THE EFFECT OF LEAD TUTORING AT APPALACHIAN STATE UNIVERSITY ON GRADES AND STUDENT CONFIDENCE

by

Jordan A. Carter

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Approved by:

Jennifer Perry Cecile, Ph.D., Thesis Director

A. Lee Cope, II, Second Reader

Jefford Vahlbusch, Ph.D., Dean, The Honors College

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ABSTRACT

Chemistry is an incredibly difficult, yet vitally important, subject for students to learn. Students face challenges such as difficulties in visualizing problems, connecting difficult subjects, and switching between the macroscopic and microscopic levels. Supplemental instruction (SI) is a method to combat these challenges and increase student success in high risk classes. Supplemental instruction is unique from private tutoring. It creates a consistent and safe environment over the course of the semester for students to return to in order to work closely and develop a relationship with a SI instructor. SI leaders encourage collaborative learning and bring strategies to students for mastering course material. SI participation has been found to significantly increase the grades earned in a class. At Appalachian State University, the SI model has been implemented for chemistry classes. The program is a part of University Tutorial Services (UTS) and is called LEAD Tutoring. The LEAD Tutoring program has many objectives including to increase student grades through better understanding of course materials and to teach skills that will impact students long term. In Fall 2019, the LEAD program had record high participation numbers in comparison to recent years. With no increases in resources for UTS or the LEAD program, it is important that the increased participation and strain on tutors did not negatively impact the enrichment quality of the program or hinder the ability of the program to reach its objectives.

In order to ensure that all objectives of the program were met, data collected by UTS on student grades and participation in the LEAD program was analyzed. Additionally, information was extracted from optional student surveys. In Fall 2019, visits had increased by 72.0%, tutoring hours had increased by 88.6%, and unduplicated headcount had increased by 32.9% from Fall 2018. In Fall 2019, the average GPA points awarded for students who participated in LEAD

tutoring (SI) was statistically different from those who did not participate in LEAD tutoring (non-SI). This was consistent with prior semesters Fall 2017 and Fall 2018. Additionally, Fall 2019 saw the largest increase in GPA points awarded between SI and non-SI of 0.54 points. When analyzing overall grade distributions, the data from Fall 2019 statistically agreed with previous semesters. An analysis of grade distributions taking SI and non-SI into consideration for Fall 2019 showed a statistical difference between the two, with the SI bell curve shifted towards higher grades (A/B). This was not a statistical difference displayed in Fall 2018 or Fall 2017. Additionally, when analyzing SI distributions by participation level, the distributions for 8+ sessions attended and 1 to 4 sessions attended were not statistically different from Fall 2018 to Fall 2019. Lastly, through analysis of survey answers, the LEAD program continued to provide the same rate of improving study skills and increasing student confidence from Fall 2018 to Fall 2019. Overall, the data indicates that not only did the additional strain on the program not negatively impact enrichment, but that LEAD also had a more positive impact in Fall 2019 than in previous years.

INTRODUCTION

Chemistry is defined by the Oxford English Dictionary as "the branch of science that deals with the identification of the substances of which matter is composed; the investigation of their properties and the ways in which they interact, combine, and change; and the use of these processes to form new substances." It is a very complex definition to encapsulate the subject at the very center of our material universe. What is in the air and water? How can energy be harvested and stored? How can more productive, less harmful pharmaceuticals be developed? At the heart of each of these important questions is chemistry. While many people will not be solving those questions, there is no shortage of chemistry applications in their life. For example, chemistry could

explain why diet sodas are not really that good for you, what building materials would be best for your new house, or why the power bill so high. Additionally, chemistry courses are often prerequisites for advanced level science classes and are required courses for a variety of subjects including nursing, pre-medical, physics, astronomy, geology, and biology. Therefore, it is critically important to be able to teach and communicate chemistry topics effectively.

DIFFICULTIES IN TEACHING CHEMISTRY

Chemistry is known to many students as the most daunting and difficult subjects they will face in their academic career. They enter the class with a negative perception of chemistry, which can put additional strain on reaching success.[2] In addition to that negative perspective, there are a number of challenges in teaching chemistry that can cause problems for both students and instructors. Because so much of chemistry occurs on a molecular level, students have difficulty visualizing concepts. Rather than truly visualizing concepts, like watching an apple drop in a physics class, students are left to learn chemistry concepts through various representations.[4] While students may be able to combine solutions in lab, visualizing or balancing the reaction happening on a microscopic level could prove difficult. Additionally, chemistry concepts constantly "interplay between the macroscopic and microscopic levels of thought" which typically causes problems for beginner chemistry students in mastering topics such as the mole, atomic structure, kinetics, and thermodynamics.[6]

In a survey of students and instructors, a number of problems were brought to light.[2] Problems were divided into "Faculty-Controlled Factors" and "Student-Controlled Factors." Faculty-controlled factors included problems such as chemistry is too abstract, the math is too hard, it is not applicable to my life, and there were not enough examples/applications done in class.

Student-controlled factors included problems such as lack of involvement in the material, not completing additional practice problems, lack of background information, and insufficient mathematical skills.

SUPPLEMENTAL INSTRUCTION

For the sake of student success, a solution was needed. Many colleges rely on a widely adopted academic program called supplemental instruction (SI). The SI model focuses on high risks classes,[1] such as chemistry, rather than focusing on high risk students which provides a source of unbiased help for all students. High risk classes are those in which over 30 % of students receive a grade of D, F, or Withdrawal. For those identified classes, a student who has previously excelled in the course is assigned as an SI leader. That student then attends the lecture of the class, works closely with the professor, and runs SI sessions. There are a few important characteristics that make the SI model unique from private tutoring. SI sessions will begin during the first week of classes to be available during the most foundational topics. During sessions, leaders will encourage students to both ask and answer questions, rewarding all answers. In doing this, they create an open and safe environment for students, in which they feel more able to disclose weaknesses and ask for help when needed.

Moreover, while completing all lectures and course work, SI leaders take on the illusion of being a peer of students. The result is SI leaders acting as session facilitators rather than acting as a second professor. In acting as facilitators, they encourage collaborative learning and move away from the tradition tutor relationship that often results in dependence and reduced transfer of academic skill. Last and most importantly, SI leaders bring strategies for mastering course content.

