complex 315-443-3193

Office hours: Wed, 11:30 am – 12:30 pm (usually) or by appointment when necessary.

Course Coordinator:

Bev Werner bfwerner@syr.edu
142 Life Sciences Complex 315-443-3722

Office hours: 9 am–4:30 pm, Mon–Fri. Lunch taken at 1-1:45 pm approximately; email or call for an appointment when necessary.

Laboratory Coordinator:

Mary Graziano mgrazian@syr.edu
138 Life Sciences Complex 315-443-9179

Office hours: 9 am–4:30 pm, Mon–Fri. Lunch taken at variable times; email or call for an appointment when necessary.

Laboratory Instructors:
Mary Graziano (Lab Coordinator/TA)
Teaching Assistants:

Fatmagul Bahar
Eddie Caro
Oliver Cocks
Rui Corderio
Anne Cure
Ryan Dunk
Spandita Dutta
Billy Haws
Trosporsha Khan
Alex Nichitean
Garrett Liddil
Neha Mohan Babu
Kelly Schmid
Yao Xiao
Niko Wagner

All BIO 121 TAs will hold office hours in LSC 152. Office hours times will be posted on Blackboard. TA office hours are open to all students, but students assigned to a TA's section will have priority during that TA's office hours. Students visiting office hours should arrive prepared with specific questions and goals for the meeting rather than expecting a TA-centered tutoring session.

Peer-led Team Learning Coordinator:

Julia Snyder, Ph.D jjseymou@syr.edu
Office hours by appointment

Required Materials

• Textbook: Campbell Biology General Biology I and II, Custom Edition for Syracuse University ISBN-978-1-323-44190-9. Includes Modified Mastering Biology (used for online homework assignments which is 10% of final course grade), and eText, available at SU Bookstore [other versions of Campbell Biology will require additional purchase of Mastering Biology]. Comparison pricing is available on the SU bookstore website: http://syracuse.verbacompare.com/

• Personal Response Device ("clicker"): TurningPoint brand Response Card, Rf (credit card size). Other clicker brands or smart phone apps are not supported. Students MUST bring their response devices to lecture if they wish to earn participation credit during lecture sessions. Lecture participation credit can ONLY be earned via your properly licensed, registered and functioning clicker. Clickers can also be purchased at the SU bookstore. [Students who believe they are required to have 2 clickers because of two different courses should email Bev Werner at bfwerner@syr.edu.]

• Other required materials, such as lab activities, will be distributed via Blackboard (Bb). All students MUST access the course Bb page to obtain weekly documents (print and take to lab/discussion session), view course announcements, participate in online discussions or other activities, and monitor their grades. You will log into Blackboard (Bb) via your NetID (the portion of your SU email address appearing before the @syr.edu). Your password is the same as the password for your SU email address. If you do not know your NetID and password, go to http://its.syr.edu/netid/ for assistance. To access Blackboard, go to https://blackboard.syr.edu.

Communication with Faculty, TAs and Staff in Bio 121

Syracuse University has established email as a primary vehicle for official communication between students and faculty, TAs and staff at the university. Email messages sent to faculty, TAs, and staff of Bio 121 should be sent from your syr.edu account. If you choose to use another email address please make arrangements that ensure you do not miss any messages sent from course instructors or staff. Students in BIO 121 should check their syr email account at least daily to be sure they receive important messages from the course professor, TA and staff.

Syllabus Changes:

The course administration reserves the right to make changes to the syllabus policies and dates as deemed necessary. Such changes will be communicated to students via Blackboard and email (university policy requires that we communicate to students via @syr.edu email accounts), and every effort will be made to minimize changes to this document.

BIO 121 Grades

Point Distribution (out of a total of 1000 points):

Exam 1 = 130 points or 13%
Exam 2 = 130 points or 13%
Exam 3 = 130 points or 13%
Exam 4 (Cumulative Final) = 210 points or 21%
Mastering Biology Assignments = 100 points or 10%

Participation/Clicker Responses = 50 points or 5%
Lab/section = 250 points or 25% Note: Students must pass the lab portion to pass the entire course.

Grading Scale

92.5 – 100	A	76.5 -- 79.49_	C+
89.5 – 92.49_	A-	72.5 -- 76.49_	C
86.5 – 89.49_	B+	69.5 -- 72.49_	C-
82.5 – 86.49_	B	59.5 -- 69.49_	D
79.5 – 82.49_	B-	0 – 59.49	F

The grading scale above is not necessarily "written in stone", as student performance may dictate a normalizing curve, which might deviate from the numbers presented here. However, this grading scale can be taken as a guarantee that you will receive a letter grade no lower than that which is listed above for a given percentage score range

LAB ATTENDANCE & GRADING:
Please read ALL of the following as you will be held accountable for this information:

Students are expected to attend all labs during the semester; however, we recognize that there may be times when absences occur for various important reasons. Please read the following policies carefully so that you will understand the expectations for attendance in Bio 121 Lab.

1. The Bio 121 lab curriculum consists of 12 lab sessions, a group lab report, and a final lab practical exam.
2. NOTE: There are no lab make-ups. Students MUST attend the lab sessions for which they are enrolled. Students may not sit in on another lab session that they are not registered for in order to make up a missed lab or in anticipation of a lab they expect to miss. It is a violation of the state and university fire codes to have people in a lab class who are not on the roster for that section. There are no provisions for lab make-up sessions in Bio 121.
3. Absence from a lab session due to an ACCEPTED DOCUMENTED REASON (see * below) will not count against the student. The total number of points available will be adjusted and the final percentage will be calculated accordingly.
4. Any absence for reasons other than an ACCEPTED DOCUMENTED REASON (see * below) will be recorded as a zero and will count in the final calculation of grades.
5. Students who are absent for more than 4 lab sessions during the semester FOR ANY REASON (documented or not) cannot receive a passing grade in Bio 121. If you find yourself in this situation, or close to it, you should meet with Professor Winterton or Bev Werner as soon as possible.
6. Students will be held responsible on weekly quizzes for content knowledge of material presented in labs, whether they are present or not, and for all lab sessions on the Final Laboratory Practical Exam. Lab documents are available on Blackboard until the end of the semester.
7. Also NOTE: There is no provision herein for the "dropping" of a lowest grade. No matter what you may hear from any other source, there is no dropping of lowest grades, at all, period. All scores, including zeroes recorded for non-documented absences, will count toward the final

grade.
8. Late policy: Be on time for lab class. This is especially important since there are points that cannot be recovered if you are late. No late assignments will be accepted.
9. Electronic Devices. Use of electronic devices, including cell phones, during any part of lab class is not allowed. We expect you to be engaged in the tasks at hand at all times. Accessing non-course related websites, email, texting or any related activities can in no way be construed as participation or working toward satisfactory completion of lab activities. Therefore, any such activity will result in the loss of ALL participation credit for the entire session (8 points), and may well result in further grade penalties and/or exclusion from the lab.
10. Checking Grades. You will have two BIO 121 Bb areas – one for lecture and one for lab. Lab documents will be obtained through the Lab Documents button of Bb at "BIO.121.Merged.FALL17.General Biology I"; this is also where you will check your grades for exams, lecture participation and extra credit. The Bb link that contains your lab section number, something like M008 (if you are in section 8), is where you will check your lab grades.
11. Turnitin: This class will use the plagiarism detection and prevention system Turnitin for the lab report. You will have the option to submit your papers to Turnitin to check that all sources you use have been properly acknowledged and cited before you submit the paper. I will also submit all papers you write for this class to Turnitin, which compares submitted documents against documents on the Internet and against student papers submitted to Turnitin at SU and at other colleges and universities. I will take your knowledge of the subject matter of this course and your writing level and style into account in interpreting the originality report. Keep in mind that all papers you submit for this class will become part of the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers.

*ACCEPTED DOCUMENTED REASONS:

1. ILLNESS: An absence due to illness requires some written confirmation that the student was seen at a hospital or doctor's office at the time specified.

2. DEATH IN THE FAMILY: An absence due to the death of a relative requires the confirmation of the funeral or memorial event via the presentation of a memorial card, newspaper obituary/notice, or link to online item. Students in this situation deserve our full sympathy and accommodation. Regrettably, however, students have been dishonest about this type of situation in the past and we must therefore require such documentation.