With all of the characteristics, SI leaders achieve both goals they were charged with, communicating both "what to learn" and "how to learn."[1]

These characteristics help combat many of the problems in teaching chemistry that are discussed above. In the SI environment, SI leaders take the time to complete additional practice problems and open the floor to students. They can spend additional time on math review and chemistry fundamentals when that time may not have been available in lecture. The personable environment can help students be open to receiving help and subsequently become more invested in their own learning. Lastly, SI leaders can help explain difficult chemistry concepts to students in terms they can apply to their own lives or careers.

The SI model has been approved by the U.S. Department of Education as an effective intervention method to improve student grades and ultimate success rate[1]. It has been shown that there is a positive relationship between attending SI sessions and higher grades. In a study performed by Congos and Schoeps (1993), students who utilized the SI program had significantly higher grades than those who did not attend SI programs despite the fact there was not a significant difference in SAT scores or motivation levels of the two groups[3]. This information suggests that the change in grades is a result of SI attendance, rather than student motivation or inherent ability. Additionally, a study by Hensen and Shelley (2003) found that students in introductory chemistry, biology, mathematics, and physics courses who participated in SI earned a significantly higher percentage of A and B grades, while earning significantly fewer F and withdrawal grades[5]. In this paper, SI students had lower ACT scores on average entering college than the non-SI group, yet still scored significantly higher grades. This supports the assertion above that grades were increased as a result of SI attendance, rather than inherent ability.

LEAD TUTORING: OVERVIEW

At Appalachian State University, the SI model has been applied for chemistry classes since the year 1998. In 2012, the program was named "LEAD Tutoring." LEAD Tutoring is a program offered through Appalachian State's Student Learning Center (SLC) and is managed in the department University Tutorial Services (UTS). UTS offers a variety of services including small group tutoring (the traditional tutoring model), walk-in help labs, and LEAD tutoring. The Department of Chemistry and Fermentation Sciences has readily accepted and supported the LEAD tutoring program. At Appalachian State University, introductory chemistry classes are often used as "weed out" classes for programs such as nursing and nutrition.

The acronym, LEAD, stands for learning enhancement across disciplines. At Appalachian State, LEAD tutors are assigned to a specific class section. All class sections of Introductory Chemistry I and II, Organic Chemistry I and II, Fundamentals of Organic Chemistry, Physical Chemistry I and II, and Biochemistry I and II have a LEAD tutor assigned to them when a qualified one is available. LEAD tutors are all undergraduate students who have previously succeed in that particular class and are approved by the class professor. Tutors attend class lectures with students, and then host two interactive study sessions per week. They work closely with professors to provide personalized supplemental instruction for a particular professor. LEAD tutoring replaces the typical small group tutoring for all chemistry courses. Tutors are paid for 12 hours of work per week: 3 for attending lecture, 3 for hosting LEAD sessions, 5 for planning LEAD sessions, and 1 for hosting office hours. The LEAD program only differs from the typical SI model in a few ways due to logistical constraints. In order to book rooms for LEAD sessions, sessions typically start the second week of classes rather than the first week of classes. Additionally, LEAD tutors are observed every few weeks rather than every week due to staffing limitations of UTS.

At the beginning of each semester a comprehensive training is provided for all tutors. In that training there is a focus on both technical and tutoring skills. Technical training includes learning skills such as tracking paid hours and logging students in for sessions, which is important for tracking participation. Tutor training is much more in depth and focuses skills such as writing worksheets and developing lesson plans for a wide range of learning styles. Tutors are encouraged to be creative in sessions in order to reach all students. Additionally, students are encouraged to engage in discussions, to answer questions, and ask their own questions.

On multiple occasions throughout the semester, LEAD tutors are observed by UTS leadership staff during their sessions. They are evaluated on how they interact with students, how well they are able to communicate their thoughts, on their ability to engage students in meaning, and additional criteria. These evaluations are used as feedback for the tutor to then improve upon their actions during LEAD sessions and to more effectively achieve the objectives of the LEAD program.

LEAD TUTORING: OBJECTIVES AND FOCUS

The LEAD program has multiple objectives. The first and most obvious is to help students improve their understanding of the course material and subsequently improve their grade in the course. Next, the program strives to bring students of different backgrounds together to discuss important concepts in a variety of ways. Lastly, the program strives to teach students skills that will impact them long-term. This includes improved organization and study habits, along with increased student confidence.

Over many years, the LEAD program has seen periods of change and growth. In the Fall semester of 2019, the program hit a record high when compared to recent years. However, high

participation does not automatically indicate that all of the goals of the program have been met. Additionally, resources for the UTS and the LEAD program have not increased, which puts additional strain on the LEAD tutors. In this paper, I will be comparing data from Fall 2019, to the previous semesters Fall 2018, Fall 2017, and Fall 2016. I will test for a significant difference between the average GPA of SI and non-SI groups. Additionally, I will be comparing the GPA point improvement of SI to Non-SI groups across years to ensure the supplemental quality is comparable. I will then test for comparability across years for grade distribution by both SI vs Non-SI groups and by number of times participate in SI sessions. The goal of this statistical testing is to ensure the enrichment quality of the program has not decreased and that the overall goals of the program are still being met.

METHODS

At the end of every semester, UTS collects and reports data on all students enrolled in a chemistry class with an assigned LEAD tutor. That data is collected through the online tutoring platform, TutorTrac, which is owned by Redrock Software Corporation. This data is used internally by UTS. The data set provided breaks down information by class section and professor. For each section, an average grade point average (GPA) points awarded for the class was calculated for those that attended LEAD (SI group) and those that had no LEAD attendance (non-SI group). These average GPA point calculation did not factor in withdrawals. Additionally, grades were broken down into A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F, or W based on SI and Non-SI groups. Lastly, grades were broken down into A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F, or W based on number of LEAD sessions attended throughout the semester.

P-value tests were used to find statistical differences in comparable data sets. Chi squared tests were used to find statistical differences in distributions. A confidence interval of 95% was set and a significance threshold of $\alpha = 0.05$ was utilized.

Survey data for student study skills and confidence levels were collected from end of semester surveys. These are optional surveys sent out to every student regardless of their participation in LEAD and no incentive was provided to complete the survey. Data from each class and tutor was individually collect. Results were compiled and converted into percentages for the purposes of analysis in this paper. Answers for each question were sorted into two categories: Positive ("Yes") and Negative ("No" and "Unsure").