3. RELIGIOUS OBSERVANCE: See policy at the following link. Note that notification must be entered into MySlice before the end of the second week of classes of the semester. http://supolicies.syr.edu/emp_ben/religious_observance.htm

ATHLETIC EVENTS:
Student athletes should NOT assume that athletic activities are accepted documented reasons. If you foresee ANY potential schedule conflict resulting from participation in athletic activities, contact the Course Coordinator (bfwerner@syr.edu) BEFORE THE END OF ADD/DROP (September 5). You may need to enroll in an alternative lab section (for the entire semester)

during which you will not have schedule conflicts. Note #5 above under "Lab Attendance & Grading".

Any changes to athletic travel schedules after Add/Drop, as well as additional travel (due to tournaments, etc.), must be brought to the attention of Bev Werner as soon as possible. Team travel/game play schedules should be given to Bev Werner, in LSC 142, at the beginning of the semester.

Lab Grading Breakdown:
Lab is worth 250 points (25%) of your final grade in BIO 121.

Weekly Labs (12 labs worth 15 points each)	180 points
Enzyme Lab Report	20 points
Lab Practical Exam	50 points
TOTAL POINTS FOR LAB	250 points (or 25% of the final grade)

NOTE: Students must pass lab in order to pass the entire course.

Weekly Lab Points Breakdown:

- Pre-lab assignment: 2 points. You will have a pre-lab exercise to do before class every week. This must be turned in to the TA at the very beginning of class to be eligible to receive credit for it. You may not complete the pre-lab in class. If you do not print your lab documents you will get a zero for this portion of the lab grade.
- Lab quiz: 5 points. Every session will begin with a short quiz. The quiz may cover material from both the previous week's lab and the current week's pre-lab. The quiz will begin at the start of the class session. If you are late to class, you will not get extra time. If you are so late that you miss the quiz, there are no make-ups.
- Lab participation: 5 points. This includes active participation in the lab activities and conversations.
- Discussion participation: 3 points. This includes active participation in discussion, including taking part in class or group discussions and activities.

Enzyme Lab Report:

- During Lab Week 5, week of Oct 4 – 7, you will perform an experiment in lab for which you will write a group lab report.
- You must be in lab to participate in the report.
- The lab report will be due 2 weeks after Lab 5, and must be handed in at the beginning of lab during the week of Lab 7, October 16 – 21. Late labs will have point penalties applied.
- The lab report is worth 20 points.
- Detailed instructions will be provided by your TA ahead of time.
- Turnitin: This class will use the plagiarism detection and prevention system Turnitin for the lab report. You will have the option to submit your papers to Turnitin through Bb to check that all sources you use have been properly acknowledged and cited before you submit the paper. All papers written for this class will be submitted to Turnitin, which compares submitted documents against documents on the Internet and against student papers submitted to Turnitin at SU and at other colleges and universities. Your knowledge of the subject matter of this course

and your writing level and style will be taken into account in interpreting the originality report. Keep in mind that all papers you submit for this class will become part of the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers.

- Students should note that academic integrity policies will apply to lab report grading and should use the link here to check compliance: http://class.syr.edu/wp-content/uploads/2017/01/What-Students-Need-to-Know_7A.pdf

Lab Practical Exam:

- The Lab Practical Exam is an assessment of your understanding of the concepts explored and your mastery of the skills taught during the lab sessions this term. During the exam, which is held during the final scheduled lab period (check calendar at the end of this document), you will rotate through 24 stations at which various representations of items encountered over the semester will be placed. Associated with these items will be questions, the answers to which you will record on a standard form that you will carry from station to station. It's like a mix of the game "musical chairs" and a cumulative final lab quiz. It might even be fun. Good luck!

LECTURE ATTENDANCE & EXAMS:

Please read ALL of the following as you will be held accountable for it:

Attendance at lectures is required.

1. Students will earn credit for PARTICIPATION in the lectures via their TurningPoint personal response device. The "clickers" will be used periodically throughout each lecture to give students opportunities to answer quiz questions, discussion questions, and class surveys. Points will be awarded for responses, so be in class, don't be late, pay attention, and don't leave early. It is each student's responsibility to bring their clicker to lecture, to ensure that it is properly registered and licensed via Blackboard (instructions can be found in the Merged Lecture section of Blackboard, under Tools, Turning Account Registration), that the batteries are working, etc. Please refer to the academic integrity statement regarding the use of clickers and sharing clickers (p. 6 & sharing is not allowed!). There will be no make-ups for missed lectures or for points missed because a student came to class late, forgot to bring their clicker, etc. Up to three scores of zero will be disregarded in the calculation of final clicker grades, which includes absences for any reason.
2. Clicker responses will be recorded and posted to the "Merged Bio" Blackboard site approximately weekly (your patience is appreciated). During the first weeks of the semester, announcements will be posted in Bb when points are posted to the My Grades area of Bb. Students should check the Blackboard (BIO 121 Merged MyGrades button) every week to ensure that their device is registered and functioning properly as reflected by points on Blackboard. Points cannot be awarded retroactively; that means, if a student misses the opportunity to respond to a question with their clicker FOR ANY REASON, including device malfunction, that opportunity is in the past. Accordingly, you should check Blackboard often and attend to any issues you may find as soon as possible if you want to earn points for the next session. Questions about clicker points should always be addressed to Bev Werner, Course Coordinator for Bio 121, either in person in 142 LSC or by email (bfwerner@syr.edu).

3. At the end of the semester, students will be awarded a percentage of the 50 available points based upon the total value of their recorded responses throughout the semester. Hence, the total amount of clicker points a student earns for the course will not be calculated until the course has ended. The percentage of course points available for clicker points is 5% of the total course grade (clicker cannot exceed 5% of the course grade even if the student earns more than 50 pts in total).

Exam Make-up Policy

1. There will be no make-up exams for any reason. Students with Monday evening classes or work schedules should prepare to clear their schedules for Monday evening exams in Bio 121.
2. If a student misses an exam, the point value of the missed exam will be added to the value of the Cumulative Final Exam. For example, if a student misses Exam 1, then the Cumulative Final Exam will be worth 34% of their total course grade. It is not recommended for students to elect to miss an exam except under the rarest and most extreme situations. It would be a very unwise decision to choose to have 34% or more of your grade to rest solely upon your performance on the Cumulative Final Exam unless it is absolutely necessary.
3. If a student takes an exam, the score they earn on the exam will be figured into their grade as shown in the point distribution on p. 3. All earned exam scores contribute to your final grade in Bio 121.
4. Any student who misses as exam (or expects to miss an exam) should email Bev Werner at bfwerner@syr.edu as soon as possible.

Mastering Biology and Extra Credit:

Prior to the first class meeting, all students enrolled in Biology 121 were sent an email indicating that there may be an opportunity for extra credit if they downloaded and read this syllabus in its entirety. Here is how you will obtain that credit:

1. To register for Mastering Biology go to "BIO.121.Merged.FALL17.General Biology I" Blackboard item, click on the button "MASTERING BIOLOGY" on the left side, and follow the instructions for registering and logging into Mastering Biology. You will need the access code purchased with the textbook (SU Bookstore edition). IF YOU HAVE TECHNICAL DIFFICULTIES PLEASE CONTACT PEARSON TECHNICAL SUPPORT AS LISTED ON THE LOGIN PAGE OF MASTERING BIOLOGY. We have found their technical support to be far superior to any assistance we can give. However, if you have contacted them and found your issues unresolved, please email Bev Werner at bfwerner@syr.edu.
2. Log into Mastering Biology via Blackboard, and complete the assignment titled "Introduction to Mastering Biology". If you complete this assignment prior to the first lecture at 10:35 AM on August 28, 2017, you will earn extra credit toward your homework percentage. If you complete the assignment after this time, you may earn a smaller amount of extra credit.
3. After completing the "Introduction to Mastering Biology", you should understand how to access and complete online homework assignments. You will have Mastering Biology assignments each week, and all together, they will comprise 10% (or 100 points) of your final grade for Biology 121. You may see your homework scores in the "My Grades" section of Mastering Biology throughout the semester, but they will not appear in Blackboard until the end

of the semester. At the end of the course, your total, final percentage score from Mastering Biology will determine how many of the 100 points for homework you have earned, and these will be added to your final grade at that time.

4. Each week, you will be required to download and print your laboratory documents from Blackboard. You can expect to sometimes have to do something first, however, before you can access the document. For example, we may post a survey or questionnaire, and you must answer all of the questions before you will be able to download the lab documents. Of course, it may be the case that you would just decide to have a friend download the documents for you or make copies. This wouldn't always be a good practice, as sometimes pre-labs may differ between different lab sections, especially if we're trying something new. However, for those who complete the surveys to access the lab documents on their own, they will receive one extra point toward their final grade per survey completed.

Note, however, that we use these surveys for evaluation of course components, and they are important to us. We need you to consider your responses carefully and answer honestly. Blackboard automatically keeps track of how long students take to complete a questionnaire. Extra credit will only be awarded to those students who complete a survey in sufficient time to indicate they actually thought about their responses.

5. There may be limited opportunities for extra credit in the form of student participation in online surveys that help the professor to evaluate various aspects of the course. There will also be extra credit opportunities involving participation in Peer-Led Team Learning (PLTL) sessions. PLTL participation will be explained by email and through Blackboard. Participation in surveys and PLTL will be the only form of extra credit available. No other form of extra credit is expected, and unsolicited proposals for extra credit will not be entertained. Therefore, all students are advised not to have expectations that a substantial amount of extra credit will be offered. If you have expectations for yourself as to what grade you would like to earn, you should plan to earn it by doing as well as you can on the regular course components.

6. These are the only opportunities for extra credit in Biology 121. There are no other opportunities for extra credit, and no other possibilities will exist for extra credit, so take heed now, and don't ask later.

ACADEMIC INTEGRITY STATEMENT

(From SU Office of Academic Integrity and also available at this web address: http://academicintegrity.syr.edu/suggested-syllabus-language/.)

"Syracuse University's academic integrity policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The university policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of participation in class activities. The policy also prohibits students from submitting the same written work in more than one class without receiving written authorization in advance from both

instructors. The presumptive penalty for a first instance of academic dishonesty by an undergraduate student is course failure, accompanied by a transcript notation indicating that the failure resulted from a violation of academic integrity policy. The presumptive penalty for a first instance of academic dishonesty by a graduate student is suspension or expulsion. SU students are required to read an online summary of the university's academic integrity expectations and provide an electronic signature agreeing to abide by them twice a year during pre-term check-in on MySlice. For more information and the complete policy, see http://academicintegrity.syr.edu."

From your professor: There are certain aspects of Biology 121, which bear particular address with regard to academic integrity. Namely, Turning Point response devices ("clickers") are to be registered to one, and ONLY one, student during the semester. Use of a clicker by a student to whom the device is not registered will be considered to be a serious breach of academic integrity. Any student involved in such activity will face swift and firm disciplinary action. DO NOT USE A TURNINGPOINT RESPONSE DEVICE THAT YOU ARE NOT PERSONALLY REGISTERED TO USE IN THIS CLASS. Periodically, the number of students actually in attendance will be checked against the number of devices that respond to questions. Should the number of "clickers" responding exceed the number of students in attendance; NO ONE will receive credit for that session.
Syracuse University sets high standards for academic integrity. Any suspected incident of academic integrity will be subject to review. If a student is found to have committed an academic integrity violation, the resulting consequences can range in severity, up to and including failure of the course and expulsion from the University. For additional information, please see http://class.syr.edu/wp-content/uploads/2016/12/Academic-Integrity-Policy-Violation-and-Sanction-Classification-Rubric.pdf

Additional Related Links:
The Academic Integrity Policy: http://class.syr.edu/wp-content/uploads/2017/05/Academic-Integrity-Policy_final.pdf

ACCOMMODATIONS (INCLUSION POLICY)

If you believe that you need accommodations for a disability, please contact the Office of Disability Services (ODS), http://disabilityservices.syr.edu, located at 804 University Avenue, Room 309, or call (315) 443-4498 for an appointment to discuss your needs and the process for requesting accommodations. ODS is responsible for coordinating disability-related accommodations and will issue students with documented disabilities "Accommodation Authorization Letters," as appropriate. Students must apply each semester they enroll in classes and expect to utilize these services. Since accommodations may require early planning and generally are not provided retroactively, please contact ODS as soon as possible. Students in Bio 121 with "Accommodation Authorization Letters" must submit these to Bev Werner, Bio 121 Course Coordinator, in room 142 as soon as possible; no appointment is needed.

Syracuse University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. My goal is to create learning environments that are useable, equitable, inclusive and welcoming. If there are aspects of the instruction or design of this course that result in barriers to your inclusion or accurate assessment or achievement, I invite any student to meet with me to discuss additional strategies beyond accommodations that may be helpful to your success.

SAFE SPACE

The classrooms and communities of Biology 121 are intended to be safe spaces for students of all identity groups. The course professor agrees with the vision, mission, and values of the SU LGBT resource center and endeavors to conduct the course under its Statement of Allyship http://lgbt.syr.edu/about/mission.html. The professor and course staff expect and are expected to foster an environment of mutual respect for and between all students.

FAITH TRADITION OBSERVANCES:

http://supolicies.syr.edu/emp_ben/religious_observance.htm

Students who expect to be absent from campus and/or Bio 121 class components due to observing a religious holiday on a class day need to register their anticipated absence via the "My Religious Observances" link, under the Student Services section of MySlice as per the policy at the link above. Note that this anticipated absence must be registered via MySlice before the end of the second week of classes. Students should also consult pp. 4 – 5 of this syllabus for specific Bio 121 policies. Our policies are designed to be fair to all students enrolled in Bio 121 and to give full disclosure to those students that expect to be absent occasionally and also to ensure the academic integrity of the 4 credit tuition value we offer to each student. If you have any questions please contact Bev Werner, Bio 121 Course Coordinator, at bfwerner@syr.edu.

Appendix H

SYRACUSE UNIVERSITY
PLTL LEADERSHIP TRAINING I (BIO 221)-Course Syllabus, Fall 2017

Tuesday 11:00-11:55am (LSC 126); Thursday 9:30-10:25 pm (LSC 011)
Instructor: Dr. Julia J. Snyder
Office: Heroy 105
Office Hours: Thursday 10:30-11:30am
Email: jjseymou@syr.edu
Phone: (315)443-2038

PREREQUISITE / CO-REQUISITE:
Consent of Instructor

AUDIENCE:
Undergraduates who have demonstrated success (grade of B or higher) in a course for which they will now serve as peer leaders.

CREDITS
1-2
For two credits, students will also complete an additional final project.

COURSE DESCRIPTION
BIO 221-Peer-Led Team Learning Leadership Training I, 1-2 credits
Training in peer leadership for undergraduate biology courses. Relates educational research literature on students and learning to classroom applications in problem solving activities. Leadership of a 1-hour problem solving session each week for undergraduates in a course the student has previously taken.

LEARNING OBJECTIVES
- To provide training and support for peer leaders of Biology Workshop sessions.
- To effectively lead small groups of peers/near-peers in problem-based learning workshops.
- To relate problem-based team learning to constructivist learning theory and other aspects of student and group development.
- To exhibit mastery of content of mentored course and communicate these concepts to fellow undergraduates.

REQUIRED MATERIALS
- Textbook: Peer-Led Team Learning- A Handbook for Team Leaders will be provided, but MUST BE RETURNED AT THE END OF SEMESTER.
- Additional readings will be distributed via Blackboard (Bb). All students must access the course Bb page to obtain assigned readings, view course announcements, and participate

in online discussions or other activities.

REQUIREMENTS:
Weekly attendance and participation in a one-hour training class and leading of a one-hour peer-led team learn session. Weekly reflective journaling. Online discussion groups. Students taking the course for two credits will complete a project and presentation.