There are a few limitations that arise from the data set utilized. Overall withdraw data was underrepresented. If students were to withdraw before the official drop date set by Appalachian State University, they would not be included in the data set provided by TutorTrac. The total withdraw number provided by the chemistry department could not be utilized as the SI or Non-SI groups could not be assigned. Additionally, the results of this analysis would not be directly comparable to Spring semester data. The chemistry department teaches different amounts of classes for each semester. For example, in Fall 2019, there were ten sections of introductory chemistry I and only four sections of introductory chemistry II. In Spring 2019, there were 4 sections of introductory chemistry I and ten sections of introductory chemistry II. Students taking introductory chemistry II in the fall were considered "off semester" students and were likely students who were retaking the class. Additionally, upper level chemistry classes such as physical chemistry and biochemistry have more enrolled students in the fall. The difference in class availability and difficulty make the two semesters hard to compare. Lastly, no pre-entry data, such as SAT, ACT, or motivation levels of students was analyzed.

DATA

As shown in Table 1, the participation in LEAD sessions according to the metrics of visits, hours, and unduplicated headcount had been declining from Fall 2016 to Fall 2018. Across metrics, there was an average decrease of 15% from Fall 2016 to Fall 2017 and an average decrease of 30% from Fall 2017 to Fall 2018. However, in Fall 2019 visits had increased by 72.0%, tutoring hours had increased by 88.6%, and unduplicated headcount had increased by 32.9% from Fall 2018. These changes were independent of the number of chemistry students enrolled in classes with LEAD tutoring, as those numbers stayed consistent across all four semesters.

Table 1: LEAD participation data by semester for visits, hours and unduplicated headcount

Semester	Chemistry Students Enrolled in Classes with LEAD	Visits	Hours	Unduplicated Headcount
Fall 2019	1341	5015	6504	912
Fall 2018	1381	2915	3448	686
Fall 2017	1440	4174	5324	894
Fall 2016	1376	5036	6388	955

Table 2 displays GPA points awarded for the chemistry classes separated by whether a student attended at least one SI (LEAD) session during the semester. As shown in the table, Fall 2019 had the largest difference between SI and non-SI GPA points awarded. A p-value test was run on the SI versus non-SI data for each year to show a statistical difference between the SI and non-SI GPA. P-values of 0.0073, 0.0013, and 0.0125 for Fall 2019, Fall 2017, and Fall 2016 respectively showed a statistical difference between the two data sets for each semester. A p-value of 0.0778 for Fall 2018 showed that there was not a significant difference between SI and non-SI groups.

Table 2: SI and Non-SI GPA award analysis across semesters

Semester	SI GPA Points Awarded	Non-SI GPA Points Awarded	GPA Difference between SI and Non-SI	p-value, SI and Non-SI data sets
Fall 2019	2.47	1.93	0.54	0.0073
Fall 2018	2.47	1.98	0.49	0.0778
Fall 2017	2.44	2.09	0.35	0.0013
Fall 2016	2.52	2.32	0.20	0.0125

The distribution of grades earned by chemistry students for Fall 2019, Fall 2018, Fall 2017, and Fall 2018 is displayed below in Figure 1 with percentage values displayed in Table 3. This distribution includes all students regardless if they attended an SI session or not. The distribution of grades for Fall 2019 was compared to the distributions of the previous three semesters using a chi squared test. P-values of 0.997 and 0.989 were calculated when comparing Fall 2019 with Fall 2018 and Fall 2017 respectively. These values indicated that the Fall 2019 distribution was not statistically different than either of the previous years. However, when Fall 2019 and Fall 2016 data was compared, the chi squared test yielded a p-value of 0.0022 indicating those two distributions were statistically different.

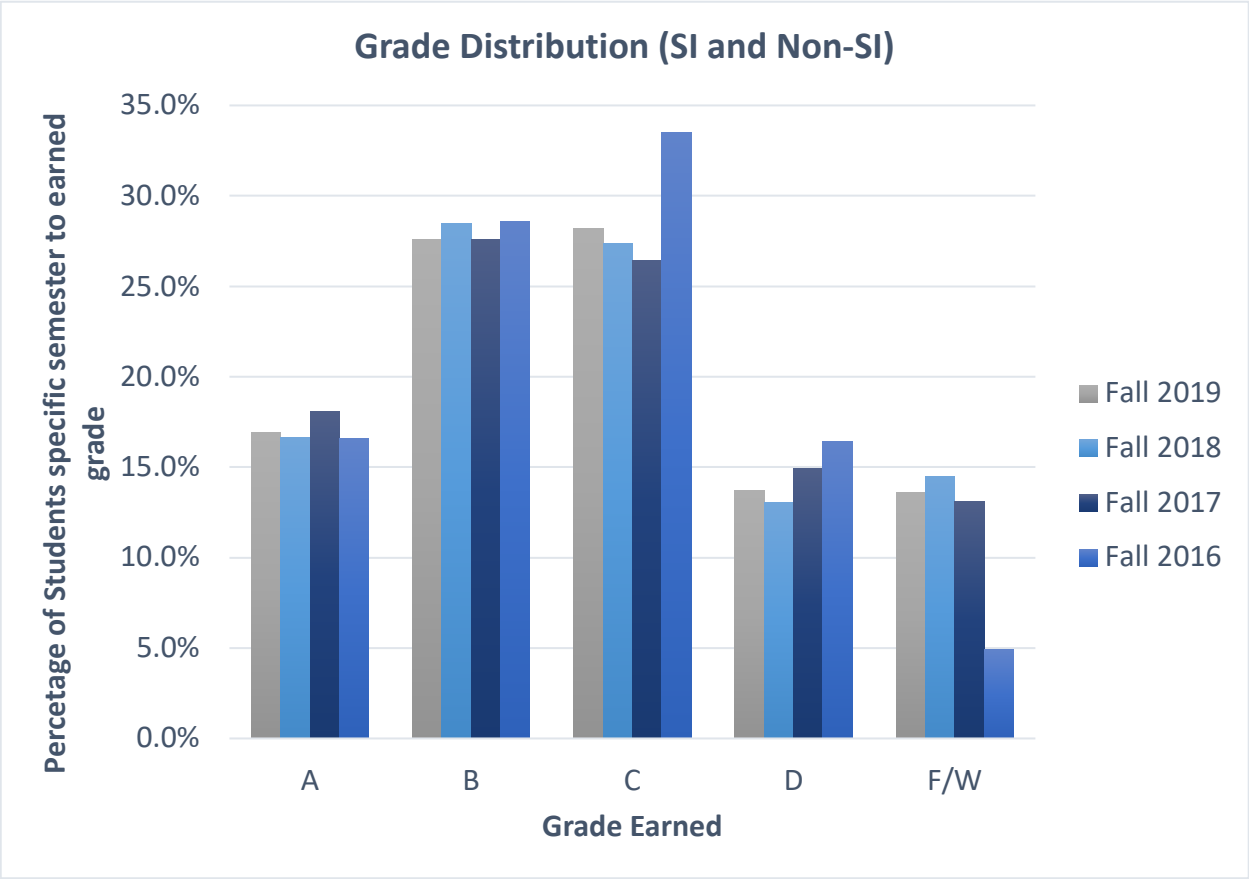

Figure 1: Overall (including SI and non-SI) grade earned distribution analysis for Fall semesters

Table 3: Overall (including SI and non-SI) grade earned distribution analysis for Fall semesters

Semester	A	B	C	D	F/W
Fall 2019	16.9%	27.6%	28.2%	13.7%	13.6%
Fall 2018	16.7%	28.5%	27.4%	13.0%	14.5%
Fall 2017	18.1%	27.6%	26.4%	14.9%	13.1%
Fall 2016	16.6%	28.6%	33.5%	16.4%	4.9%

The grade distribution between SI and Non-SI groups is displayed below in Figure 2 with percentage values displayed in Table 4. A chi squared test comparing the SI and non-SI distributions from Fall 2019 data yielded a p-value of 0.0036, indicating there was a statistical

difference between the distributions. Figure 2 supports this analysis, as the SI "Grade Earned" bell curve is sifted further right than that of the non-SI group.

Table 4 also displayed grade distribution data comparing SI and non-SI groups for Fall 2018, Fall 2017, and Fall 2016. A chi squared test yielded p-values of 0.0690, 0.3305, and 0.016 for Fall 2018, Fall 2017, and Fall 2016 respectively. The test failed to find a statistical difference between the SI and non-SI distributions for Fall 2018 and Fall 2017; however, the SI and non-SI distributions in Fall 2016 were found to be statistically different. Lastly, Figure 3 compares the SI distributions across semesters. It is visually shown that the bell curves for Fall 2019 and Fall 2016 are shifted further left toward the A and B grade earned than Fall 2018 and Fall 2017.

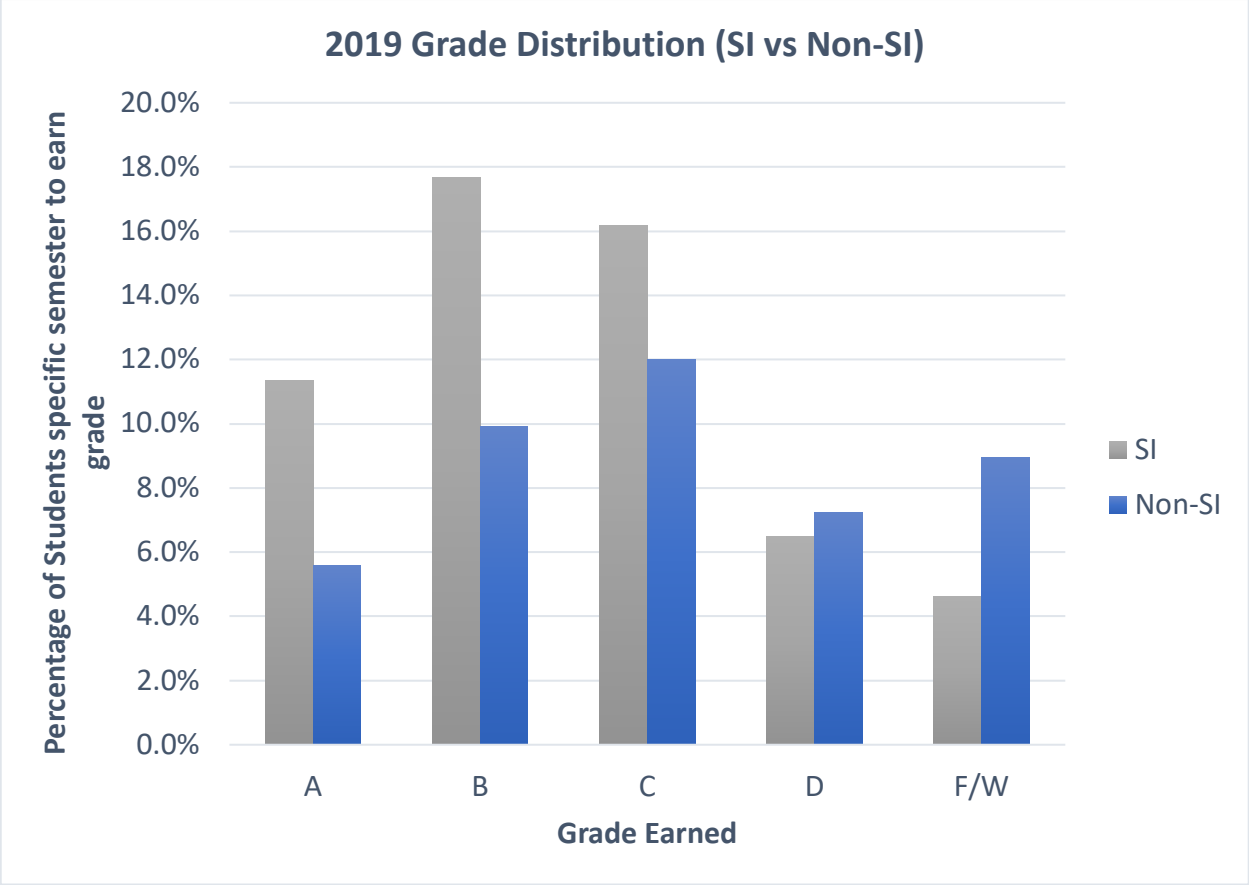

Figure 2: SI versus Non-SI grade earned distribution for Fall 2019

Table 4: SI versus Non-SI grade earned distribution for Fall 2019

Semester	Type	A	B	C	D	F/W	p-value
Fall 2019	SI	11.3%	17.7%	16.2%	6.5%	4.6%	0.0036
Fall 2019	Non-SI	5.6%	9.9%	12.0%	7.2%	8.9%	
Fall 2018	SI	9.6%	17.2%	15.5%	5.5%	4.6%	0.0690
Fall 2018	Non-SI	7.1%	10.9%	12.2%	7.7%	9.6%	
Fall 2017	SI	10.6%	15.6%	14.3%	6.9%	4.7%	0.3305
Fall 2017	Non-SI	7.4%	12.0%	12.1%	8.1%	8.3%	
Fall 2016	SI	10.2%	18.4%	19.8%	8.6%	1.7%	0.016
Fall 2016	Non-SI	6.5%	10.2%	13.7%	7.8%	3.0%	