BIO 221 GRADING
Point Distribution (out of 500 points)
1. Class attendance and participation (140 points or 28%)
2. Leading of PLTL Workshop Sessions (120 points or 24%)
3. Weekly journals (120 points or 24%)
Each week, you will write a journal entry and reflect on what your workshop was like and how it relates to the weekly reading, as well as submit an attendance roster (Ex. What you did, how your students responded, how the problems worked, what went well, what could have gone better, how your students interacted with you and each other, etc.).
4. Blackboard discussion groups (120 points or 24% for students taking the course for 1-credit; 60 points or 12% for students taking the course for 2-credits)
5. Project (60 points or 12% for students taking the course for 2-credits)
The project will be done with a partner. Using various teaching and learning strategies discussed throughout the semester, you will design a problem set related to a topic not covered during the semester. You will then present your problem set to a group of peers.

Grading Scale

92.5-100	A	77.0-79.49	C+
89.5-92.49	A-	72.5-76.99	C
86.5-89.49	B+	69.5-72.49	C-
82.5-86.49	B	59.5-69.49	D
79.5-82.49	B-	0-59.49	F

ATTENDANCE POLICY
Attendance in class and Workshops is required. During class each week, peer leaders will work with the instructor to discuss various learning techniques and engage in problem-solving sets that will be done in Workshop sessions. For this reason, it is imperative that you do NOT miss class. However, I recognize that absences may occur for various reasons. If you must miss class or a Workshop session, you must contact me as soon as possible so that I can make other arrangements for your Workshop session if necessary. As a leader, you CANNOT decide to cancel or reschedule your session without my permission.

1. Absence from class or a Workshop session due to an ACCEPTED DOCUMENTED REASON* will not count against the student. The total number of points available will be adjusted and the final percentage will be calculated accordingly.

2. Any absence for reasons other than an ACCEPTED DOCUMENTED REASON will be recorded as a zero and will count in the final calculation of grades.

****Students who are absent for more than 4 classes and/or Workshop sessions during the semester FOR ANY REASON cannot receive a passing grade in BIO 221***.**

*****ACCEPTED DOCUMENTED REASONS:

1. ILLNESS: An absence due to illness requires some written confirmation that the student was seen at a hospital or doctor's office at the time specified.
2. DEATH IN THE FAMILY: An absence due to the death of a relative requires the confirmation of the funeral or memorial event via the presentation of a memorial card, newspaper obituary/notice, or link to online article. Students in this situation deserve our full sympathy and accommodation. Regrettably, however, students have been dishonest about this type of situation in the past and we must therefore require such documentation.
3. FAITH TRADITION OBSERVANCE: Please refer to the SU policy below.

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(From SU Office of Academic Integrity and also available at this web address: http://academicintegrity.syr.edu/suggested-syllabus-language/.)

"Syracuse University's academic integrity policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The university policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of participation in class activities. The policy also prohibits students from submitting the same written work in more than one class without receiving written authorization in advance from both instructors. The presumptive penalty for a first instance of academic dishonesty by an undergraduate student is course failure, accompanied by a transcript notation indicating that the failure resulted from a violation of academic integrity policy. The presumptive penalty for a first instance of academic dishonesty by a graduate student is suspension or expulsion. SU students are required to read an online summary of the university's academic integrity expectations and provide an electronic signature agreeing to abide by them twice a year during pre-term check-in on MySlice. For more information and the complete policy, see http://academicintegrity.syr.edu/"

In BIO 221, there are certain aspects that must be addressed with regard to academic integrity. As leaders, you will record attendance and participation points for the students enrolled in your PLTL sessions. Points should only be awarded to students who are BOTH present and participating. Awarding points to students that are not actually present at the sessions will be considered a breach of academic integrity. In addition, submission of journal entries for sessions that you did NOT hold will also be considered a breach of academic integrity. A summary of what happened throughout the session cannot be written in a journal response if the session was not held. Any leader involved in such activity will be reported to the Academic Integrity Office. Periodically, unannounced visits may be made to the PLTL sessions.

DISABILITY-RELATED ACCOMMODATIONS

If you believe that you need accommodations for a disability, please contact the Office of Disability Services (ODS), http://disabilityservices.syr.edu, located in Room 309 of 804 University Avenue, or call (315) 443-4498, TDD: (315) 443-1371 for an appointment to discuss your needs and the process for requesting accommodations. ODS is responsible for coordinating disability-related accommodations and will issue students with documented Disabilities Accommodation Authorization Letters, as appropriate. Since accommodations may require early planning and generally are not provided retroactively, please contact ODS as soon as possible.

DIVERSITY AND DISABILITY:

Syracuse University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. My goal is to create learning environments that are useable, equitable, inclusive and welcoming. If there are aspects of the instruction or design of this course that result in barriers to your inclusion or accurate assessment or achievement, I invite any student to meet with me to discuss additional strategies beyond accommodations that may be helpful to your success.

FAITH TRADITION OBSERVANCES

SU religious observances notification and policy, found at http://hendricks.syr.edu/spirituallife/index.html, recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holidays according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance provided they notify their instructors before the end of the second week of classes for regular session classes and by the submission deadline for flexibly formatted classes.

For fall and spring semesters, an online notification process is available for students in **My Slice / StudentServices / Enrollment / MyReligiousObservances / Add a Notification.** Instructors may access a list of their students who have submitted a notification in My Slice Faculty Center.

STUDENT ACADEMIC WORK POLICY

SU policy on student academic work may be found at:
http://coursecatalog.syr.edu/content.php?catoid=3&navoid=270#Student_Academic_Work

Student work prepared for University courses in any media may be used for educational purposes, if the course syllabus makes clear that such use may occur. You grant permission to have your work used in this manner by registering for, and by continuing to be enrolled in, courses where such use of student work is announced in the course syllabus.

Educational use of student work: I intend to use academic work that you complete this semester for educational purposes in this course during this semester. Your registration and continued enrollment constitute your permission.

Educational use of student work: I intend to use academic work that you complete this semester in subsequent semesters for educational purposes. Before using your work for that purpose, I will either get your written permission or render the work anonymous by removing all your personal identification.

Week of	Topic	Reading Assignment
August 28	Introductions to PLTL/Leader Expectations	Chs. 1-3; PLOS Biology and CBE-Life Sciences Ed Articles
September 4	Role of a peer leader/Getting a group started; Biological Molecules Problem Set	Ch. 5
September 11	Teaching Tools/Questioning Techniques; Cell Membranes and Transport Problem Set	Ch. 6; Vygotsky and PLTL
September 18	Learning Theory/Vygotsky; Metabolism and Cellular Respiration Problem Set	Self-Regulation and Making the Grade Articles
September 25	Student Development/Perry; DNA, RNA, and Protein Synthesis Problem Set	Ch. 4; Complete Roger's Indicator of Multiple Intelligences
October 2	Learning Styles/Multiple Intelligences; Mitosis and Meiosis Problem Set	Communication by Asking Questions and Communication in Small Group Learning Articles
October 9	Communication; Mendelian Genetics Problem Set	Problems with Word Problems Articles
October 16	Problem Solving Strategies; Population Genetics Problem Set	Pgs. 72-78 and 80-82; Stages of Group Dynamics Article
October 23	Group Development; Plant Diversity Problem Set	Motivation-Richard Article
October 30	Learning Theory/Motivation; Animal Diversity Problem Set	Chs. 7 and 8
November 6	Diversity; Evolution of Vertebrates Problem Set	Biology in Bloom Articles
November 13	Bloom's Taxonomy/Problem Set Project; Ecology Problem Set	Reflections by a Reserved Workshop Leader and From PLTL to Professional Articles
November 20	Thanksgiving Break-No Class	
November 27	Reflective Teaching; Ecology Case Study Problem Set	Problem Set Project
December 4	Project Presentations/Wrap Up	

Note: Schedule of Topics/Problem Sets is Subject to Change.

Table 1

Results of Mixed Design ANOVA Testing Differences in SALG Scores Reported By Both Peer Leaders and Students

Source	SS	df	MS	F	P	partial η^2
Between-Subjects						
Leader	26291	35	751	1.57	.041*	.326
Error	54245	113	480			
Within-Subjects						
Scores (Student v. Leader)	11043	1	11043	24.1	.000*	.176
Scores*Leader	30872	35	882	1.93	.005*	.374
Error	51686	113	457			

Note. Significant at the $p<0.05$ level.