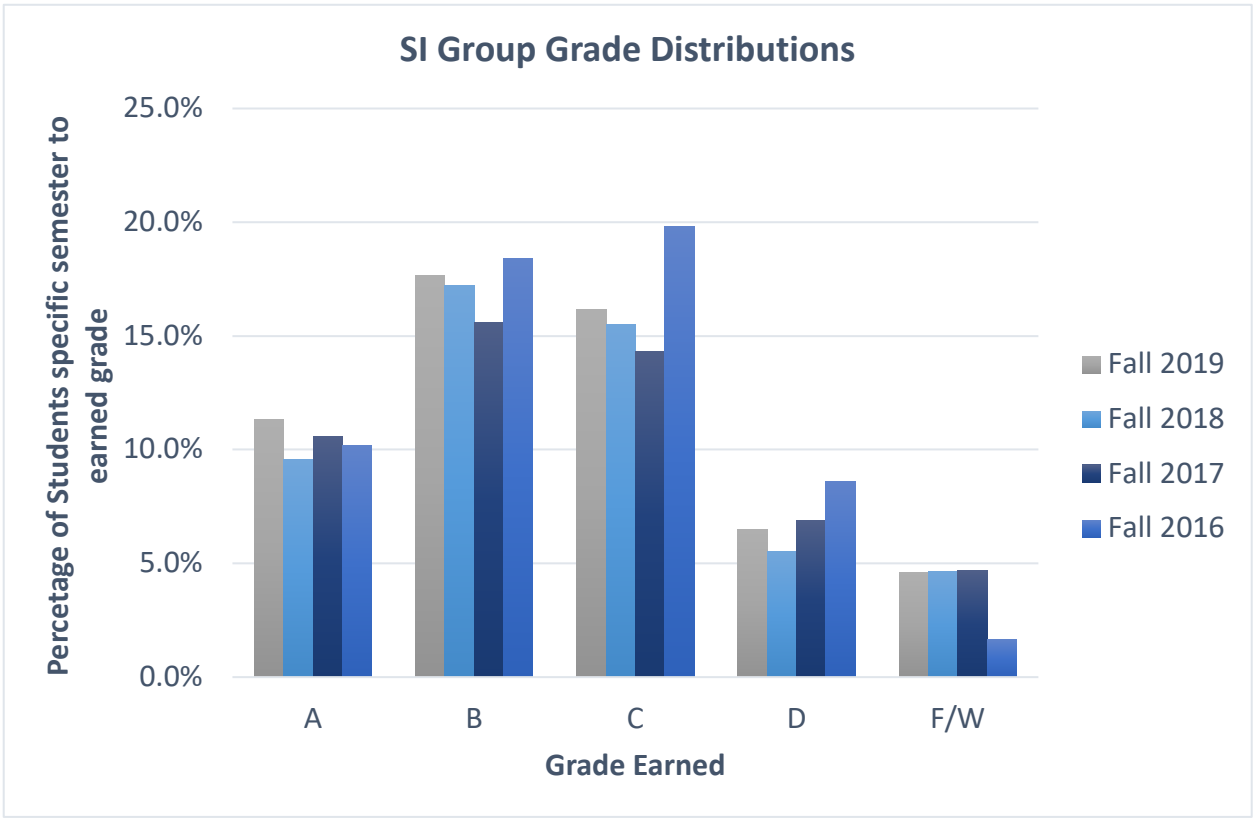

Figure 3: SI grade earned distributions for Fall semesters

Grade earned distributions were also produced by the number of SI sessions attended by a student. Attendance was split into three levels: 8+ sessions attended, 5 to 7 sessions attended, and 1 to 4 sessions attended. Non-SI data was completely excluded from this analysis. The time of attendance was not included as a factor. Figure 4 displays this grade earned distribution for Fall 2019. A chi squared test between the grade distribution of those who attended 8+ sessions and 1 to 4 sessions yielded a p-value of 0.00016. This p-value indicates there is a statistical difference between the distributions. Additionally, in Figure 4 the bell curve of grades earned is shifted to the left for those who attended 8+ sessions in comparison to those who attended 1 to 4 sessions.

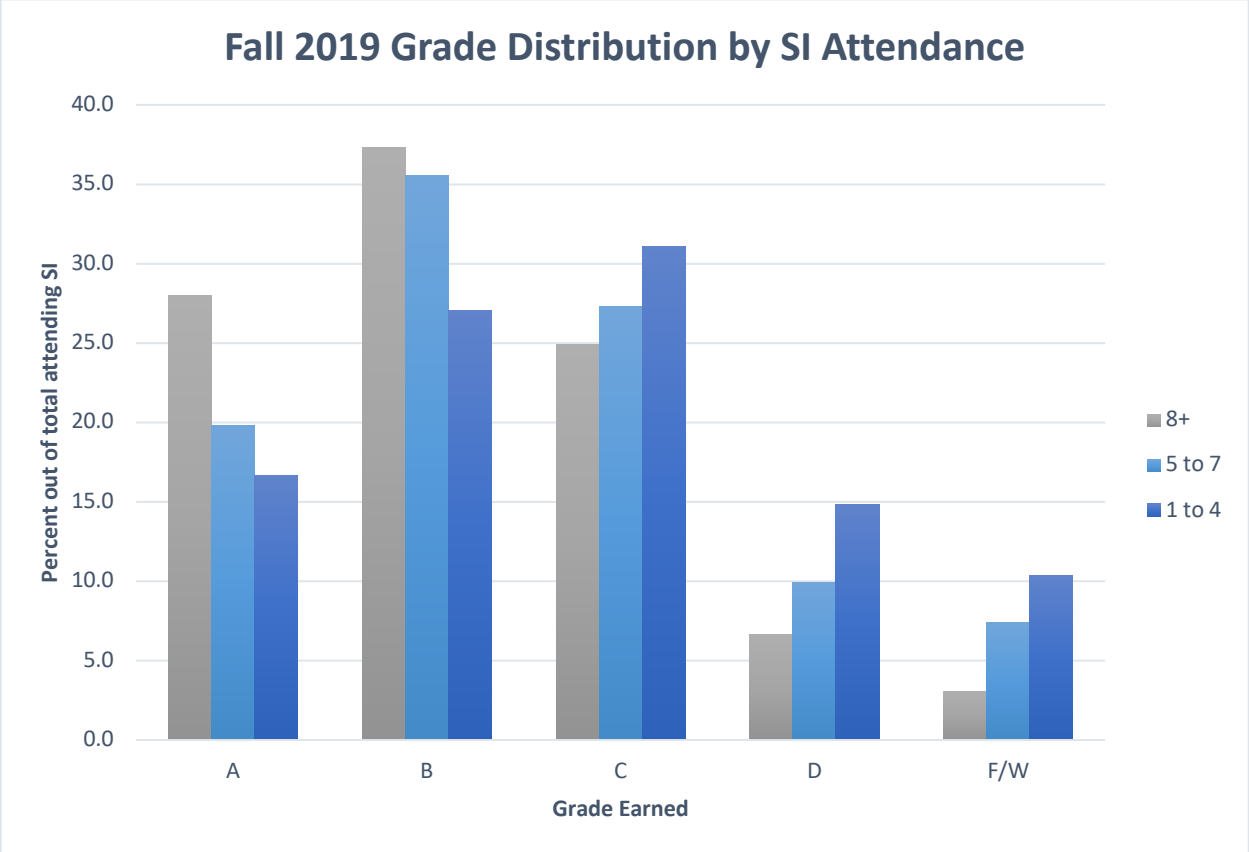

Figure 4: Grade earned distributions for SI group based on number of SI sessions attended for Fall 2019

Figure 5 displays similar distribution of grades earned by number of SI sessions attended for Fall 2018. A chi squared test between the grade distribution of those who attended 8+ sessions

and 1 to 4 sessions yielded a p-value of 0.000020. This p-value indicates there is a statistical difference between the distributions. Additionally, in Figure 5 the bell curve of grades earned is shifted to the left for those who attended 8+ sessions in comparison to those who attended 1 to 4 sessions.

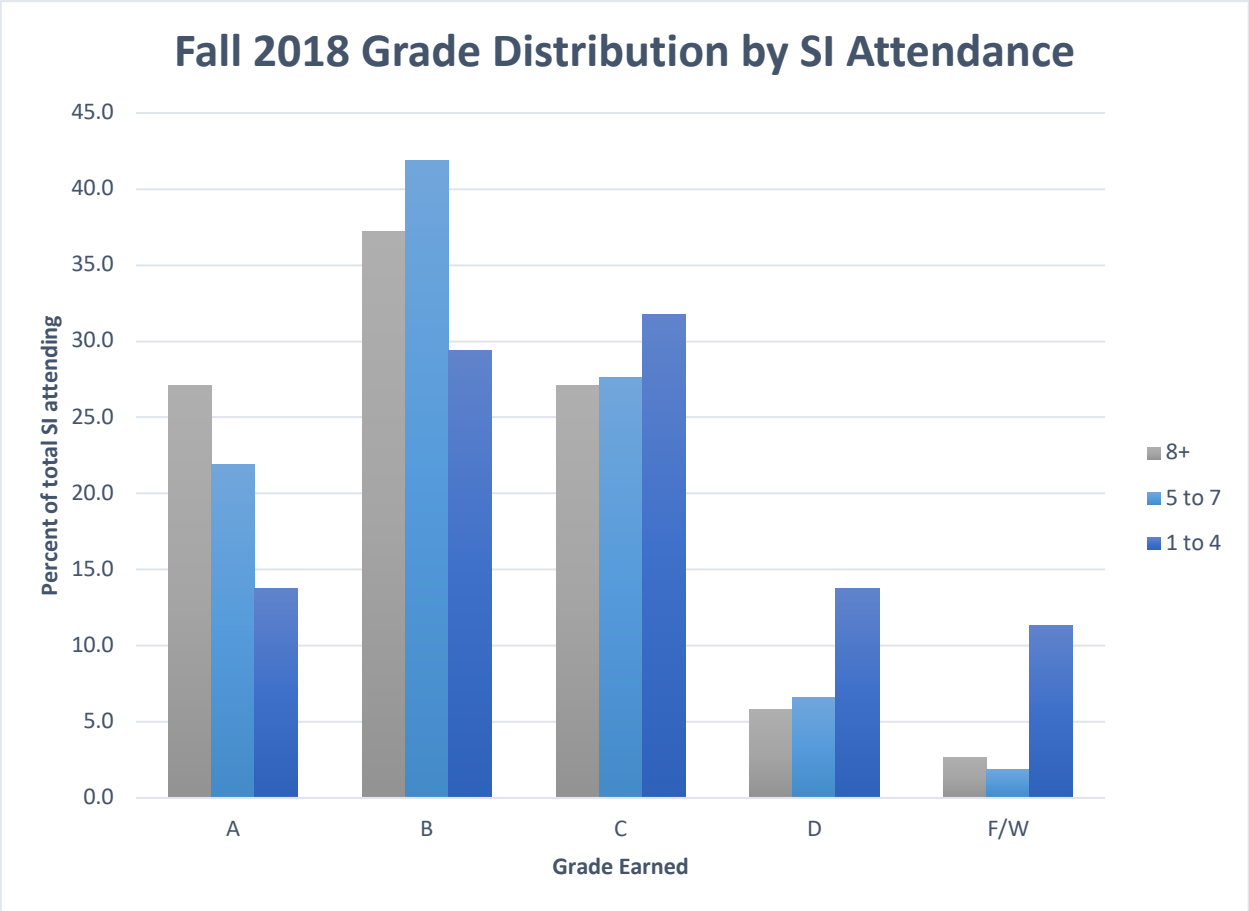

Figure 5: Grade earned distributions for SI group based on number of SI sessions attended for Fall 2018

Table 5 shows the data from the distributions in Figure 4 and Figure 5. A chi squared test was run on data between the years for each participation level. A p-value of 0.985 was calculated from the chi squared test on the Fall 2019 and Fall 2018 8+ sessions attended grade distributions, which indicates those distributions were not statistically different. A p-value of 0.00084 was calculated from the chi squared test on the Fall 2019 and Fall 2018 5 to 7 sessions attended grade

distributions, which indicates those distributions were statistically different. Lastly, a p-value of 0.903 was calculated from the chi squared test on the Fall 2019 and Fall 2018 1 to 4 sessions attended grade distributions, which indicates those distributions were not statistically different.