Table 2

Results of Two-Way ANOVA Testing for the Effect of Relating to the Peer Leader and Student Major on Student Perceived Learning Gains

Source	SS	df	Mean-square	F	P
STEM Major	3	1	3	.01	.943
Relatability	2932	1	2932	5.18	.025*
STEM Major:Relatability	47	1	47	.08	.775
Error	63447	112	566.49		

Note. Significant at the $p<0.05$ level.

Table 3

Frequencies of students by final course grade, whether the student relates to their peer leader, and student major

		BIO 121 Grade	
		AB	CDF
All Participants	Not Relatable	17	19
	Relatable	112	56
STEM Major	Not Relatable	5	4
	Relatable	34	9
Non-STEM Major	Not Relatable	5	6
	Relatable	31	22

Note. Major information was not available for all students in the sample.

Table 4

Results of Two-Way ANOVA Testing for the Effect of Considering the Peer Leader a Role Model and Student Major on Student Perceived Learning Gains

Source	SS	df	Mean-square	F	P
STEM Major	539	1	539	1.05	.308
Role Model	2125	1	2125	4.13	.044*
STEM Major:Role Model	1482	1	1482	2.88	.092
Error	57051	111	513.97		

Note. Significant at the $p<0.05$ level.

Table 5

Frequencies of students by final course grade, whether the student considers their peer leader to be a role model, and student major

		BIO 121 Grade	
		AB	CDF
	Not a Role Model	27	21
	Role Model	102	51
STEM Major	Not a Role Model	9	4
	Role Model	30	9
Non-STEM Major	Not a Role Model	10	8
	Role Model	26	19

Note. Major information was not available for all students in the sample.

Figure 1.

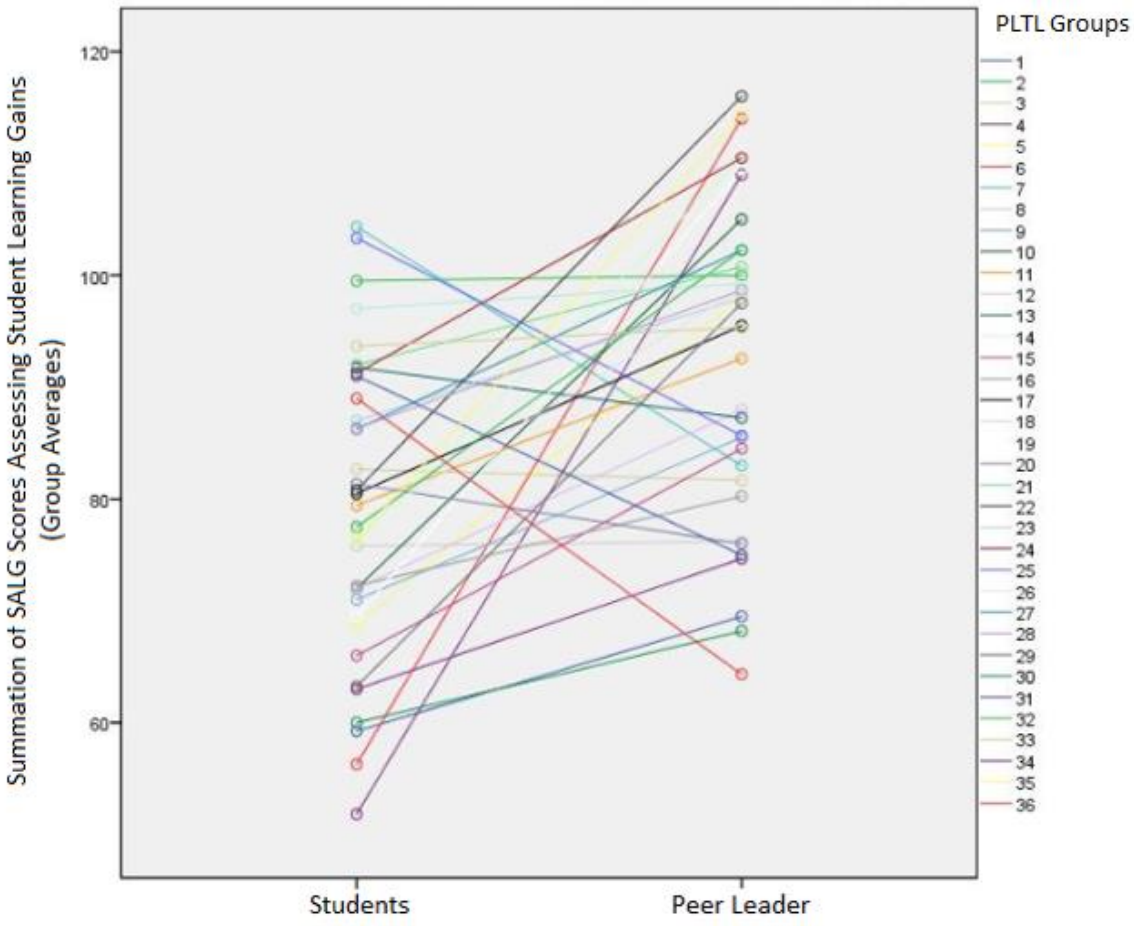

Figure 1. Comparison of mean student SALG scores for PLTL groups by student SALG scores and peer leader assessments of student SALG scores. The data plotted are the average SALG score reported by all of the students in each PLTL group as compared to the average SALG score assigned to each student by the peer leader of their group. Thirty-six peer leader and student groupings are displayed. Testing shows students and leaders significantly differed in their assessment of the students' learning gains $F(1,113) = 24.1$, $p < .001$, this difference significantly differed by leader, $F(35,113) = 1.93$, $p = .005$, and students in different PLTL groups had significantly different SALG scores $F(35,113) = 1.57$, $p = .041$.

Figure 2.

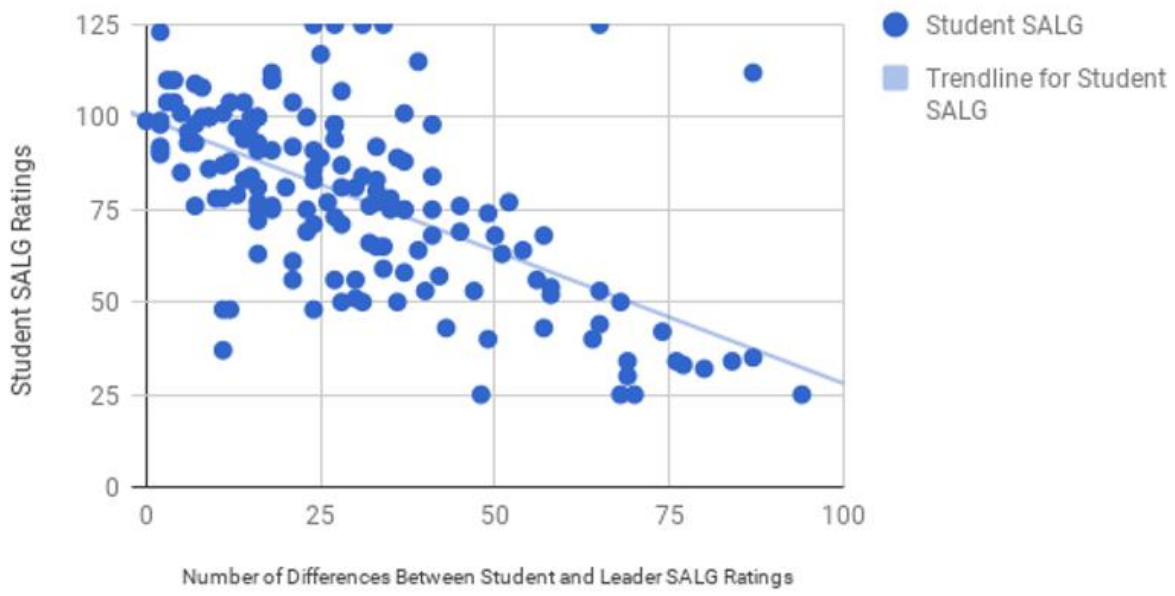

Figure 2. Student SALG ratings versus differences in student-leader paired SALG responses. Summation of student self-assessed SALG score increases as the number of differences found between student and leader ratings of the student learning gains decreases. When tested statistically, there is a significant relationship between the number of differences in SALG ratings and student SALG ratings ($p \ll 0.001$).

Figure 3.

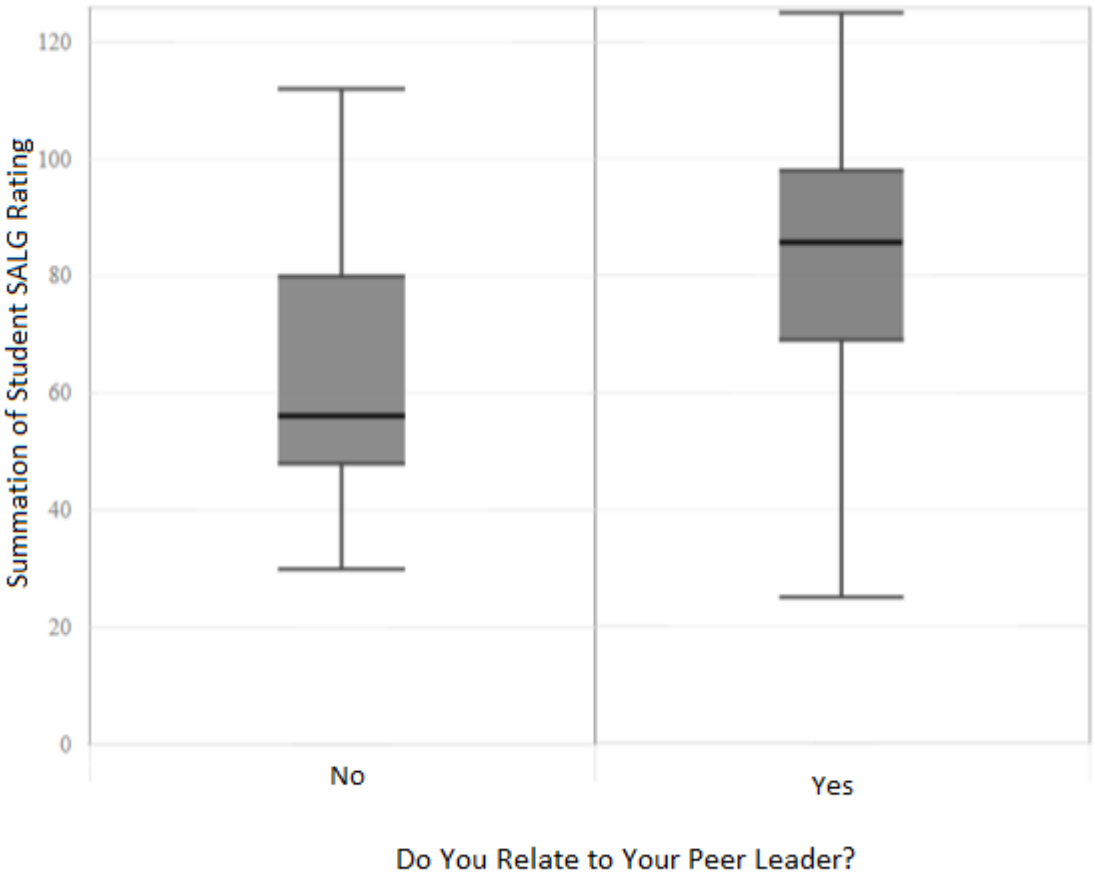

Figure 3. The effect of peer leader relatability on student perceived learning gains in PLTL. This figure illustrates the differences in self-assessed learning gains between groups of students who relate to the peer leader and those who do not (p=.0248).

Figure 4.

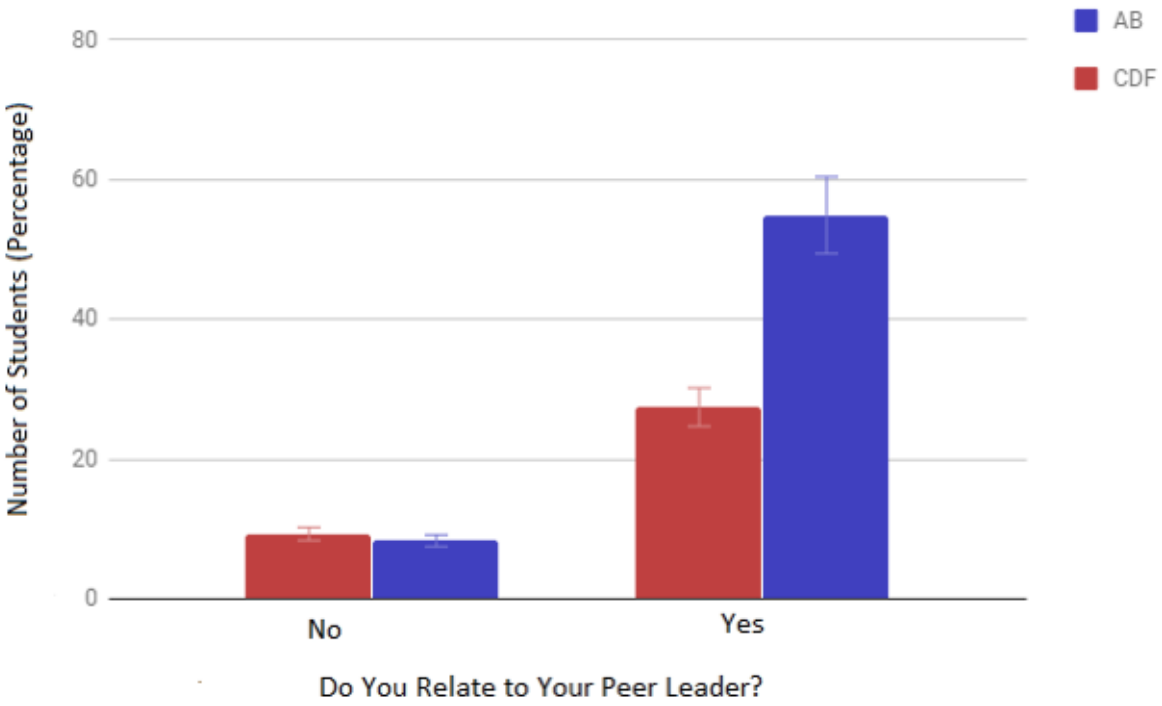

Figure 4. BIO 121 course grades versus relating to the peer leader. This figure illustrates the student's final course grade in BIO 121, with error bars indicating the standard error of the percent. During the Fall 2018 semester and shows differences in grades (AB or CDF) for students who relate to their peer leader and those who do not (p=.029).

Figure 5.