Table 5: Grade earned distributions for SI group based on number of SI sessions attended for Fall 2019 and Fall 2018

SI Sessions Attended	Semester	A	B	C	D	F/W	p-value
8+	Fall 2019	28.0%	37.3%	24.9%	6.7%	3.1%	0.985
	Fall 2018	27.1%	37.2%	27.1%	5.9%	2.7%	
5 to 7	Fall 2019	19.8%	35.5%	27.3%	9.9%	7.4%	0.00084
	Fall 2018	21.9%	41.9%	27.6%	6.7%	1.9%	
1 to 4	Fall 2019	16.7%	27.0%	31.1%	14.9%	10.4%	0.903
	Fall 2018	13.7%	29.4%	31.8%	13.7%	11.4%	

At the end of each semester, students' complete optional surveys in which they reflect upon their LEAD (SI) experiences. These surveys contain a variety of questions in hopes of evaluating if the goals of LEAD tutoring are met. Information from two questions were extracted from all individual surveys and analyzed for Fall 2019 and Fall 2018. Those two questions were:

1. Do you feel that participating in LEAD Tutoring helped you improve your study skills for this particular course? (Question 16)
2. Do you feel that participating in LEAD sessions helped you gain self-confidence in the course? (Question 17)

In Fall 2019, a total of 191 students responded to the optional survey. When asked if LEAD helped to improve study skills for that particular course 76.4% of students answered "yes," with the remaining 23.6% answering "no" or "unsure". This is similar to results of the Fall 2018 survey where out of the total 208 respondents, 76.0% answered "yes" and 24.0% responded "no" or "unsure." This data is displayed in Figure 6 and Table 6.

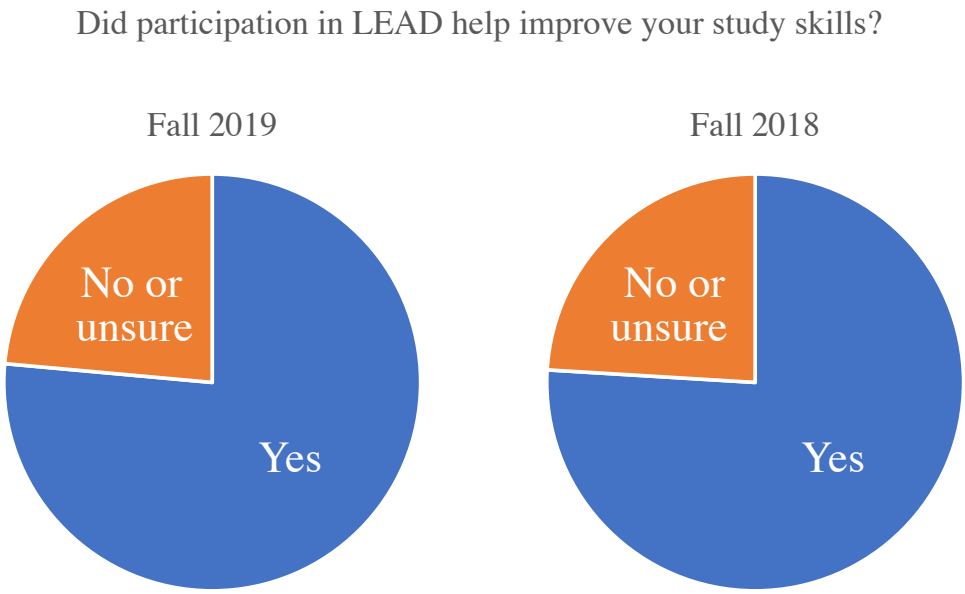

Figure 6: Responses to the question "Do you feel that participating in LEAD Tutoring helped you improve your study skills for this particular course?" for Fall 2019 and Fall 2018

Table 6: Responses to the question "Do you feel that participating in LEAD Tutoring helped you improve your study skills for this particular course?" for Fall 2019 and Fall 2018

	Fall 2019		Fall 2018	
	Raw Data	Percent of total	Raw Data	Percent of total
Yes	146	76.4%	158	76.0%
No/Unsure	45	23.6%	50	24.0%
Total Responses	191	100%	208	100%

When asked if LEAD helped to improve self-confidence for that particular course 73.8% of students answered "yes" and the remaining 26.1% answered "no" or "unsure" in Fall 2019. This is similar to results of the Fall 2018 survey where 75.0% of students answered "yes" and 25.0% responded "no" or "unsure." This data is displayed in Figure 7 and Table 7.

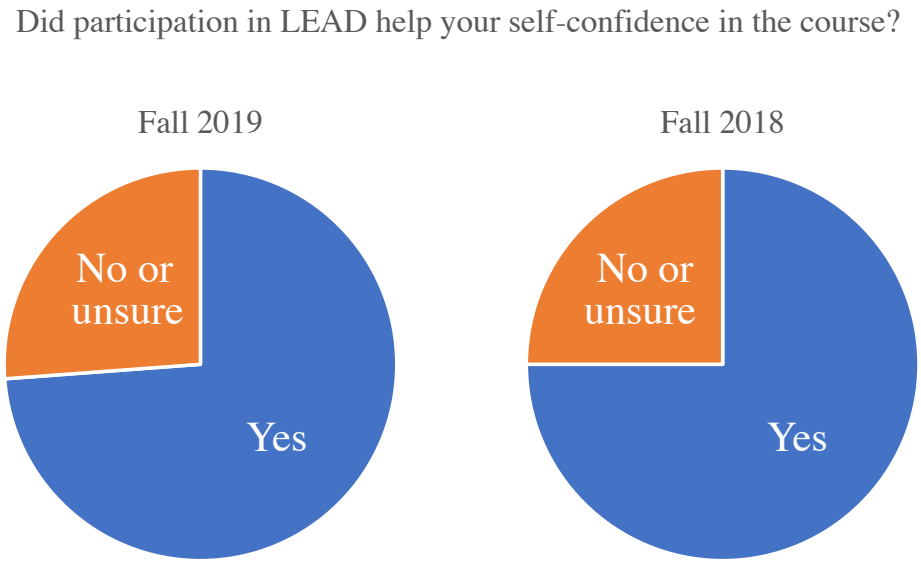

Figure 7: Responses to the question "Do you feel that participating in LEAD sessions helped you gain self-confidence in the course?" for Fall 2019 and Fall 2018