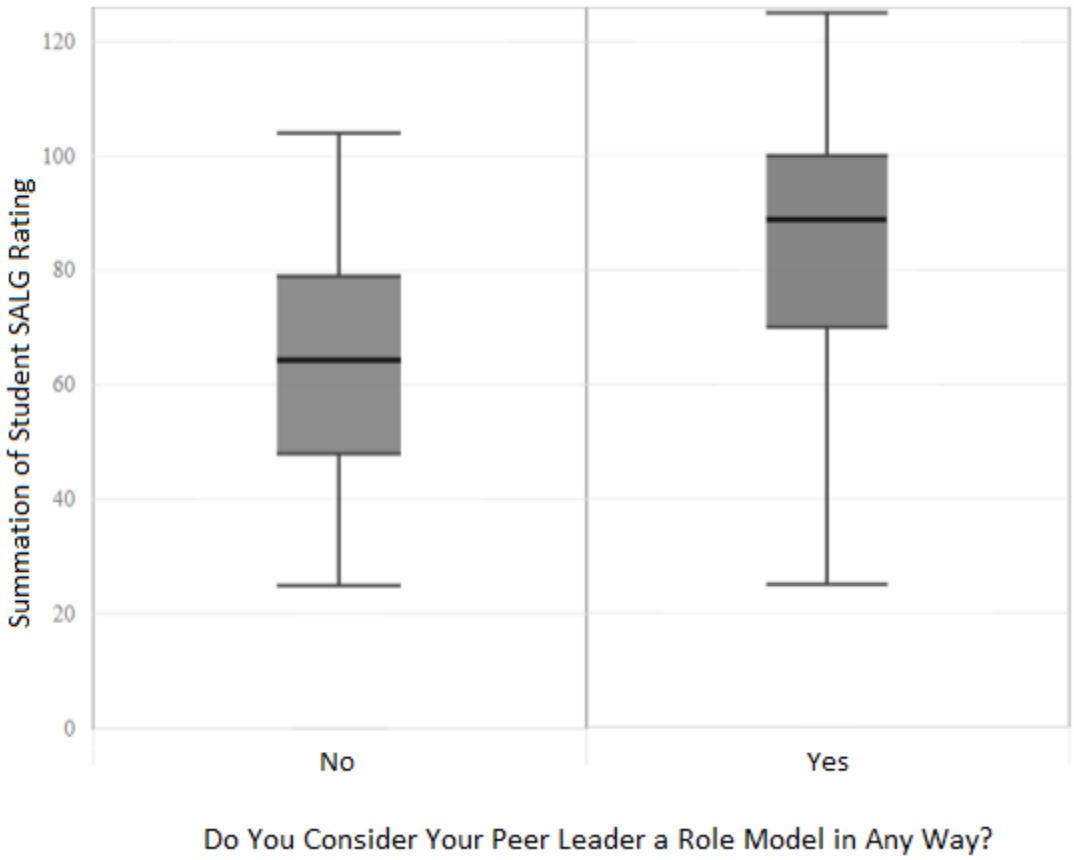

Figure 5. The effect of considering the peer leader a role model on student perceived learning gains in PLTL. This figure illustrates the differences in self-assessed learning gains between groups of students who consider their peer leader to be a role model and those who do not (p=0.044).

Figure 6.

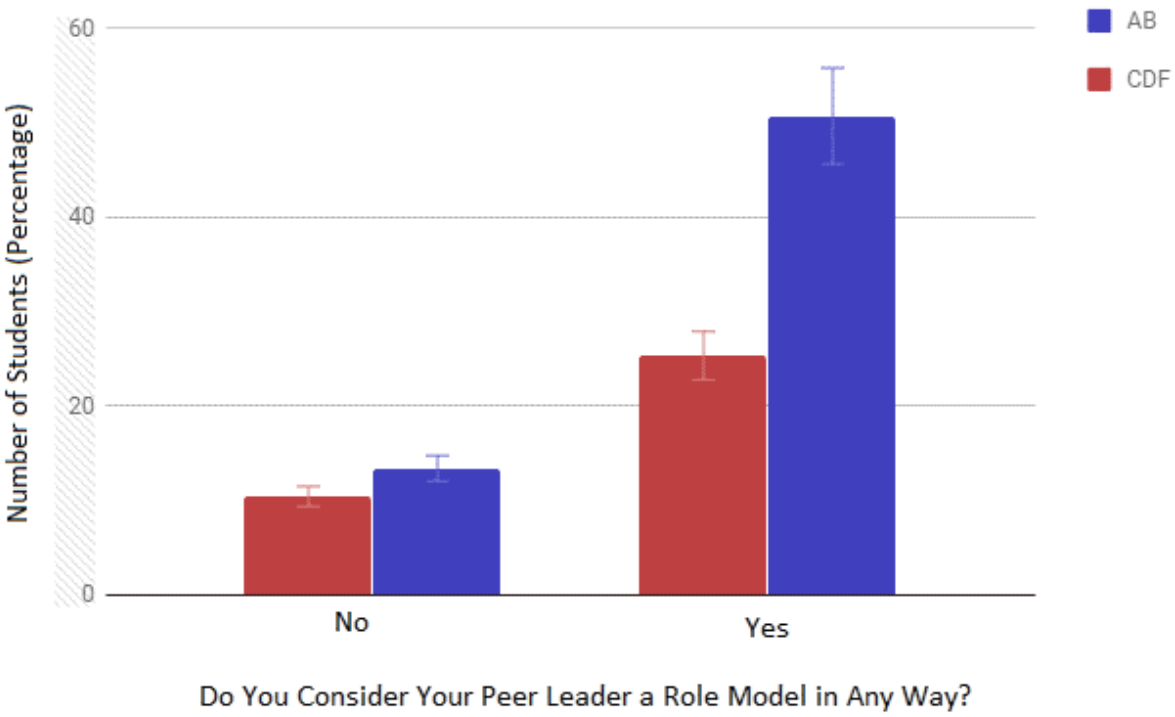

Figure 6. BIO 121 course versus consider the peer leader to be a role model. This figure illustrates the student's final course grade in BIO 121, with error bars indicating the standard error of the percent. During the Fall 2018 semester and shows differences in grades (AB or CDF) for students who consider their peer leader to be a role model and those who do not (p=.257).

Figure 7.

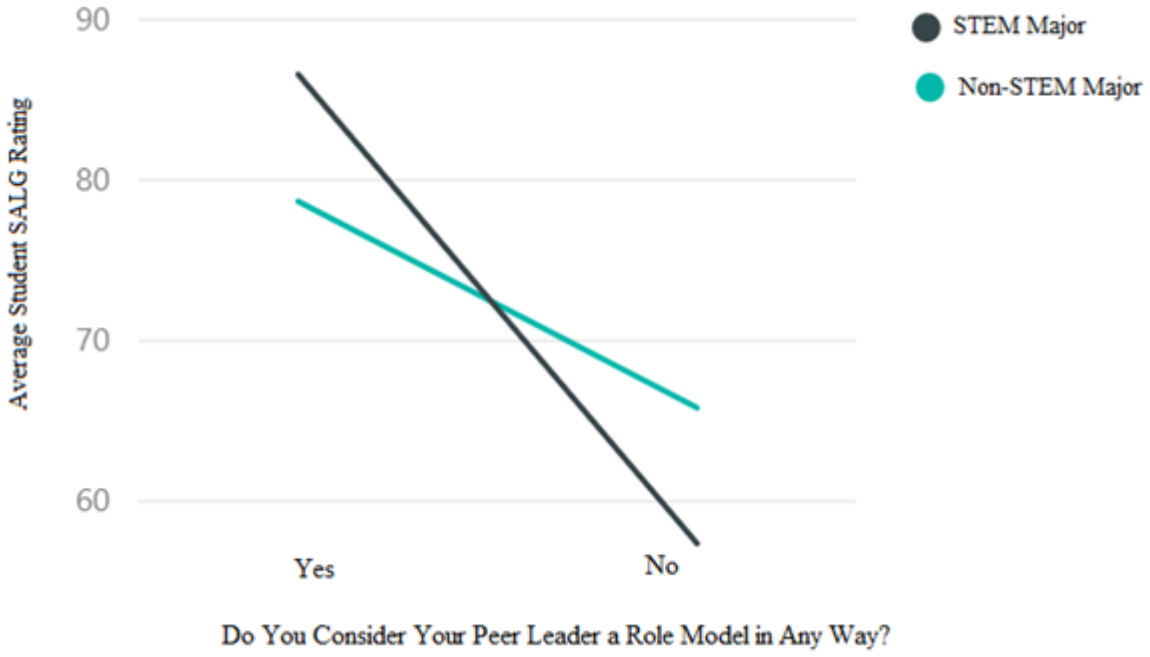

Figure 7. Interaction of student major and considering the peer leader a role model on the outcome of student perceived learning gains. This figure illustrates the trend that a peer leader who is considered to be a role model by their students has a stronger yet statistically insignificant (p=.092) influence on the student perceived learning gains of STEM majors as compared to non-STEM majors.

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Professional Affiliations
Future Professoriate Program
Women in Stem and Engineering (WISE)

Education
Ph.D., College Science Teaching
Syracuse University, 2018
Concentration: Educational Theory

M.S., Forensic Science, Syracuse University, 2013
Concentrations: Genetics, DNA, Evolution, Comparative Anatomy

B.S., Biology, Syracuse University, 2011
Integrated Learning Major, Forensic Science, 2011
Capstone: DNA Degradation, Inhibition, and Contamination

Experience

Lecturer, Fall 2017
Syracuse University, Syracuse, NY
Course: General Biology

- Designed an engaging, informative, and interactive teaching curriculum
- Modernized examination questions, laboratory experiments, and homework assessments
- Gained familiarity with online applications such as Blackboard, Starfish, and Mastering Biology (Pearson)
- Coordinated with departments across campus such as Office of Disability Services, Athletics, Registrar, and Health Services
- Managed 16 laboratory teaching assistants, course coordinator, and laboratory coordinator
- Collaborated with learning specialists to implement Peer Led Team Learning and active learning assessments in the course
- Posted grades and responded to student emails within 24 hours
- Held well-attended office hours and hosted weekly meetings with course coordinators and Teaching Assistants
- Wrote letters of recommendation and offered guidance to students
- Resolved conflicts amongst students and other members of the course

Advanced Placement Biology Instructor, September 2015-June 2016
Manlius Pebble Hill School, Manlius, NY
Course: AP Biology

- Incorporated the nature of science into lessons to expand on suggested curriculum
- Motivated students, encouraged original thinking, and adhered to College Board standards
- Supervised laboratory activities, calibrated equipment, demonstrated proper use of tools
- Assessed learning and adapted teaching methods to engage all students
- Faculty sponsor for extracurricular activities such as Science Olympiad and the science fair
- Advised high school seniors and juniors about future academic choices

Adjunct Professor, Fall 2015, 2016
SUNY Oswego, Oswego, NY
Course: Genetics

- Overcame obstacles typical to adjunct positions by utilizing online tools such as Blackboard
- Developed supplemental laboratory content to aid in lessons
- Provided prompt feedback to online and written assessments
- Evaluated and critiqued weekly laboratory reports
- Conducted all laboratory meetings for the upper level biology course
- Held office hours and wrote letters of recommendation for students

Teaching Assistant/Active Learning Leader, Fall 2011- Spring 2017
Syracuse University, Syracuse, NY
Courses: Molecular Biotechnology Laboratory, General Biology Laboratory I & II, Questions and Quests: Physical Phenomena II

- Designed new laboratory documents, procedures and experiments implemented University-wide
- Performed guest lecturer duties with active learning methods for 600+ students
- Created lesson plans and proctored exams
- Developed exam questions in accordance with Bloom's taxonomy
- Corrected student laboratory techniques and demonstrated proper use of equipment
- Emphasized safety and reinforced course concepts during laboratories
- Communicated concepts and ideas effectively through lectures, presentations, and activities
- Provided students with prompt feedback on assignments and reports
- Wrote letters of recommendation and held office hours
- Monitored student participation, assigned final grades, and wrote progress reports

Syracuse University Project Advance Tutor and Orientation Leader, Spring 2016; Summers 2012-Present
Bishop Grimes Jr./Sr. High School & Syracuse University, Syracuse, NY
Course: Biology

- Host orientation for high school teachers who will be adapting the Syracuse University Biology course for teaching in a high school setting
- Explain syllabi, demonstrate laboratories, suggest adjustments from college level to high school level
- Provide overview of main concepts and objectives of the General Biology course at Syracuse University
- Correct misconceptions and explain underlying biological concepts
- Tutored juniors and seniors in a participating SUPA high school
- Held group tutoring sessions as well as provided one-on-one help

Laboratory Instructor, 2012, 2015; Summer 2014-2016
University College, Syracuse, NY
Courses: General Biology I, General Biology II

- Instructed undergraduates and adults returning to college and adjusted teaching methods and pace of the course accordingly
- Supervised laboratory work, enforced safety rules, submitted final grades
- Utilized technology to clarify topics through lectures, presentations, and activities
- Monitored laboratory participation, graded assignments and provided prompt feedback
- Maintained inventory and ordered laboratory supplies

Substitute Teacher, April 2014-August 2016
Syracuse City School District, Syracuse, NY

- Performed teaching duties in innercity classrooms at elementary and middle schools on a per diem basis
- Interacted with and motivated underrepresented students
- Created a classroom environment that was safe and conducive to learning
- Adjusted instructional methods to fit the diverse needs of each class and grade-level
- Maintained a neat and orderly classroom

Forensic Science Instructor, Summer 2012-2013
Blueprint Signature Summer Programs
Stonehill College Campus, Easton, MA

- Spearheaded the Forensic Science program as the first instructor of Forensic Science at Massachusetts location
- Designed a curriculum and original lesson plans, for both the laboratory and lecture portions of course
- Created and organized laboratory experiments for students to perform
- Provided support for high school students preparing for college
- Served as an advisor for students interested in math and science and participated in panel discussions

Pharmacokineticist, 2013-2014
ICON Development Solutions, Whitesboro, NY

- Perform assays on biological samples from pre-clinical and clinical trials for pharmaceutical and biotechnology projects
- Complete assays for routine batch analysis of biomarkers in biological fluids/chemical matrix involving simple to complex analytical techniques.
- Achieve FDA and GXP standards on all laboratory work
- Generate high quality results and confidently report that all analytical data are reliable
- Ensure calibration, maintenance, and proper operation of laboratory equipment and instrumentation systems
- Followed supervisor instructions, validated methods, and company or client SOPs in a satisfactory manner
- Effectively utilized computer programs to organize, review, and present scientific findings and data

Presentations and Publications

Winterton, C. Dissertation. "Peer Led Team Learning: The Effect of Peer Leader to Student Interactions on Student Learning Gains and Course Achievement". Pending.

Winterton C., Wiles J. "Peer Leaders as Potential Role Models and the Impact on Perceived Student Learning Gains". Society for the Advancement of Biology Education Research (SABER) Conference. Upcoming. July 27-29, 2018.

Sloane, J., Snyder, J., Dunk, R., Winterton, C., Shmid, K., & Wiles, J. "Peer-Led Team Learning Improves Minority Student Retention in STEM Majors" (Pending). A discussion of effective pedagogy increasing the presences of underrepresented minorities in the STEM fields.

Winterton, Christina and Cecilia Leonard, M.D., "Road Rage and the Insanity Defense" (Pending). A historical account of courtroom cases involving aspects of road rage and the success of various pleas and positions taken by the defense.

Snyder, J., Sloane, J. Dunk, R., Winterton, C., Wiles, J. "The Influence of Peer-Led Team Learning on the Recruitment and Retention of Underrepresented Minority Students in STEM Majors". National Association for Research in Science Teaching. Presentation at annual conference April 22-April 25, 2017.

Winterton, C. (2016). "Practice Gel Reduces Risk and Cost of Student Laboratory Activity". Association of College & University Biology Educators. Poster presentation and demonstration at annual conference October 21-22, 2016.

Salge, E. B. (2015). *Careers: The graphic guide to finding the perfect job for you* Library Journals, LLC. (Special Thanks as Christina Giovinazzo)

Giovinazzo, C. & Wiles, J. (2014). "Traxoline and Student Learning". Contributing author to research presented at a conference evaluating the research and learning methods of undergraduates and their degree of reliance on internet resources.

Giovinazzo, C., Zalepeski, L., Hu, M., Fillion, S., Aquafondata, C., Fondy, T. (2011). "Preferential Physical Destruction of Human Promyelocytic U037 Leukemia Using Ultrasound". Presentation at Syracuse University undergraduate research symposium.

Awards and Honors

- Certificate of Undergraduate Teaching
- Dean's Scholarship
- Dean's List
- SMART Grant (Science and Mathematics Access to Retain Talent)
- Spring 2011 Capstone: DNA Degradation, Contamination, and Forensic Analysis
- 2011 Research Award from SU Department of Biology

Skills, Certifications and Qualifications

- Certificate of Undergraduate Training
- Certificate of Safe Environment Training
- State of New York (SUNY) Training and Certificates
- Chemical Hygiene Plan Certification
- Greenhouse Safety Training
- Conflict Resolution
- Microsoft Office Suite
- Curriculum Design & Syllabi Development
- Exam & Laboratory Construction
- Blackboard, Starfish, Angel
- Active Learning & Communication Skills
- Data Analysis (SPSS, SEM, Qualtrics)
- Student Advising