Table 7: Responses to the question "Do you feel that participating in LEAD sessions helped you gain self-confidence in the course?" for Fall 2019 and Fall 2018

	Fall 2019		Fall 2018	
	Raw Data	Percent of total	Raw Data	Percent of total
Yes	146	73.8%	156	75.0%
No/Unsure	45	26.1%	52	25.0%
Total Responses	191	100%	208	100%

ANALYSIS

Analysis of overall participation data shows that although overall students enrolled in a LEAD class did not change over the past four fall semesters, Fall 2019 visits had increased by 72.0%, tutoring hours had increased by 88.6%, and unduplicated headcount had increased by 32.9% from Fall 2018. This additional strain on tutors did not decrease the positive impact on average GPA points awarded, as there was a statistical difference between GPA points awarded for SI and non-SI students similar to results in Fall 2017 and Fall 2016. Moreover, Fall 2019 saw the largest increase in GPA points awarded of 0.54. Additionally, when analyzing the overall grade distributions including both SI and non-SI students, Fall 2019 was not statistically different from the overall grade distributions from previous semesters Fall 2018 and Fall 2017. Fall 2019 was determined to be statistically different from Fall 2016 data; however, fail and withdraw (F/W) data was underreported in that year calling into question the accuracy of the comparison of Fall 2019 and Fall 2016.

In further analysis of grade distributions, a statistical difference between the SI and non-SI grade distribution for Fall 2019 was determined. The bell curve for the SI grade distribution was shifted left toward the high grade (A/B) side of the graph. When the SI and non-SI grade distributions from previous semesters were analyzed, the SI and non-SI groups from Fall 2018 and Fall 2017 were not statistically different. A significant difference between the SI and non-SI groups was found for Fall 2016; however, this analysis is again affected by the underreporting of fail and withdraw (F/W) data discussed in the previous paragraph. This suggests that even though there was additional strain on the LEAD system, the SI grade distribution was more positively impacted than in previous years.

Grade distributions were also analyzed by the number of LEAD sessions attended, only taking into account those students who actually attended LEAD. Attendance was split into three levels (8+ sessions, 5 to 7 sessions, and 1 to 4 sessions) and analyzed for Fall 2019 and Fall 2018. When comparing the grade earned distribution for students who attended LEAD 8+ times to those who attended LEAD 1 to 4 times, a statistical difference was determined. The 8+ sessions attended distribution was shifted left toward the high grade (A/B) side of the spectrum in comparison to the 1 to 4 sessions attended distribution. The same statistical difference was determined for Fall 2018. Additionally, when comparing the 8+ sessions attended distributions for Fall 2019 and Fall 2018 there was no statistical difference. The same result was determined when comparing the 1 to 4 sessions attended distributions for Fall 2019 and Fall 2018. These resulted indicated no negative change across the years despite the increase strain. Overall, analysis of the grade distribution data by session participation indicates that repeated and consistent use of the LEAD tutoring services had the desired positive effect on grades.

Lastly the effect of LEAD tutoring on study skills and student confidence was analyzed across Fall 2019 and Fall 2018 from optional surveys sent out to students at the end of each semester. When asked the first question “Do you feel that participating in LEAD Tutoring helped you improve your study skills for this particular course?”, 76.4% answered “yes” and 23.6% answered “no” or “unsure” in Fall 2019. Results in Fall 2018 were similar with 76.0% answering “yes” and 24.0% answering “no” or “unsure.” When asked the second question “Do you feel that participating in LEAD sessions helped you gain self-confidence in the course?”, 73.8% answered “yes” and 26.1% answered “no” or “unsure” in Fall 2019. Results in Fall 2018 were similar with 75.0% answering “yes” and 25.0% answering “no” or “unsure.” These results indicate this

objective of the LEAD program to instill long-term skills was not negatively impacted by the increased strain in Fall 2019. There was not a statistical analysis run on survey results.

There are many interesting avenues for this research in the future. Completed fail/withdraw data would allow a more complete grade distribution analysis. Required student surveys would provide a better picture for understanding long-term impacts such as improved study skills and increased confidence in course materials. Lastly, it would be interesting to see how hosting LEAD tutoring sessions online would impact the tutor-to-student relationship, and thus grades. This is a change we will likely see moving forwards to increase accessibility and reduce in-person contact.

In considering all of the data analysis, it can be concluded that the additional strain put on the LEAD tutors and the LEAD tutoring program caused by the increased participation did not keep the program from achieving its goals of positively impacting student grades and increasing student study skills and confidence. Additionally, not only were UTS standards of service and goals for LEAD maintained, they were improved upon in the case of grades where Fall 2019 saw the greatest improvement on grades in recent history of the LEAD program.

CONCLUSION

At Appalachian State University, the LEAD tutoring program has been implemented in order to combat the traditional difficulties in teaching college-level chemistry. The LEAD program is based on the SI model and has been effective in increasing student grades and improving long-term attributes such as study skills and confidence levels. A significant difference between SI and non-SI groups was found for both average GPA awarded and between grade distributions. Fall 2019 found the largest GPA improvement between SI and non-SI

groups. A significant difference was found between the grade distributions of those who attended 8+ sessions and 1 to 4 sessions. Additionally, study skills and student confidence improvement data were consistent with previous years. Therefore, even with the increased strain on the LEAD program from a rapid increase in participation, these objectives are still being met and, in some cases, exceeded.

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